Bank Balance Sheets and Monetary Policy Transmission: The Impact of Negative Interest Rates on Household Deposits*

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Abstract

How do negative interest rates on household deposits impact bank balance sheets and the transmission of monetary policy? To explore this question, I perform a staggered difference-in-difference analysis using novel, self-collected data on household deposit rates from German banks and bank balance sheet data. I find that over 30% of German banks implemented a negative household deposit rate of -0.5% between May 2019 and April 2022. These banks experienced a 3% reduction of household deposits within twelve months, despite largely generous exemption limits. Banks that adopted negative rates significantly increased their lending activity. This demonstrates that the bank lending channel of monetary policy remains active under negative policy rates.

Keywords: Negative Interest Rates, Zero Lower Bound, Transmission of Monetary Policy
JEL Codes:

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I. Introduction

In the aftermath of the Global Financial Crisis, slow economic growth and inflation rates below target led central banks worldwide to implement accommodative monetary policy measures. As nominal interest rates approached the zero lower bound (ZLB), central banks resorted to unconventional policies. In several countries, these unconventional policies included setting one of the main policy rates to a level below zero. Denmark's central bank first introduced negative interest rate policy (NIRP) in 2012, Sweden and Switzerland followed suit. Among the world's major central banks, the European Central Bank and the Bank of Japan have resorted to NIRP over an extended period of time, while e.g. the Bank of England and the U.S. Federal Reserve never resorted to this measure. This reflects the lack of a consensus that NIRP is universally effective in steering economic activity and inflation.

One key aspect for the effectiveness of NIRP is the pass-through of negative policy rates to deposit rates. In a positive interest rate environment, policy rate cuts are largely transmitted to deposit rates, lowering banks' cost of funding, and thereby increasing bank net worth and lending (Kashyap and Stein, 2000; Jiménez et al., 2012; Kishan and Opiela, 2000). However, deposit rates may be downward sticky at zero, as customers can escape negative rates by moving to cash (Jobst and Lin, 2016; Heider, Saidi and Schepens, 2019).[1] If this is the case, and if the pass-through to loan rates is still intact, policy rate cuts below zero compress interest margins for banks. Reduced margins decrease bank profitability and may have a negative effect on lending, thereby reducing the effectiveness of monetary policy. To judge the effectiveness of NIRP, it is thus essential to understand to what extent banks (can) pass on negative rates to their depositors.

In a recent contribution, Altavilla et al. (2022) study the pass-through from policy rates to corporate deposit rates in the Euro Area. They show that firms which face negative deposit rates reduce their liquid asset holdings and invest more than comparable firms that do not face negative rates. Monetary policy transmission, they conclude, is not impaired when policy rates move into negative territory. However, as of today there is still little evidence on the pass-through of negative policy rates to deposits held by households. Given that household overnight deposits are twice as large as total corporate deposits in the Euro Area, concerns about the potential impairment of monetary transmission remain valid.[2] This is not diminished by the recent period of rising interest rates, as negative policy rates are likely to become an important policy tool again in the future, given the secular decline of the natural rate of interest (Holston, Laubach and Williams, 2017; Schmelzing, 2020).

In this paper, I shed light on the interplay of negative policy rates and overnight household deposit rates. I present descriptive and empirical evidence on the occurrence of negative house-

[1] In reality, the argument of a strictly binding zero lower bound is softened by storage costs of holding cash as well as preferences for deposits, such as making electronic transactions and safety.The negative nominal interest rate below which agents would withdraw all their funds in spite of these reasons has been termed the physical lower bound (Cœuré, 2016) or effective lower bound (Brandao-Marques et al., 2021).

[2] Deposits are the most important source of bank funding in the Euro Area, making up for nearly 60% of total bank assets in the Euro Area. Within this group, household overnight deposits constitute the largest fraction and are twice as large as total corporate deposits. See the following link to the ECB Data Portal https://data.ecb.europa.eu/main-figures/banks-balance-sheet/deposits or to the European Banking Federation https://www.ebf.eu/factsandfigures/ for more information.

hold deposit rates and their effects for bank balance sheets and the transmission of monetary policy. Thereby, I contribute to the existing literature in three ways.

First, I provide evidence that the zero lower bound on interest rates on household deposits is not as binding as generally believed. For this purpose, I compile a novel data set of German banks which shows that between May 2019 and April 2022 more than 30% of German banks introduced negative interest rates of -0.5% on overnight household deposits. The introduction of negative deposit rates was complemented by exemption limits only above which the negative remuneration applied.[3] Throughout the rest of this paper, these banks will be referred to as NIR-banks.

Second, I conduct an empirical analysis to study the effects of the introduction of negative household deposit rates on various balance sheet positions of these NIR-banks. Are household deposits of NIR-banks affected in a significant way? If yes, how? And is credit creation impaired? To address these questions, the novel data set on German NIR-banks is merged with balance sheet data and data on profit and loss accounts, provided by the Research Data and Service Centre (RDSC) of the Deutsche Bundesbank. To estimate the effects on banks' balance sheet positions, I use a difference-in-differences (DiD) analysis, for which treatment is defined as the staggered introduction of negative household deposit rates.[4]

The main result is that NIR-banks experience a reduction in their household deposits of up to 3% within twelve months of the adoption of negative household deposit rates. Considering the negative interest rate of -0.5% and the sizable exemption limits, this effect is substantial. The result suggests that a zero interest rate could be a focal point for households, and rate cuts below this rate might be particularly salient (Heider, Saidi and Schepens, 2021). Interestingly, according to anecdotal evidence obtained during the data collection process, the reduction in household deposits was desired by NIR-banks. Reducing deposits usually implied reducing excess reserves, which were remunerated at a negative rate during that time. This mitigated the pressure on bank profitability by reducing interest payments to the European Central Bank (ECB).[5]

Third, I provide evidence that lending of NIR-banks is positively affected following the adoption of negative deposit rates. Household loans increase by up to 2 % within twelve months after the adoption. To some extent, this finding is surprising because a decrease in the amount of loanable funds to banks is usually associated with a decrease in the supply of credit. However, besides reducing the amount of household deposits, increasing lending is another way for NIR-banks banks to reduce their excess reserve holdings at the central bank.

From the policymaker's perspective, the increase in household loans is encouraging since it

[3] 10 additional banks introduced fees instead of punitive interest payments on household deposit accounts, resulting in a factual negative remuneration. These have been excluded from the analysis because fees do not depend on the amount of funds held in these deposit accounts. As such, they are economically very different from interest rates.

[4] I employ estimation strategies by Borusyak, Jaravel and Spiess (2024) and Callaway and Sant'Anna (2021) which incorporate recent advancements in the theoretical DiD literature. These estimators address the challenges associated with two-way fixed effects (TWFE) regressions under staggered treatment and potentially time-varying treatment effects. (Goodman-Bacon, 2021; De Chaisemartin and d'Haultfoeuille, 2023; Athey and Imbens, 2022; Sun and Abraham, 2021)

[5] Moreover, the introduction of negative household deposit rates may deter potential customers, further reducing the pressure on bank profitability.

indicates that NIRP has a positive effect on lending to households after negative policy rates are (partially) passed-through to household deposit rates. This can be interpreted as a variant of the bank lending channel being operative. While the classical bank lending channel emphasizes the role of binding reserve requirements (e.g., Bernanke and Blinder (1988) and Kashyap and Stein (1994)), here the volume of excess reserves is at the center of the mechanism. Higher lending has a positive effect on bank profitability by reducing reserves in two ways. First, as soon as the funds from the loan are used to buy a property or undertake an investment, this directly leads to an outflow of reserves. Second, increasing lending enables banks to take part in the targeted longer term refinancing program at the ECB, called TLTRO-III during that time. Through this program, banks could borrow at a rate as low as -1%, making participation itself a profitable endeavor (Benetton and Fantino, 2021; Da Silva et al., 2021).

The evidence presented in this paper complements existing findings regarding the ramifications of negative policy rates (see, for instance, Demiralp, Eisenschmidt and Vlassopoulos, 2021; Basten and Mariathasan, 2023) and negative corporate deposit rates (Altavilla et al., 2022) by studying the effects of negative household deposit rates on banks' balance sheet positions and the transmission mechanism of monetary policy. Compared to previous contributions by Heider, Saidi and Schepens (2021) and Eisenshmidt and Smets (2019), I use self-collected data on the bank level instead of average overnight household deposit rates at the country level. Further, I extend the time horizon under investigation until the conclusion of NIRP in July 2022. This allows me to uncover dynamics that have not been considered up to this point, offering important implications for both current and future research on the topic of negative interest rates.

For example, numerous empirical studies rely on mechanisms that use the asymmetric adjustment of loan and deposit rates to negative nominal interest rates to rationalize their findings. In Molyneux, Reghezza and Xie (2019), the authors argue that sticky deposit rates are one of the reasons for compressed interest margins which in turn lead to eroding capital bases and eventually a fall in profits. Similar arguments can be found in Heider, Saidi and Schepens (2019) and Lopez, Rose and Spiegel (2020). Likewise, several theoretical papers use the zero lower bound on household deposit rates as an established assumption in their models (see e.g., Eggertsson et al., 2024; Ulate, 2021; Abadi, Brunnermeier and Koby, 2023). On the one hand, the findings of this paper challenge this assumption by showing that a sizable fraction of German banks set interest rates on household deposits below zero. On the other hand, the strong reaction of the amount of household deposits to a relatively small interest rate change supports the notion of an effective lower bound relatively close to the zero lower bound.

This paper also contributes to the literature on deposit pricing and the reaction of deposit volumes (Yankov, 2022; Driscoll and Judson, 2013; Egan, Hortaçsu and Matvos, 2017). Existing research shows that deposit rates typically adjust slowly and asymmetrically, responding more strongly to policy rate cuts than hikes. However, for household deposits the downward adjustment breaks down around the ZLB (Heider, Saidi and Schepens, 2019, 2021). I demonstrate that even in an environment of negative nominal interest rates, there remains some pass-through from policy rates to household deposit rates, with significant implications for deposit volumes.

This paper is also related to Drechsler, Savov and Schnabl (2017), who show that deposits flow out of the banking system if policy rates increase because the spread between policy and deposit rates increases. The mechanism is that deposits become less attractive relative to other forms of investments. In this paper, the spread between the deposit and policy rate decreases once deposit rates turn negative and, still, deposits flow out. Nevertheless, the results are still in line with Drechsler, Savov and Schnabl (2017) because lower deposit rates make deposits relatively less attractive. Further, Drechsler, Savov and Schnabl (2017) show that lending contracts if deposits flow out of the banking system because banks cannot costlessly replace the funding from these deposits. In this paper, lending of NIR-banks is positively affected because it has a positive effect on bank profitability through the reduction in excess reserves and participation in the TLTRO-III program.

The remainder of the paper is structured as follows. In Section 2, I describe the self-collected data set as well as the data provided by the RDSC. Then, I present a descriptive analysis, discussing the most important facts related to the occurrence of negative household deposit rates. In Section 3, I briefly discuss the empirical strategy before turning to the main results in relation to the introduction of negative household deposit rates.[6] At the end of this section, I present additional results. Section 4 addresses some issues concerning the robustness of the empirical analysis and Section 5 concludes.

II. Data and Descriptive Analysis

A. Data Sources and Terminology

The core element of the empirical analysis is a novel, self-collected data set which contains detailed information on banks that have introduced negative interest rates on overnight household deposits.

The basis for the data set on NIR-banks was collected from the price comparison websites Verivox and Biallo as well as newspaper articles. This rudimentary data set, which included only the names of NIR-banks, was amended with self-collected data that provided detailed information on these banks. This additional information consists of the rate of remuneration, the date of introduction as well as details on the exemption limits, above which the negative remuneration applied. At the conclusion of the collection process, I have been able to identify 483 banks that have introduced negative household deposit rates. After adjusting the sample for bank entry, exit and mergers during the sample period, 422 NIR-banks remain in the sample.[7]

In the final data set, the self-collected data is merged with data sets provided by the Research Data and Service Centre (RDSC) of the Deutsche Bundesbank. The data sets provided by the RDSC cover the universe of German banks and consist of the balance sheet statistics (BISTA), selected master data for monetary financial institutions (MaMFI) and the banks' profit and loss

[6] Parts of the methodology are based on very recent advancements in the difference-in-differences literature and, hence, deserve a more thorough explanation. This is provided in Appendix A.

[7] For the empirical analysis, further banks with missing observations of key variables are dropped from the sample. At the end of this section, I show that the sample of NIR-banks for which the date of introduction has successfully been collected is representative of all NIR-banks along the dimensions of bank size and deposit intensity.

accounts (GuV).[8] The final data set has monthly frequency and runs from May 2018 to June 2022. Variables are recorded in units of €1000. Additional information on the data collection process and the data sources are provided in Section A of Appendix A.

Summary statistics for key balance sheet variables are provided in Table 1 in Appendix B for NIR-banks, non-NIR banks and both groups combined at the start and the end of the sample period. NIR-banks for which the date of introduction or key variables (e.g. deposits, loans, savings) are missing are excluded from the table. All variables exhibit right-skewed distributions, with means notably higher than medians. For instance, the mean bank size, measured by its total assets, is approximately €5.4 billion — almost five times the median and double the 75th percentile. While this example is extreme, the pattern holds across variables. On average, NIR-banks are larger, more deposit-intensive, and issue more loans, driven by the fact that most large German banks have adopted negative household deposit rates.

Concerning the terminology, the term 'deposits', which is used throughout this paper, refers to the banking products of a 'Girokonto' or 'Tagesgeldkonto'. These are the German equivalent to a current, checking or deposit account. To be more precise, a 'Girokonto' is defined as an account with the main purpose of accommodating any transaction within the payment system. Funds on this account are readily available without any period of notice, but it typically pays less interest than other banking products. The 'Tagesgeldkonto' has to be connected to a deposit account and funds can be instantaneously transferred from one account to the other. However, the 'Tagesgeldkonto' itself is not integrated in the payment system and, hence, cannot be used for payment transactions. As such, this account is intended as a simple and flexible savings account without any agreed upon maturity, paying a slightly higher interest rate than an ordinary deposit account in normal times. Negative interest rates for households were introduced primarily for the 'Girokonto', but whenever a 'Tagesgeldkonto' was available the same rate of remuneration applied.

B. Descriptive Analysis

Interest rates on household deposits in the Euro Area declined steadily until they became very low in 2018 and nearly hit the zero lower bound. This can be seen in Figure 1, which depicts the interest rate for the total outstanding amount of overnight household deposits reported by all monetary financial institutions (MFI) in the Euro Area and Germany. Average household deposit rates in the Euro Area never turned negative during the whole time period of NIRP, and only did so in Germany in May 2021.

This explains why early contributions on the implications of negative interest rate policy, such as Jobst and Lin (2016) and Heider, Saidi and Schepens (2019) have not found any evidence for negative interest rates on overnight household deposits. Given that They focused on Euro Area aggregates and did not cover the whole timer period of NIRP until July 2022, there simply was not much to find.

To truly challenge the notion of a binding zero lower bound on household deposit rates, one has to look beyond (supra)national averages - at the bank-level. For this purpose, I have

[8] For the BISTA, see Bundesbank (2023*a*). For the MaMFI, see Bundesbank (2023*c*) and For the GuV, see Bundesbank (2023*d*).

collected a data set on German banks that have introduced negative interest rates on household deposits. These NIR-banks have uniformly adopted an interest rate of -0.5%, which was equal to the deposit facility rate in effect during that time period.

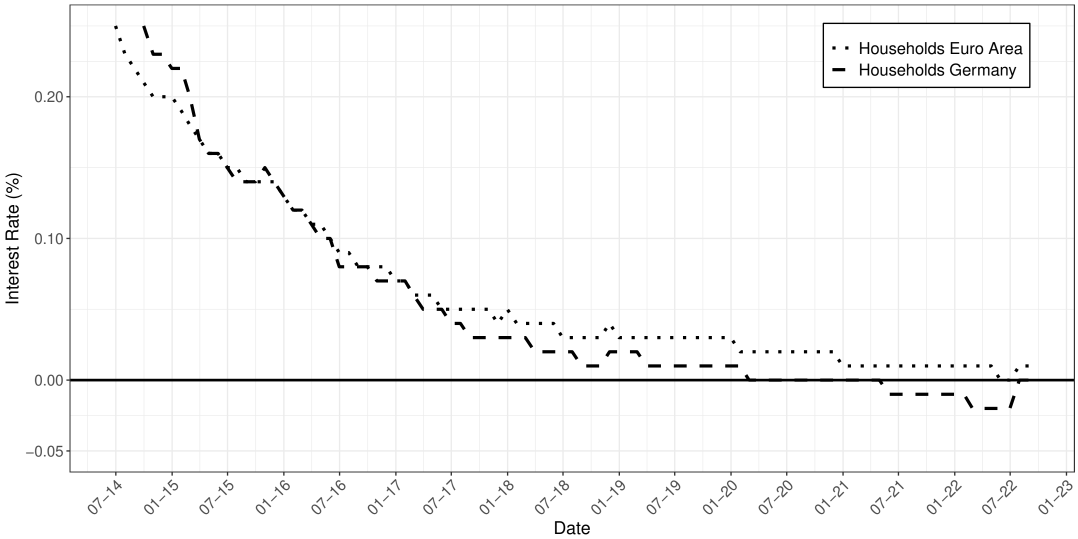

Figure 1: Household Deposit Rates for the Euro Area and Germany

Note: This figure depicts the interest rate on total outstanding overnight household deposits reported by MFIs in the Euro Area and Germany from June 2014 to August 2022. Own illustration. Data source: ECB Data Portal.

Figure 2 shows the distributions of NIR-banks across different bank types and geographical location. The left panel depicts the distribution of NIR-banks across the different types of banks. The majority of NIR-banks belongs to the second and third pillar of the German banking system, namely cooperative and public banks. These bank types are very prevalent in the German banking system and are characterized by their specific legal form.[9] Of the two categories, 399 out of 954 bank have introduced negative interest rates on household deposits. The category of 'Other Types' includes most notably big, regional and other commercial banks as well as state-owned banks. Out of the 236 banks in this category, only 23 have introduced negative deposit rates.

A potential mechanism explaining this finding is rooted in the structure of the German banking system. As shown by several studies and official banking statistics published by the OECD, the German banking system is on average less profitable than many of its international counterparts (Dombret, Gündüz and Rocholl, 2019). The main reason is the strong reliance on deposit financing of both credit cooperative and public banks. Considering the downward stickiness of deposit rates, these banks have a harder time passing on the costs related to excess liquidity holdings. Furthermore, these banks follow the so-called house bank principle, according to which profit maximization is not their primary objective (Harhoff and Körting, 1998). As a consequence, cooperative and public banks were disproportionately affected from persistent negative interest rate policy, which was exacerbated by an increase in excess liquidity in the banking system during the same time period. Eventually, this meant that it was primarily those banks that have introduced negative household deposit rates.

[9]More information on the different bank types and the German banking system can be found in Appendix A.

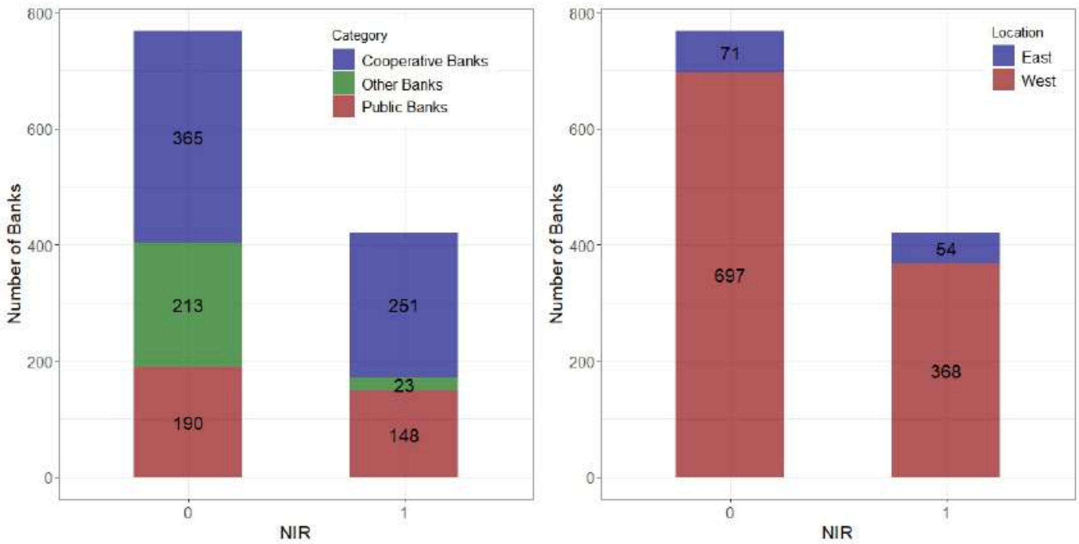

Figure 2: Distribution of NIR-Banks for Bank Type and East-West Location.

Note: This figure shows in the panel on the left the distribution of NIR-banks across bank types as recorded in the MaMFI data set. The panel on the right shows the distribution of NIR-banks across states in East and West Germany as recorded in the MaMFI data set. Own illustration. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

The right panel of Figure 2 shows that 368 NIR-banks are located in states belonging to former West Germany, while only 54 are located in states of former East Germany. However, relative to the total number of banks, more NIR-banks are located in East German states. While 43% of banks in former East Germany have introduced negative household deposit rates, this was only the case for 35% of banks in West German states. The location of a bank is determined by the location of its head office, as recorded in the official statistics of the Deutsche Bundesbank. The exact geographical distribution across states is depicted in Figure 15 in Appendix B.

While Figure 1 has shown that average overnight household deposit rates in Germany turned negative only in May 2021, the first individual bank has already adopted them as early as May 2019.[10] This is shown in the left panel of Figure 3, which depicts the number of banks that have introduced negative household deposit rates in each month during the sample period. The right panel depicts the cumulative number of banks that have introduced negative household deposit rates up to a certain month.

Three points are worth noting here. First, no NIR-bank has abolished negative household deposit rates before the end of June 2022.[11] This was shortly before the ECB ended its negative interest rate policy by increasing the main refinancing rate to 0.5% and the deposit facility rate to 0%. This is important for the empirical strategy because it makes treatment, defined as the introduction of negative household deposit rates, an absorbing state.

Second, it can be seen that there is no clear pattern in introduction dates over time. This indicates that no special event during the period under study led banks to introduce negative interest rates on household deposits at any specific point in time. Importantly, a legislative

[10] Three banks that have introduced negative household deposit rates in 2016 and 2017 have been dropped from the sample because it was not possible to confirm whether the date of introduction was correct.

[11] Abolishing negative household deposit rates means that the bank set the negative remuneration equal to 0% rather than removing them from the contract. The latter would have required the notification and approval of the customers, while the former could be done at the banks' discretion.

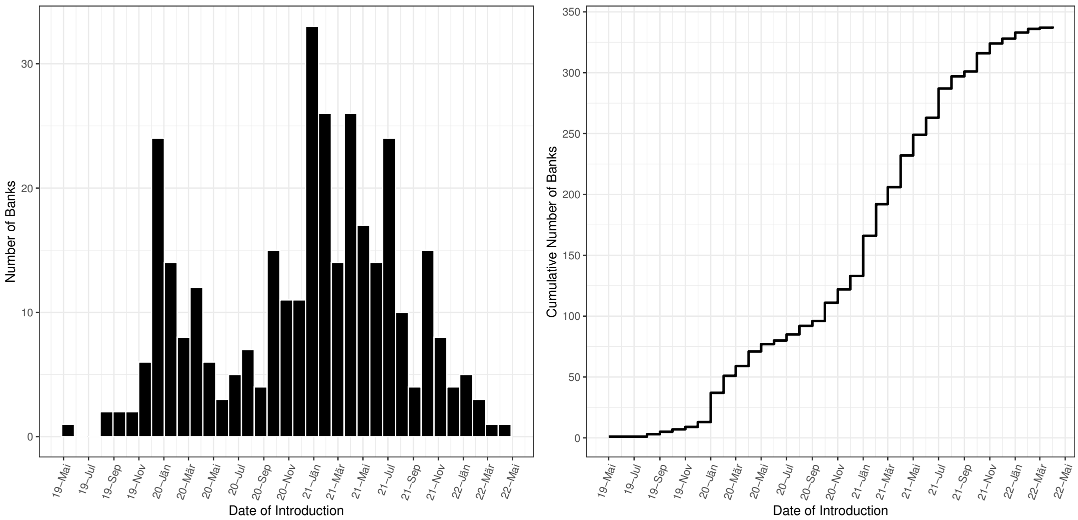

Figure 3: Date of the Introduction of Negative Household Deposit Rates.
Note: The left panel depicts the number of banks that have introduced negative household deposit rates in a given month. The right panel depicts the cumulative number of NIR-banks up to a given month. Own illustration. Data source: Self-collected data set.

change from April 2021, which forced banks to have changes in their terms and conditions being actively approved by their customers instead of only notifying them, had no visible effect.

Third, the majority of German NIR-banks have only started to introduce negative deposit rates for households in early 2020, more than five years after the ECB introduced negative policy rates. This is consistent with several contributions in the literature, such as Lopez, Rose and Spiegel (2020) and Heider, Saidi and Schepens (2019), who assert that, while negative policy rates initially had rather benign effects, their full impact might only unfold at a later stage.

In the right panel of Figure 3, it can also be seen that the introduction of negative household deposit rates plateaued in early 2022. This shows that the adoption slowed down towards the end of NIRP in the Euro Area. This can be explained by anecdotal evidence according to which banks anticipated the regime shift away from negative policy rates due to rising inflation rates in early 2022, caused by the war in Ukraine, ensuing supply chain disruptions and energy price spikes. These developments deterred banks from introducing negative household deposit rates from then onward.

As mentioned before, most NIR-banks have introduced exemption limits in tandem with negative household deposit rates, which implied that only funds held in excess of these limits have been subject to the negative interest rate.

The left panel of Figure 4 depicts data on these exemption limits, which has been successfully collected for 286 NIR-banks. If the exemption limit for a bank has changed over time, the average is depicted.[12] Overall, 24 banks have adjusted their exemption limits at least once, and nine banks have done so within the first twelve months after the introduction of negative household deposit rates.

Exemption limits are very dispersed and range from €0 to €500k, with the majority of NIR-banks setting limits up to and including €100k. 87 banks have introduced exemptions of

[12] Accounting for how long a specific exemption limit has been in effect for a given bank does not change the results in a meaningful way.

up to €25k, another 81 banks are in the bracket of up to €100k and 82 banks have introduced exemptions levels of exactly €100k.

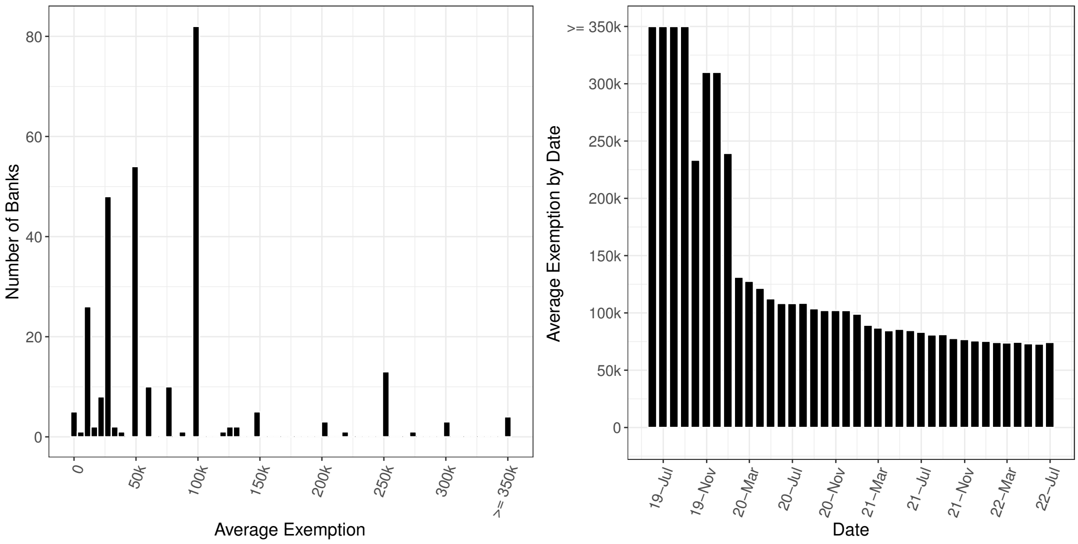

Figure 4: Average Exemption Limits of NIR-banks.

Note: The left panel depicts the number of banks that have introduced a given exemption limit. The right panel depicts the exemption limit averaged across all banks that have introduced negative household deposit rates up to the date depicted on the x-axis. Information on exemption limits is available for 286 banks. If a bank has changed the exemption limit over time, the average of the exemption limits is depicted here. Own Illustration. Data source: Self-collected data set, author's calculations.

To put the exemption limits into context, let us contrast them with a Bundesbank (2023*b*) report which includes findings from a survey on both financial and non-financial wealth holdings of German citizens conducted in 2021. According to this report, Germans hold on average €12.7k in their deposit account, with the average in East Germany (€9.5k) being substantially lower than in West Germany (€13.6k). Based on these figures, only 32 banks have introduced limits low enough to effectively affect the average German's financial wealth holdings in these accounts. Nevertheless, NIR-banks have experienced significant effects on deposit volumes following the introduction of negative deposit rates.

The right panel of Figure 4 depicts the average exemption limit over all NIR-banks that have introduced negative household deposit rates up to a certain point in time. The average exemption limit decreased from approximately €125k in early 2020 to around €75k in 2022. This suggests that banks became increasingly inclined to pass on the costs associated to negative interest rates by implementing more stringent policies.

To conclude the descriptive analysis, I show that the sample of NIR-banks, for which the date of the introduction has been successfully collected, is representative for all NIR-banks. This is important for the empirical analysis because it shows that the banks which were willing to cooperate with this study are not systematically different from non-cooperative ones. Out of the 483 NIR-banks that have been identified, the date of introduction has been successfully collected for 341.

I use quantile-quantile plots to compare distributions of the two groups at the start and the end of the sample period for two variables: bank size and deposit intensity. Each point in the plot represents the cutoff value of a given decile of the respective distribution, with points near the 45 degree line indicating similar distributions between the two groups. The results are depicted in Figure 5. It can be seen that the subset of NIR-banks for which the date of introduction has been successfully collected closely matches the full sample of German NIR-banks, supporting the representativeness of the sample on which the regressions are run.

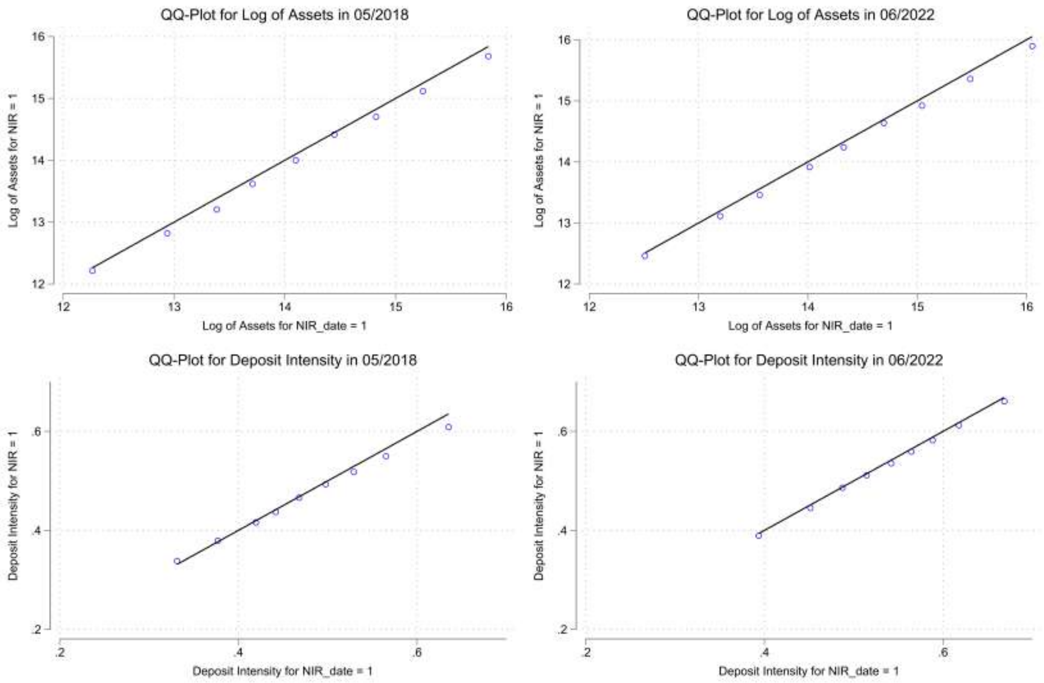

Figure 5: Quantile-Quantile Plots.

Note: This graph depicts quantile-quantile plots comparing bank Size (top panels) and deposit Intensity (bottom panels) for NIR-Banks with and without the date of introduction in 05/2018 and 06/2022. Own Illustration. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

III. Empirical Strategy and Results

A. Empirical Strategy

The main objective of this paper is to examine whether the adoption of negative interest rates on household deposits had an effect on various balance sheet positions of banks, most notably household deposits and loans. For this purpose, it is necessary to use a methodology that estimates a causal relationship between the introduction of negative household deposit rates and the dependent variable. In the empirical analysis, treatment is defined as the staggered introduction of negative household deposit rates by banks and modeled as a binary variable. Moreover, the introduction of negative household deposit rates is endogenous because, contrary to a change in policy rates, banks decide themselves whether to introduce these negative rates. In such a setting, the most commonly used method is difference-in-differences, which allows for a time-invariant bias from selecting into treatment (Roth et al., 2023).

Assuming that the timing of treatment is independent to bank-specific and time-specific fixed effects, treatment effects can be estimated in a DiD model. This model can be described by the following equation:

$$\mathbf{y_{i,t}} = \alpha_\mathbf{i} + \lambda_\mathbf{t} + \sum_{k=-K}^{-2} \beta_\mathbf{k}^\mathbf{lead} \mathbf{D_{i,t}^k} + \sum_{k=0}^{L} \beta_\mathbf{k}^\mathbf{lag} \mathbf{D_{i,t}^k} + \theta \mathbf{X_{i,t}} + \epsilon_\mathbf{i,t}, \tag{1}$$

where α_i and λ_t denote unit and time period fixed effects, $X_{i,t}$ are time-varying covariates and β_k^{lag} depicts the treatment effect k periods after treatment, while β_k^{lead} denotes pre-trends. Equation (1) is an event-study specification which can be estimated with ordinary least squares (OLS). This estimator is commonly referred to as the two-way fixed effects (TWFE) estimator.

This approach has been used in various scenarios, including settings with a single or multiple treatment periods as well as homogeneous or heterogeneous treatment effects. However, recent contributions have shown that estimators obtained by a TWFE regression specification are potentially biased in many of these cases (Goodman-Bacon, 2021; Sun and Abraham, 2021; De Chaisemartin and d'Haultfoeuille, 2023). The underlying reason for the arising biases is a problem of so-called 'bad comparisons' being included in the computation of the treatment effect, in which already treated units act as comparison units to later treated units. In this case, the difference between the effective comparison and later treated unit does not reflect the true treatment effect because the outcome change of the comparison unit over time itself might reflect a treatment effect.

I address the concerns associated with the TWFE estimator by applying diagnostic statistics proposed by Goodman-Bacon (2021) and De Chaisemartin and d'Haultfoeuille (2023). I show that the problems related to the TWFE estimator have limited relevance in the empirical analysis of this paper. According to the method by De Chaisemartin and d'Haultfoeuille (2023), no negative weights are used in the computation of the average treatment effect of the treated (ATT) under the TWFE specification. Further, for the data generating process to be compatible with an ATT equal to 0, treatment effect heterogeneity would need to be implausibly large. The diagnostic statistic by Goodman-Bacon (2021), which is graphically depicted in Figure 16 in Appendix B, yields a similar result. More than 90% of the weight in the computation of the ATT are attached to entirely good 2x2 comparisons, in which never treated banks are compared to treated ones. In addition, the ATT which uses timing groups as the control group, which also include 'bad comparisons', is very similar to the ATT computed with entirely good comparisons.[13]

Even though the diagnostic statistics suggest that the TWFE estimator is usable in the current study, I employ additional estimation strategies that are robust to the aforementioned issue of bad comparisons. To be more precise, the estimators by Callaway and Sant'Anna (2021), short *CS*, and Borusyak, Jaravel and Spiess (2024), short *BJS*, are chosen.

On top of allowing for dynamic and heterogeneous treatment effects, they allow for the incorporation of time-varying control variables to relax the unconditional parallel-trends assumption to a conditional one. This leads to the following key identifying assumption for this empirical study: conditional on unit and time fixed effects as well as observable control variables, changes in the amount of household deposits of banks that have not introduced negative household de-

[13] A recent paper by Chiu et al. (2023) finds that, even if the TWFE estimator is problematic from a theoretical point of view, its estimates are in many cases very similar to the ones obtained from more robust methods.

posit rates provide a good counterfactual for changes in the amount of deposits that would have been observed in NIR-banks absent of treatment.

In the current setting with household deposits (or subgroups of it) as the main outcome variable, loans are included as a time-varying control variable. The reason is that a change in loans also affects the amount of bank deposits from a balance sheet perspective. For example, comparing a treated bank that experiences an increase in lending to a bank in the control group that did not experience a comparable increase, implies a relatively stronger increase in the treated bank's deposits. Even if most of the newly created loans are used for various endeavors and are not kept at the bank, at least a small fraction of these loans will still be held as bank deposits. Consequently, comparing banks between the treatment and control group that follow different trajectories in their lending would result in estimating a treatment effect that may be potentially obscured by ensuing differential trends in deposits. Hence, the estimated treatment effects in the following analysis should be interpreted as the direct effect of the introduction of negative household deposit rates on the amount of household deposits.[14]

For a more thorough exposition of the empirical strategy, I refer the reader to Section C. of Appendix A, in which I discuss the results from the diagnostic statistics and the empirical strategy in more detail. In particular, I elaborate on the differences between the approaches by Callaway and Sant'Anna (2021) and Borusyak, Jaravel and Spiess (2024) and how these affect the suitability of the respective estimator for the current study. Most importantly, the aforementioned estimation strategies differ with respect to the incorporation of time-varying control variables and the definition of the parallel trends assumption.

In the following sections, all models are estimated using the natural logarithm of the outcome variable, which is originally expressed in units of €1000. Clustering is done at the bank level, the unit at which treatment is assigned.[15] Confidence intervals are at the 95% level.

B. Main Results

The main result of this paper is presented in Figure 6, which shows an event-study plot depicting the effect of the introduction of negative household deposit rates on the volume of household deposits of NIR-banks. Each point estimate can be interpreted as the average treatment effect across all NIR-banks k periods after treatment. Point estimates to the left of the vertical line are pre-trend coefficients, while point estimates to the right are treatment effects. The graph shows the result for each of the three estimation strategies discussed in the previous section. It can be seen that the estimated coefficients for all three estimation techniques are statistically significant across the entire time horizon under study. The coefficients for the pre-trends are not statistically different from zero, indicating that the parallel trend assumption holds for all three approaches.[16]

[14] In a sense, you can think of household loans as a mediator variable, that dampens the effect of the introduction of negative household deposit rates on the amount of household deposits if not controlled for.

[15] According to Bertrand, Duflo and Mullainathan (2004), the persistence in the treatment variable induces serial correlation in the error terms of the treated units, which should be adjusted for.

[16] Note that the pre-treatment estimates for the CS estimator are "short differences", i.e. comparisons between consecutive periods. On the other hand, pre-treatment estimates for the BJS and TWFE estimator are "long differences", i.e. comparisons between period t and the earliest available period. For a more in-depth explanation see Roth (2024).

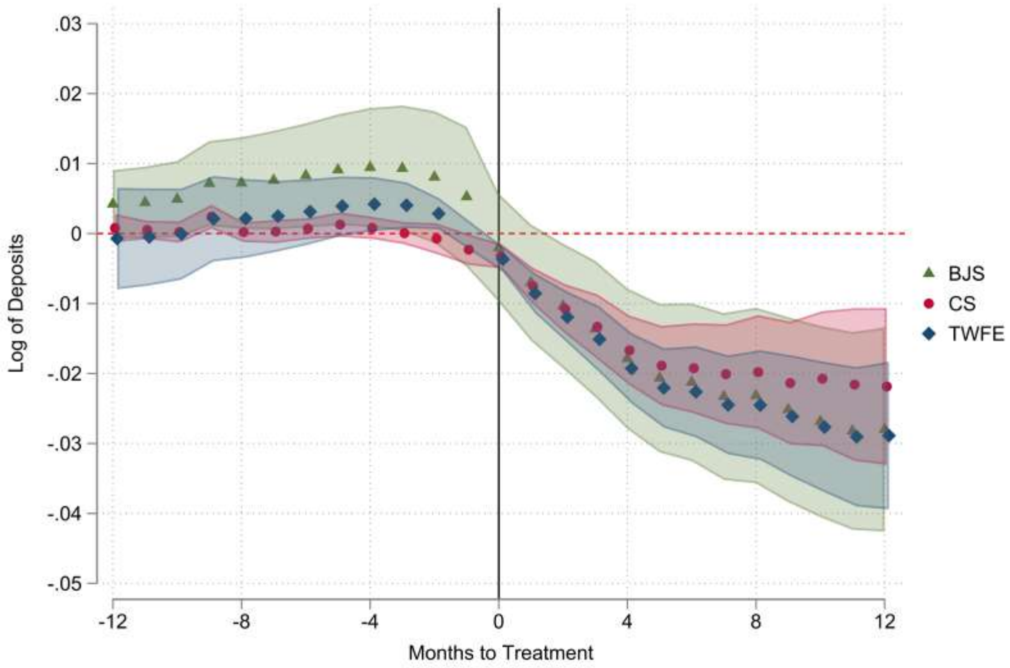

Figure 6: Event Study Plot of the Effect on Household Deposits.

Note: Figure 6 shows an event study plot for the introduction of negative household deposit rates on the volume of household deposits. BJS = Borusyak, Jaravel and Spiess (2024), CS = Callaway and Sant'Anna (2021), TWFE = two-way fixed effects. Own illustration. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

Household deposits of German NIR-banks decrease between 2%-3%, depending on the estimation strategy. It can be seen that the effect on deposits takes a few months to fully unfold, with the initial reduction being around 1%.[17] To put the estimated effects into perspective, the median NIR-bank in June 2022 held roughly €590 million in deposits from domestic households. Hence, a decrease of 3% implies a reduction of €17.7 million household deposits.

One potential explanation for the reduction in household deposits is higher substitutability of deposits for households opposed to firms or institutions. This argument emphasizes households' lower liquidity holdings and less-frequent needs to conduct large transactions, which should make it easier to substitute deposits for cash or savings deposits. Previously, this argument has been used in support of the relatively rigid lower bound on household deposits.

Another possible explanation is that rate cuts in negative territory are more salient than in positive territory, making a zero nominal interest rate a focal point Heider, Saidi and Schepens (2021). This is supported by the sizable exemption limits that have been introduced concurrently with negative interest rates on household deposits. Keep in mind that only 32 NIR-banks have set exemption limits low enough for the negative interest rate to materially affect the deposit holdings of the average German account holder. Alternatively, customers may have doubted the credibility of the exemption limits, expecting that they would increase in the near future.

To the best of my knowledge, there is no existing evidence of household deposit rate cuts in positive territory producing effects of comparable magnitude. This suggests that interest rate cuts in negative territory are differently perceived by households than rate cuts in a positive

[17]The event study estimates and the average treatment effect across all banks and time periods are depicted in Tables 3, 4 and 2 in Appendix B.

interest rate environment.

The similarity of the point estimates of the three estimation strategies can be interpreted as a first robustness check of the main result. This supports the evidence from the diagnostic statistics by De Chaisemartin and d'Haultfoeuille (2023) and Goodman-Bacon (2021) that the problems associated with the TWFE regression approach under staggered treatment adoption are not of major importance for the current study.

The second main result is related to the balance sheet item that plays a pivotal role for the transmission of monetary policy to the real economy - loans. Figure 7 depicts the reaction of household loans to the introduction of negative household deposit rates. Depending on the estimation strategy, household loans increase by 1%-2% within twelve months after the adoption of negative household deposit rates.[18]

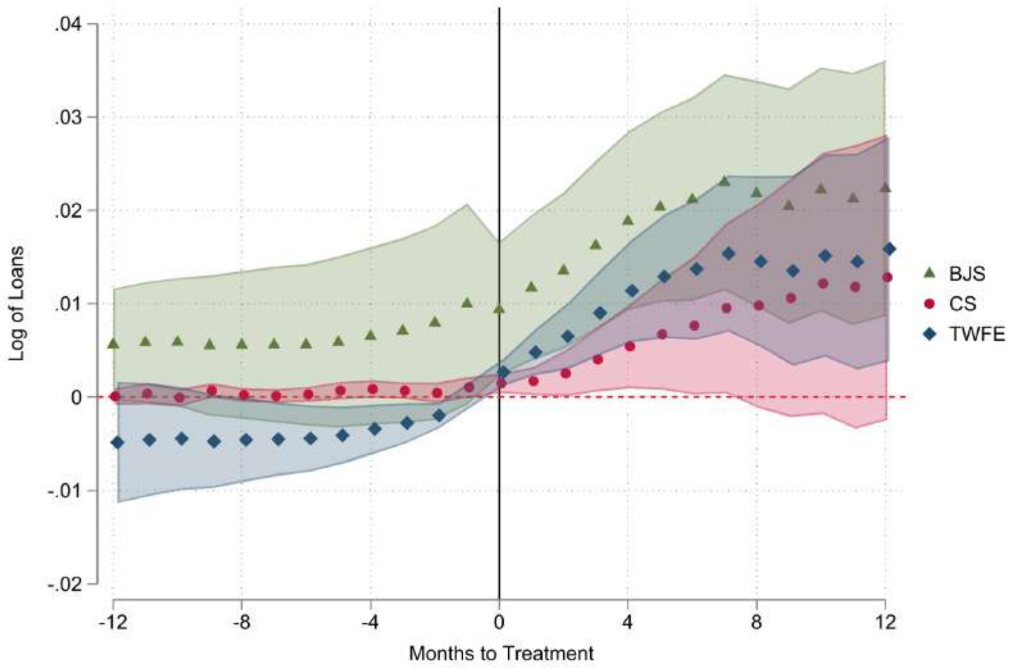

Figure 7: Event Study Plot of the Effect on Household Loans.

Note: This figure shows an event study plot of the introduction of negative household deposit rates on the amount of household loans. BJS = estimator by Borusyak, Jaravel and Spiess (2024), CS = estimator by Callaway and Sant'Anna (2021), TWFE = two-way fixed effects. Own illustration. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

Compared to the findings on household deposits, the results of the different estimation strategies are a bit more mixed, most likely due to less precise identification of the treatment effect. Importantly, the impact on household loans might not be solely attributable to the introduction of negative household deposit rates, but might also depend on some other factors. First, concurrent changes on the supply side, such as changes in loan conditions, cannot be excluded or controlled for due to a lack of data. Second, NIR-banks might have implemented additional measures to optimize their reserve holdings during the time period under study. One example is the third tranche of the ECB's targeted longer-term refinancing operation (TLTRO-III) pro-

[18]The event study estimates and the average treatment effect across all banks and time periods are depicted in Tables 3, 4 and 2 in Appendix B.

gram, which was active from June 2020 to June 2022. Through TLTRO-III, banks could access funding at rates as low as -1% if they surpassed a lending target related to loans to households and non-financial corporations.[19] If NIR-banks opted to introduce negative household deposit rates while also planning to participate in the TLTRO-III program, this would likely contribute to the observed increase in household loans.

Nevertheless, the staggered nature of the adoption of treatment and the statistical significance of the estimated effects across all three estimation strategies strongly indicate that there is indeed a concurrent positive effect on lending. To some extent, this finding might be surprising because a decrease in the amount of loanable funds to banks, due to the reduction in household deposits, is usually associated with a decrease in the supply of credit. However, a potential mechanism at work is that, besides reducing the amount of household deposits, increasing lending is another way for banks to reduce their excess reserve holdings at the central bank. Reducing these excess reserves, which were remunerated at a negative rate during that time, mitigates the pressure on profitability due a reduction of interest payments to the ECB.

From the policymaker's perspective, the increase in household loans is encouraging since it indicates that NIRP has a positive effect on lending to households after negative policy rates are (partially) passed through to household deposit rates. This can be interpreted as a variant of the bank lending channel being operative. While the classical bank lending channel emphasizes the role of binding reserve requirements (e.g., Bernanke and Blinder (1988) and Kashyap and Stein (1994)), here the volume of excess reserves is at the center of the mechanism. Up to now, the literature has considered this channel as muted given the downward stickiness of household deposit rates.

C. Additional Results

Household subsets. Figure 8 dissects the effects of the introduction of negative household deposit rates on household deposits by breaking down domestic households in three subcategories.[20] The first group of economically independent households comprises all self-employed individuals. The second group of employed households consists of all salary and wage earners, pensioners and unemployed people. The third group of other households includes housewives, infants, schoolchildren, students and individuals not disclosing their occupation.

The effects differ significantly across these subcategories. Deposits of self-employed households are reduced by up to 4% and deposits of employed households experience a reduction of roughly 2%. Contrarily, deposits of other households do not experience a statistically significant reduction. The results indicate that higher income earners and individuals in the active labor force are more responsive to the introduction of negative interest rates on household deposits.[21]

[19] For a comprehensive overview of the ECB's TLTRO programs, see Da Silva et al. (2021) and Benetton and Fantino (2021).

[20] The term household is a bit misleading here because it refers to the owner of a deposit account rather than an actual household. While these two can potentially coincide, they do not necessarily have to.

[21] According to Fritsch, Kritikos and Sorgner (2015), self-employed people in Germany earn on average more than employed ones. However, the earnings distribution of self employed exhibits greater variation.

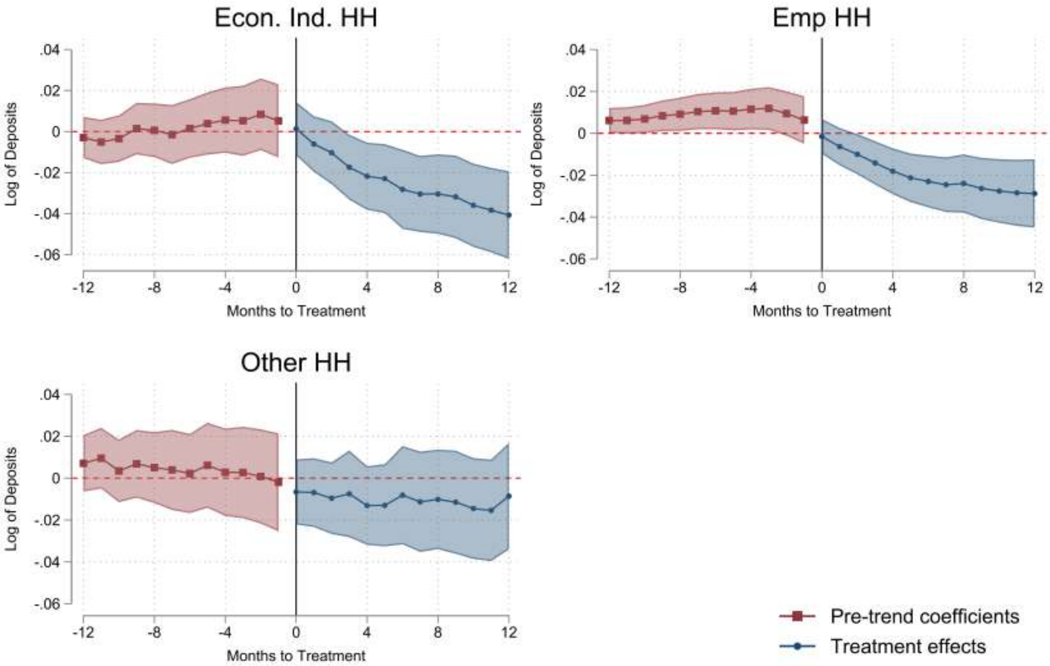

Figure 8: Event Study Plot of the Effect on Deposits of Subcategories of Domestic Households.

Note: Results for this graph are obtained with the BJS estimator. Own illustration. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

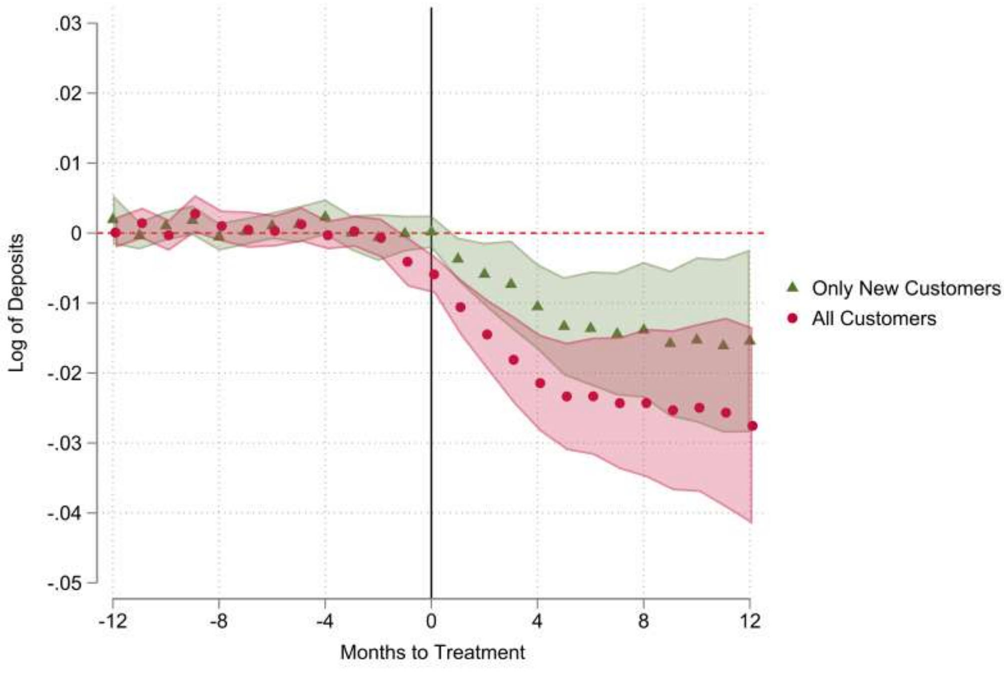

Figure 9: Event Study Plot of the Effects on Household Deposits for all vs. only new Customers.

Note: Results for this graph are obtained with the CS estimator. Own illustration. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

Only new vs. all customers. One facet of the adoption of negative household deposit rates that has not been discussed so far is that not all banks have introduced negative household deposit rates for all customers alike. While most banks have introduced them for all of their customers, some banks opted to introduce them only for new customers. For these banks, the aim of the policy was to deter new customers from potentially depositing with them rather than incentivizing existing ones to move their deposits. Figure 9 shows that, while all NIR-banks experienced a significant reduction in their household deposits after adopting negative household deposit rates, the effect was more pronounced for banks that introduced them for all of their customers. This is not surprising since it concurrently deters new customers and incentivizes existing ones to shift their funds.

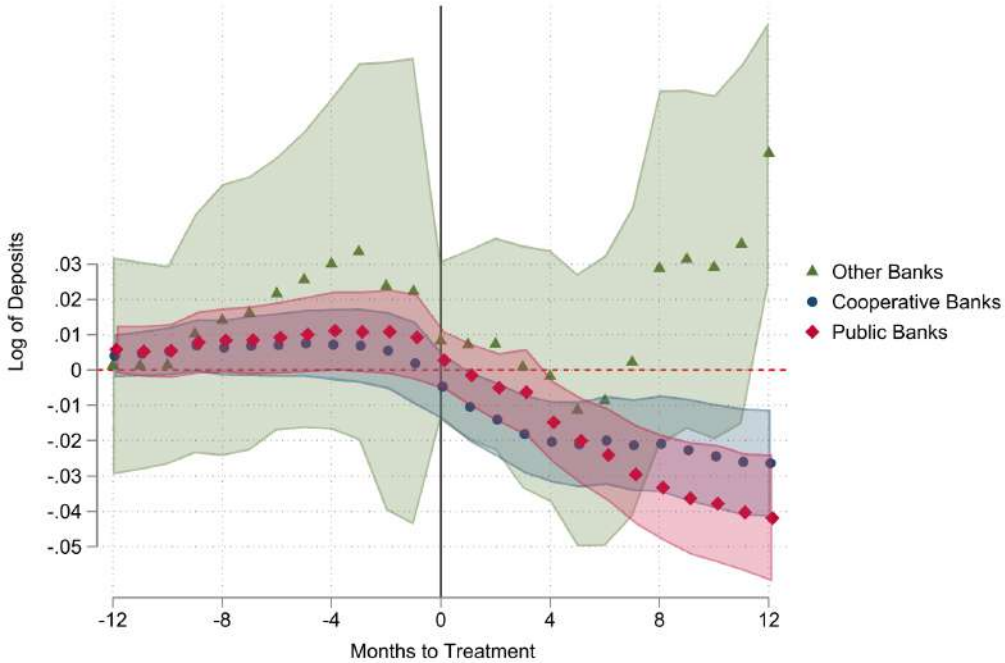

Figure 10: Event Study Plot of the Effects on Household Deposits by Bank Type.

Note: Results for this graph are obtained with the BJS estimator. Own illustration. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

Bank type. The type of bank also plays a role for the response of household deposits after the introduction of negative household deposit rates. Figure 10 depicts the treatment effects separately for public banks, termed as 'Sparkassen', cooperative banks and the group of other banks. While the reaction of household deposits for cooperative and public banks is negative, the group of other banks does not experience a reduction in their household deposits. The reason for the stronger effect on cooperative and public banks, besides the relatively small sample for the group of other banks, is most likely rooted in the structure of the German banking system. Cooperative and public banks are usually smaller banks that operate locally and have strong customer relationships. Furthermore, they follow the house-bank principle, rather than having profit maximization as their primary maxim. Consequently, these banks are disproportionately affected from persistent negative interest rate policy, making them more likely to introduce negative household deposit rates with potentially stricter conditions.

Exemption limits. Figure 11 shows that exemption limits play a role for the reaction of household deposits to the adoption of negative household deposit rates, even though the effect is more muted than one might expect. Treatment effects are very similar for all groups with exemption limits of up to €100k, with banks with exemptions between €26k and €50k experiencing a slightly stronger decline in their household deposits. Solely NIR-banks with exemption limits in excess of €100k do not experience a statistically significant reduction in household deposits.

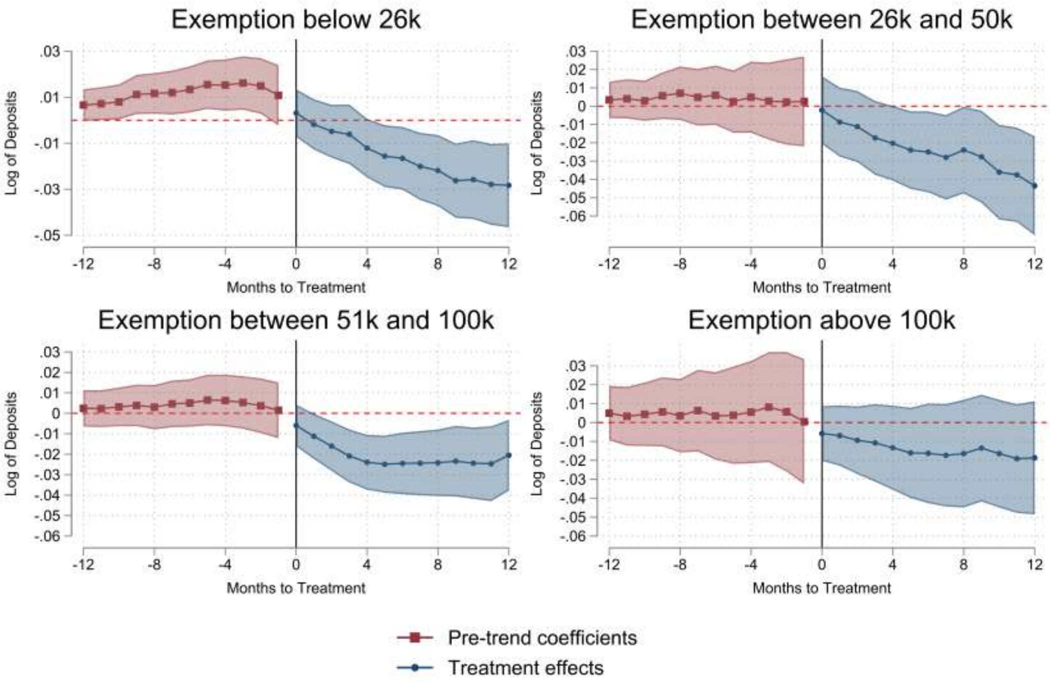

Figure 11: Event Study Plot of the Effects on Household Deposits by Exemption Limits.
Note: Results for this graph are obtained with the BJS estimator. Own illustration. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

Deposit intensity. Heider, Saidi and Schepens (2019) show that deposit intensive banks' net worth is relatively stronger adversely affected following the introduction of negative policy rates because their funding costs decrease less compared to less deposit-intensive banks. According to this finding, the introduction of negative household deposit rates should have a relatively stronger positive effect on lending for more deposit intensive banks. Figure 17 in Appendix B shows that this is indeed the case. Banks below the fifth decile, when ranked according to their deposit intensity, do not experience a statistically significant increase in lending, while banks above the fifth decile do.

Savings deposits. According to anecdotal evidence from the data collection process, banks tried to convince their customers to invest their funds elsewhere with the bank after introducing negative household deposit rates. Figure 18 in Appendix B depicts the effects of the introduction of negative household deposit rates on savings deposits. It can be seen that there is a statistically significantly positive effect on savings deposits from eight months after the treatment onward. This increase is driven by the group of employed households and by savings deposits with an agreed period of notice of three months.

Sample split. When the first banks started to adopt negative interest rates on household deposits in late 2019, it was sufficient to notify customers of the change in the terms of conditions of their deposit contracts. As a result of a legislative change, which became binding in April

2021 after a ruling of the German Federal Court of Justice, banks needed their customers' approval in order to charge negative interest rates on their deposits. I exploit this legislative change by splitting the sample in a way that treatment effects are estimated separately for NIR-banks that introduced negative household deposit rates before and after the ruling in April 2021. Figure 19 in Appendix B shows that banks, which introduced negative household deposit rates before April 2021, experienced a stronger reduction in their household deposits compared to later treated banks. One potential mechanism to rationalize this finding is that customers of banks introducing negative household deposit rates before April 2021 might have felt blindsided. Opposed to that, banks that adopted this policy after April 2021 had to contact their customers in advance, making it more likely that a solution has been found that made their customers keep some funds in their deposit accounts.

Intensive margin. So far, the estimated effects have focused on the extensive margin of the treatment, i.e. comparing banks that have introduced negative interest rates on household deposits to banks that have not. The collection of data on exemption limits also allows me to study the intensive margin of a differential increase of the exemption limit. However, these results should be interpreted with caution, since they require significantly stronger identifying assumptions. To be more precise, to compare treatment effects across banks with different exemption limits requires that bank A with a higher exemption limit would have experienced the same treatment effect as bank B with a lower limit if bank A would have adopted the same limit as bank B (Callaway, Goodman-Bacon and Sant'Anna, 2024). This assumption would be violated if banks deliberately introduced a certain exemption limit to optimize the reaction of their customers. In this case, the level of the exemption limit would be correlated with the treatment effect on the outcome variable.

Furthermore, the specific design of the current analysis limits the availability of suitable estimation techniques to study the intensive margin. I use the estimator proposed in De Chaisemartin and d'Haultfoeuille (2024), which allows for different treatment intensities that can monotonically change multiple times. This is important because some banks have lowered their exemption limits over time.

The treatment effects depicted in Figure 20 in Appendix B are non-normalized event study estimates, which can be interpreted as the average effect across all switchers that have experienced their actual treatment rather than their period zero treatment for the respective event study horizon.[22]

The average effect across all switchers is very similar to the estimates obtained in the main results section. This is most likely driven by the fact that the majority of NIR-banks has introduced negative household deposit rates once and has not changed its exemption limit afterwards. Hence, the average across all these banks is very similar to the baseline estimates.

[22]The definition of a switcher includes all banks that have changed their treatment at least once, including the initial adoption of negative household deposit rates by banks.

IV. Robustness

Regional disparities. One potential concern regarding the validity of the results is that they are driven by regional clusters in specific states. To alleviate these concerns, Figure 12 depicts the effect of the introduction of negative interest rates on household deposits, where each line represents an estimation in which one German state has been dropped from the sample (leave-one-out exercise).[23]. It can be seen that there is next to no variation in the treatment effects across the different samples, even though the geographical distribution of NIR-banks is quite unequal. This indicates that there are no regional differences in treatment effects that might cause any bias for the aggregate treatment effect. It has also been checked that treatment assignment is neither regionally clustered, nor by region-bank type.[24]

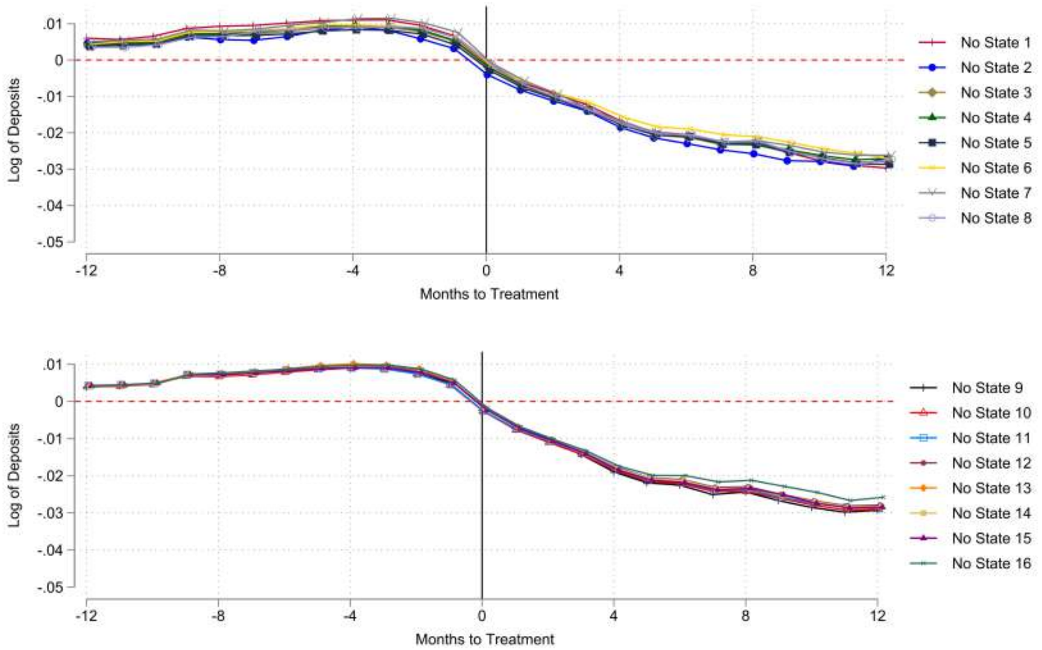

Figure 12: Leave One Out Exercise with States.

Note: This graph shows a leave-one.out exercise with states. Each regression line represents a regression to estimate treatment effects, leaving out one state each time. Results are obtained with the BJS estimator. Own illustration. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

Placebo tests. As an additional robustness check, I conduct a placebo exercise in which I use deposits of the domestic general government and foreign non-banks as outcome variables. Since negative interest rates have only been introduced on household deposits, these variables should have remained unaffected by the treatment. This rules out that time-varying factors, which would not have not been picked up by the fixed effects in the empirical analysis, are affecting the main results. Figure 13 shows that deposits of the domestic general government and foreign non-banks are indeed unaffected by the treatment.

[23]The confidence intervals are omitted for clarity

[24]An animated graph which shows the geographical distribution of NIR-banks by month of the introduction and bank type is available upon request. This animated graph shows no evidence of regional clustering.

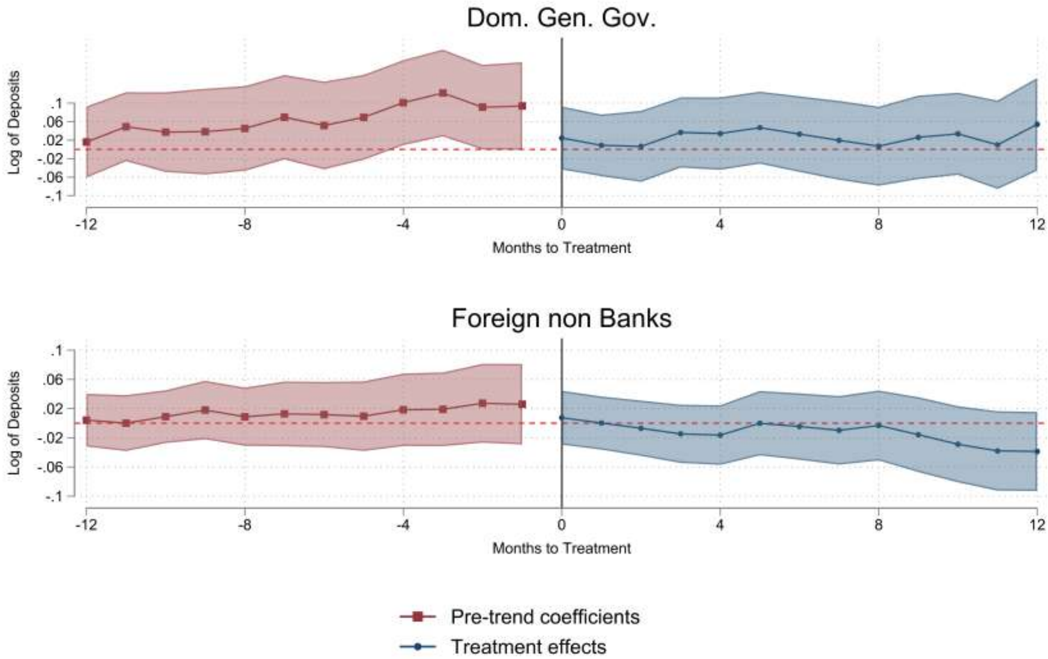

Figure 13: Event Study Plot of the Effects on Deposits of Domestic General Government and Foreign non-Banks.

Note: Results are obtained with the BJS estimator. Own illustration. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

Alternative control group. Another potential objection to the empirical analysis is that non-NIR-banks do not provide a suitable control group for NIR-banks. While these concerns have already been addressed by controlling for both time varying and invariant factors in the regression analysis, using only the not-yet treated NIR-banks as a control group is another approach to tackle this issue. This assumes that the evolution of household deposits of not-yet treated NIR-banks is better suited than that of non-NIR banks as a counterfactual for the evolution of the treated outcome variable. Figure 14 shows that the results of this exercise are qualitatively in line with the main results, supporting the suitability of non-NIR banks as a control group in the empirical analysis.[25]

[25] Both the pre-trend coefficients and the treatment effects are slightly more erratic than in Figure 6 due to the smaller sample size of the control group that consists only of not-yet treated NIR-banks.

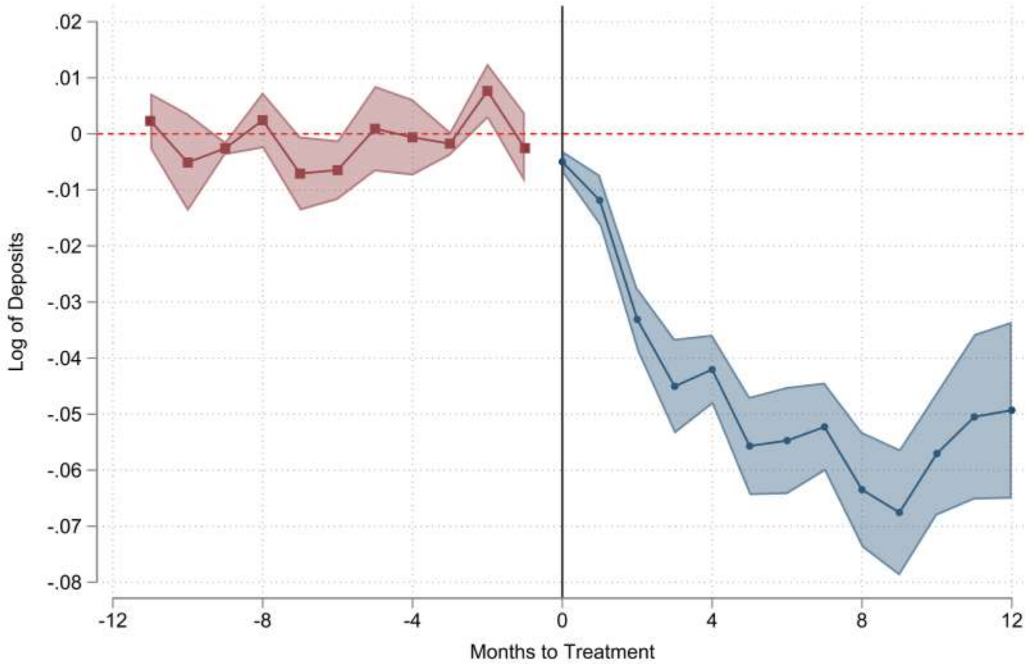

Figure 14: Event Study Plot of Effects on Household Deposits using only Not-Yet Treated Banks as Control Group.

Note: Results obtained withe CS estimator. Own illustration. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

V. Conclusion

In this paper, I present novel evidence on the occurrence of negative household deposit rates. Between May 2019 and April 2022, more than 30% of German banks have introduced negative interest rates of -0.5% on overnight household deposits. Concurrently, these banks introduced exemption limits, only above which the negative remuneration was applied. These limits are quite diverse, ranging from €0 to more than €500k.

Most of these NIR-banks are located in states in the Western part of Germany, while in relative terms more NIR-banks are located in the Eastern part of Germany. In terms of the bank type, the vast majority of NIR-banks belongs to the groups of cooperative or public banks, while only 23 NIR-banks belong to other types of banks such as big or private banks. This finding is rooted in the structure of the German banking system. It is characterized by a large number of cooperative and public banks, which are usually smaller, operate locally and exhibit a strong reliance on deposit funding. These banks were disproportionately affected by persistent negative policy rates and increased liquidity levels during the same time period. As a consequence, these banks resorted to negative household deposit rates more frequently than banks with a different business structure.

The empirical analysis conducted in this paper employs a staggered DiD approach, for which treatment is defined as the staggered introduction of negative household deposit rates. Recent advancements in the literature are incorporated into the analysis, including diagnostic statistics by De Chaisemartin and d'Haultfoeuille (2023) and Goodman-Bacon (2021) as well as new estimation strategies by Callaway and Sant'Anna (2021) and Borusyak, Jaravel and Spiess (2024).

The main result is that NIR-banks experience a reduction in their household deposits of up to 3% within twelve months of the adoption of negative household deposit rates. Considering the negative interest rate of -0.5% and the sizable exemption limits, this effect is substantial. The result suggests that a zero interest rate could be a focal point for households, and rate cuts below this rate might be particularly salient (Heider, Saidi and Schepens, 2021). Moreover, households' lower liquidity holdings and less-frequent needs to make large transactions should make it easier for them to substitute deposits for cash (see e.g., Brandao-Marques et al., 2021; Eisenshmidt and Smets, 2019). Reducing deposits usually implied reducing excess reserves, which were remunerated at a negative rate during that time. This mitigated the pressure on bank profitability by reducing interest payments to the ECB.

Furthermore, I show that lending is positively affected by the introduction of negative household deposit rates. Depending on the estimation technique, household loans increase by 1%-2%. One potential reason for this finding is that, besides reducing the amount of household deposits, increasing lending is another way for banks to reduce their excess reserve holdings at the central bank.

The positive effect on lending can be interpreted as evidence for an operative bank lending channel of monetary policy after banks decrease their household deposit rates below zero. Up to now, this channel has been considered as muted due to the perceived zero lower bound of household deposit rates. This finding complements already existing contributions on the implications of negative policy rates and negative corporate deposit rates for monetary policy.

Improving our understanding of the broader implications of negative household deposits is crucial for academics and policymakers alike. While this paper aims to provide a comprehensive study on the effects of negative household deposit rates, several important dimensions remain outside its scope and are left for future research. First and foremost, access to more granular data would allow to study questions related to household finance. For instance, what household characteristics drive the observed outcomes? Where do deposits end up precisely? Which households expand their loan portfolio in response to the treatment? Another promising route for further investigation involves examining the impact on bank profitability, potentially through a theoretical framework that explicitly models the partial pass-through of negative interest rate policy (NIRP) to household deposit rates.

1. Appendix A

A. Additional Information on the Data and Terminology

The self-collected data set is the core element for the empirical analysis conducted in this paper. It contains detailed information on banks that have introduced a negative remuneration on deposits held by households. The information on NIR-banks recorded in the self-collected data set consists of the name of the bank, the rate of remuneration, the date of introduction and abolition of negative deposit rates as well as details on the exemption limits, above which the negative remuneration applied.

The basis for the data set on NIR-banks was collected from the price comparison websites Verivox and Biallo, which kept a record of banks that have introduced negative deposit rates. For most of these banks, the interest rate and exemption limits were listed as well. While the information provided on interest rates was very accurate, this was not the case for the exemption limits. In many cases, information on these limits was incomplete or missing altogether.[26] This initial list of NIR-banks from the aforementioned websites was complemented with additional NIR-banks gathered from other websites and newspaper articles.

This rudimentary data set on NIR-banks was amended by self-collected data on the date of the first adoption of negative household deposit rates, the date of their abolishment and more details on exemption limits. The collection process for this additional data consisted of four main steps. In the first step, all available information was collected from the banks' websites. In most cases, the information was only available in the so-called 'Preisaushang' or 'Preis- und Leistungsverzeichnis', which are documents in which the bank lists prices and conditions for its products. Albeit these documents are the most comprehensive ones that are publicly available, in many cases information on the date of the first introduction of negative household deposit rates was missing. As a second step, all banks, for which no information was available on their websites, were contacted by mail. Then, all remaining banks, for which no information has been successfully collected yet, were contacted by phone. Last but not least, the so-called "Wayback Machine" was used to browse archived versions of banks' websites. All steps of the collection process were conducted in a standardized manner.[27]

In the end, data on the date of the first introduction of negative household deposit rates was successfully collected for 341 of 483 banks that have introduced them. Out of the missing 142 banks, 68 actively refused to cooperate, 48 were not able to provide a definite answer and 26 have not responded at all.

In the final data set, the self-collected data is merged with data sets provided by the Research Data and Service Centre (RDSC) of the Deutsche Bundesbank. The final data set has a monthly frequency and runs from May 2018 to June 2022. The data sets provided by the RDSC consist of the balance sheet statistics (BISTA), selected master data for monetary financial institutions

[26] Incompleteness could happen because several banks have changed their exemption limits over time, sometimes even more than once.

[27] The research interest and academic affiliation of the author was specified right at the beginning of any interaction. Afterwards, all banks received identical questions in both the mails and phone calls.

(MaMFI) and the banks' profit and loss accounts (GuV).[28] The BISTA is recorded at a monthly frequency and contains domestic banks' assets and liabilities based on the books at the end of the month. All balance sheet items are recorded at the bank, but not an individual level. The BISTA only records the domestic part of a bank's business, while the international activities of banks are excluded. The BISTA comprises of the main form and several annexes, in which balance sheet items are broken down by type, term, debtor and borrower sector.

The MaMFI contains information on the category to which a bank belongs, the type of institute, its location and some information on bank exit, mergers and acquisitions.

The GuV is recorded yearly and contains data on the income and expenditure of MFIs, including the evaluation of profits and losses calculated from the annual accounts as well as profit and loss statistics based on yearly averages from the BISTA. Opposed to the BISTA, the GuV also includes profits and losses generated from international business activities.

B. The German Banking System

The German banking system is built upon a so-called three pillar system, consisting of private banks, cooperative banks and public banks. Private banks are legally and economically independent and operate under the objective of profit maximization. Most notably, this sector comprises the biggest German banks as well as some regional and other commercial banks.

Cooperative banks are characterized by a special legal form, in which customers can acquire shares of the respective bank. Cooperative banks are usually smaller banks that operate regionally with the objective to support their customers in the best possible way. The biggest subgroup of cooperative banks are the 'Volks- und Raiffeisenbanken'.

Public banks, which represent the third pillar of the German banking system, are predominantly owned and financed by public entities, such as cities and other municipalities. They operate under the regional principle, according to which they only do business within the region of their ownership. Their activities are focused around the traditional banking services of taking deposits and providing loans. The most important subgroup of public banks are the Sparkassen, followed by Landesbanken.[29]

An important characteristic of the German banking system is the prevalence of the so-called house bank principle (Harhoff and Körting, 1998). This principle refers to the fact that, for many banks, profit maximization is not the primary objective. This is especially true for smaller banks and banks from the second and third pillar of the banking system. According to this principle, banks primary objective is to ensure the long-term financial success of their customers. This different focus results in a stronger relationship between banks and their customers, which has consequences for the banking system. It can either lead to more favorable borrowing and lending conditions even in dire economic circumstances, but also to more market power for banks. This can affect the reaction of a bank's customers following a policy change, such as

[28] More information on the data sets can be found here:
Monthly balance sheet statistics DOI: 10.12757/BBk.BISTA.99Q1-22Q4.01.01
Banks' profit and loss statements DOI: 10.12757/BBk.GuV.9922.01.01
Selected master data for MFIs DOI: 10.12757/BBk.MaMFI.199901-202212.01.01

[29] For a more in-depth analysis of the German banking system, see (Urbschat, 2018)

the introduction of negative deposit rates. Presumably, the stronger bank-customer relationship makes customers more lenient with respect to a change in conditions, increasing the likelihood of staying at the bank after the introduction of negative deposit rates. This alleviates concerns for local spillover effects in the estimation process later on. Additionally, anecdotal evidence obtained during the data collection process suggests that banks tried to convince customers to stay with the bank after the introduction of negative deposit rates. NIR-banks motivated their customers to invest their funds held in deposit accounts into other products with the same bank.

C. Additional Comments on the Empirical Strategy

This section gives a more detailed account of the estimation strategy. This section is self-contained, which has the advantage that the reader does not have to jump back and forth between the appendix and the main text. The downside is that some parts are repetitive compared to the main text.

Treatment in the empirical analysis is defined as the staggered introduction of negative household deposit rates by banks and modeled as a binary variable, taking on values of either zero or one.[30] In the current setting, treatment is an absorbing state, meaning that no bank that has introduced negative household deposit rates abolished them during the period of study. Moreover, the introduction of negative household deposit rates is endogenous because, contrary to a change in policy rates, banks decide themselves whether to introduce negative rates. In such a setting, the most commonly used method is difference-in-differences.

Assuming that the timing of treatment is independent to bank-specific and time-specific fixed effects, treatment effects can be estimated in a DiD model which can be described by the following equation:

$$y_{i,t} = \alpha_i + \lambda_t + \sum_{k=-K}^{-2} \beta_k^{lead} D_{i,t}^k + \sum_{k=0}^{L} \beta_k^{lag} D_{i,t}^k + \theta X_{i,t} + \epsilon_{i,t}, \tag{2}$$

where α_i and λ_t denote unit and time period fixed effects, $X_{i,t}$ are time-varying covariates and β_k^{lag} depicts the treatment effect k periods after treatment, while β_k^{lead} denotes pre-trends. Equation (1) is an event-study specification, which can be estimated with ordinary least squares (OLS). Its estimator is commonly referred to as the two-way fixed effects (TWFE) estimator.

This approach has been used in numerous cases, including settings with a single or multiple treatment periods, dynamic or static as well as homogeneous or heterogeneous treatment effects. However, recent contributions have shown that estimators obtained by a TWFE regression specification are potentially biased in many of these cases. For example, Goodman-Bacon (2021) shows that the static treatment effect obtained by a TWFE regression is not per se interpretable as the average treatment effect on the treated (ATT). Sun and Abraham (2021) and De Chaisemartin and d'Haultfoeuille (2023) show that the estimated treatment effect might be biased in a setting with staggered treatment and treatment effect heterogeneity, even if one allows for dynamic treatment effects, as in (1).

[30] Theoretically, the availability of data on exemption limits also allows for a continuous treatment design. However, in that case the sample would be significantly smaller since data on exemption limits has not been available for all NIR-banks for which the date of introduction was collected.

The underlying reason for the arising biases is a problem of so-called 'bad comparisons' being included in the computation of the treatment effect. To be more precise, treatment effects obtained by the TWFE regression approach are variance-weighted averages of many 2x2 DiDs, in which the average change in the outcome variable of treated units is compared to the average change in the outcome variable of untreated units. In the unproblematic 2x2s, units from the treatment and comparison group are compared before and after units from the treatment group receive treatment. However, there are also problematic cases included in the computation, in which already treated units act as comparison units to later treated units. In this case, the difference between the effective comparison and later treated unit does not reflect the true treatment effect because the outcome change of the comparison unit over time might itself reflect a treatment effect. The consequence is that the estimated ATT might be different from the true one. In the extreme case, one might estimate a statistically significant ATT, while the true effect is equal to zero or of opposite sign.

I address the concerns associated with the TWFE estimator in a setting with staggered treatment by applying diagnostic statistics proposed by Goodman-Bacon (2021) and De Chaisemartin and d'Haultfoeuille (2023). The latter method computes the number of negative weights attached to 2x2's in the estimation process and informs the researcher whether the true treatment effect is potentially zero or of opposite sign to the estimated one. According to this approach, no negative weights are used in the computation of the ATT by the TWFE specification in this analysis. For the data generating process to be compatible with an ATT equal to 0, the individual treatment effects would need to have a standard deviation of 0.0811. For the empirical analysis in this paper, this implies that treatment effect heterogeneity would need to be implausibly large for the true ATT to be equal to 0.

The diagnostic statistic by Goodman-Bacon (2021) yields similar results, showing that more than 90% of the weight in the computation of the ATT are attached to entirely good 2x2 comparisons, in which never treated banks are compared to treated ones. The 10% of the weight attached to timing groups, which also include bad comparisons of earlier vs. later treated units, exhibit an ATT which is very similar to the one computed by the other 90%. The results from this decomposition are depicted graphically in Figure 16 in the Appendix B.

The results from the diagnostic statistics indicate that the problems associated with the TWFE estimator do not seem to be of first-order importance for this empirical analysis. Nevertheless, bad comparisons are still assigned some weight in the estimation process of the TWFE estimator and warrant some attention. As a consequence, additional estimation strategies that are robust to this issue are applied. To be more precise, the estimators by Callaway and Sant'Anna (2021), short *CS*, and Borusyak, Jaravel and Spiess (2024), short *BJS*, are chosen. On top of allowing for dynamic and heterogeneous treatment effects in a setting with staggered adoption of treatment, they allow for the incorporation of control variables to relax the unconditional parallel-trends assumption to a conditional one. This leads to the following key identifying assumption for this empirical study: conditional on unit and time fixed effects as well as observable control variables, changes in the amount of household deposits of banks that have not introduced negative household deposit rates provide a good counterfactual for changes in the amount of deposits that would have been observed in NIR-banks absent of treatment.[31]

While both the CS and BJS estimator allow for the inclusion of time-varying control variables, they differ slightly in how they incorporate them. The CS estimator uses base period covariates, which means that they are kept constant in post-treatment periods at the value of the period prior to the one in which the treatment occurred. Opposed to that, the BJS estimator includes the whole time path of time-varying control variables, i.e. they are not kept constant in post-treatment periods. I have conducted a simulation exercise to test the differential treatment of time-varying covariates of the two estimation strategies. It is indeed the case that changes in post-treatment periods for time-varying covariates do not affect the CS estimator, while they change the estimated treatment effect of the BJS estimator.[32]

In the case that the control variables might be potentially affected by treatment, including time-varying control variables might lead to biased results. Caetano et al. (2022) show that in such a case, it is sufficient to condition on pre-treatment values of time-varying covariates if the covariates evolve similarly between treated and control units that have the same time-invariant covariates and the same pre-treatment time-varying covariates. Hence, if the researcher is not convinced by the exogeneity of the included control variables, the estimator by Callaway and Sant'Anna (2021) should be applied and results based on the BJS estimator should be interpreted with caution.

Additionally, the CS and BJS estimator differ in the strictness at which they make use of the conditional parallel trends assumption. CS only imposes only post-treatment parallel trends, while BJS imposes it for all groups and time periods. In other words, BJS uses the average of all pre-treatment periods as a comparison for the treated outcome, while CS only uses the last pre-treatment period (Roth et al., 2023). This difference comes with a trade-off. On the one hand, using all pre-treatment periods can increase efficiency (Wooldridge, 2021). On the other hand, if the (conditional) parallel trends assumption does not hold exactly, relying on a longer time horizon of pre-treatment observations increases a potential bias. Consequently, which estimator is preferable depends strongly on the application.

Based on the preceding discussion, both estimators are applicable from a theoretical standpoint, although the CS estimator is slightly preferable for two reasons. First, it is more robust with respect to potential endogeneity concerns related to the included control variables because it only includes base period values. Second, the weaker parallel trend assumption that is imposed in the estimation process of the CS estimator reduces a potential bias if this assumption does not hold exactly. Nevertheless, both the CS and BJS as well as the TWFE estimator are used to assess the robustness of the results. In all cases, the estimated treatment effects are very similar across the three strategies, indicating that the results are robust.

Since the estimators by Callaway and Sant'Anna (2021) and Borusyak, Jaravel and Spiess (2024) have only been recently proposed, they are discussed in a bit more detail. The CS estimator is build upon a particular disaggregation of the overall treatment effect, namely the

[31] After replacing household deposits by household loans, the same assumption holds for household loans as the dependent variable.

[32] If you are interested in the results of this simulation exercise, feel free to contact me.

group-time average treatment effect. The group-time average treatment effect is defined as the treatment effect for group g at time t, where a group is defined as a cohort of units first treated at time g. This effect is denoted in a potential outcomes framework by

$$ATT(g,t) = \mathbb{E}[Y_t(g) - Y_t(0)|G_g = 1].$$

The unit subscripts are omitted for clarity. $Y_t(g)$ denotes the actual outcome of units at time t, treated at time g, while $Y_t(0)$ denotes their potential outcome. The group-time effect parameters can then be used to compute more aggregated ones, for example event study parameters where group-time effects are aggregated for each event horizon e and weighted accordingly:

$$(3) \qquad \beta_{es}(e) = \sum_{g \in G} \underbrace{\mathbf{1}\{g+e \leq T\}\mathbf{1}\{t-g=e\}P\{G=g|G+e \leq T\}}_{w(g,t)} ATT(g, g+e)$$

Here, $\beta_{es}(1)$ is the average treatment effect across all groups g one time period after their respective treatment. The weight for each group and time horizon, $w(g,t)$, includes indicator functions that only consider identified group-time average treatment effects. The last component of the weight, given by $P\{G = g|G + e \leq T\}$, specifies the summation method. In this case, groups are weighted by their respective size.[33]

While the treatment effects in the dynamic TWFE specification are estimated by using OLS, Callaway and Sant'Anna (2021) show that the $ATT(g,t)$'s in their approach can be recovered by extending either an outcome regression procedure proposed by Heckman, Ichimura and Todd (1997) and Heckman et al. (1998), inverse probability weighting by Abadie (2005) or doubly robust estimands by Sant'Anna and Zhao (2020) to a framework with multiple groups and multiple time periods.

For the outcome regression approach to yield a consistent estimate for the ATT, the outcome model used to estimate the conditional expectation function of the evolution of the control group needs to be correctly specified. On the other hand, the inverse probability weighting approach relies on a correct specification of the propensity score, which is defined as the conditional probability of unit i belonging to the treatment group g, given its pre-treatment covariates X. The doubly robust estimation approach combines the two aforementioned approaches and requires either the outcome model of the conditional expectation function or the propensity score to be correctly specified. In this sense, the doubly robust estimation is more forgiving with respect to misspecifications. Due to these advantages compared to other estimation techniques, the results in this paper based on the CS estimator are computed using the doubly robust estimation technique. The estimator for the group-time ATT is given by

$$(4) \quad ATT^{ny}_{dr}(g,t;\delta) = \mathbb{E}\left[\left(\frac{G_g}{\mathbb{E}[G_g]} - \frac{\frac{P_{g,t+\delta}(X)(1-D_{t+\delta})(1-G_g)}{1-P_{g,t+\delta}(X)}}{\mathbb{E}\left[\frac{P_{g,t+\delta}(X)(1-D_{t+\delta})(1-G_g)}{1-P_{g,t+\delta}(X)}\right]}\right)\left(Y_t - Y_{g-\delta-1} - m^{ny}_{g,t,\delta}(X)\right)\right]$$

[33] With a staggered adoption of treatment, this aggregation method potentially suffers from compositional changes across event horizons unless one imposes very strong assumptions on treatment effect dynamics (Callaway and Sant'Anna, 2021). A potential solution is to only include balanced groups, i.e. only banks that have been treated e' periods. In the current setting, this is not very appealing because a significant fraction of the treatment group would be lost.

where $m^{ny}_{g,t,\delta}(X) = \mathbb{E}[Y_t - Y_{g-\delta-1}|X, D_{t+\delta} = 0, G_g = 0]$ is the population outcome regression using the not-yet treated as a control group. δ is the anticipation horizon, i.e. by how many periods units anticipate the treatment, and $P_{g,t+\delta}(X)$ denotes the propensity score for a given group and event horizon.[34]

The BJS estimator by Borusyak, Jaravel and Spiess (2024) belongs to the class of imputation estimators. The procedure for this estimator can be quite easily explained. In the first step, the outcome for non-treated units is estimated by a TWFE regression which includes only units and time periods that have not yet been treated: $Y_{i,t} = \alpha_i + \lambda_t + \theta X_{i,t} + \epsilon_{i,t}$. Then, the fitted values from this regression $(\hat{\alpha_i}, \hat{\lambda}_t, \hat{\theta}$ are used to impute the potential non-treated outcome for treated units, given by $\hat{Y}_{i,t}(0)$. The treatment effect for each treated unit can then be computed as the difference between the actual outcome and the potential non-treated outcome for treated units, $Y_{i,t}(1) - \hat{Y}_{i,t}(0)$, which can then be aggregated to obtain the estimands of interest.

In general, for the results from the different estimation techniques to yield consistent estimates of the true ATT, a few essential assumptions have to be satisfied. First of all, treatment has to be irreversible.[35] Secondly, it is assumed that the sample under study consists of i.i.d draws from a population. Thirdly, the overlap assumption states that there is a positive fraction of units receiving treatment in period g and that the conditional probability of belonging to the treatment group, given the observed covariates, is bounded away from one. In other words, this assumption rules out issues arising due to irregular identification.

Another important assumption is that there is no (or only limited) treatment anticipation.[36] This means that treatment in period t has no effect on the outcome variable prior to treatment. For the empirical study in this paper, this means that household deposits of NIR-banks must not have been affected by negative household deposit rates prior to their introduction. This is very likely to be satisfied because, while banks themselves have made the decision to introduce negative deposit rates, its the customers' reaction to the introduction which leads to a change in deposits. There is no indication that customers have reacted before the negative remuneration has been actually introduced.[37] From a theoretical point, both the CS and BJS estimator also hold under limited treatment anticipation as long as it is accounted for.

[34]In the current setting δ is assumed to be zero, i.e. there is no treatment anticipation.

[35]Some recent contributions show how to deal with reversible treatments. See e.g. Viviano and Bradic (2021) for incorporating sequential ignorability into economic analysis.

[36]In the case of no anticipation, $\delta = 0$ from Equation (3) in Appendix A.

[37]Before April 2021, customers only had to be notified after negative household deposit rates were introduced. After April 2021, banks had to inform their customers and wait for their approval before charging negative deposit rates. Nevertheless, there is no indication that customers would have had an incentive to shift their funds prior to the actual start of the negative remuneration.

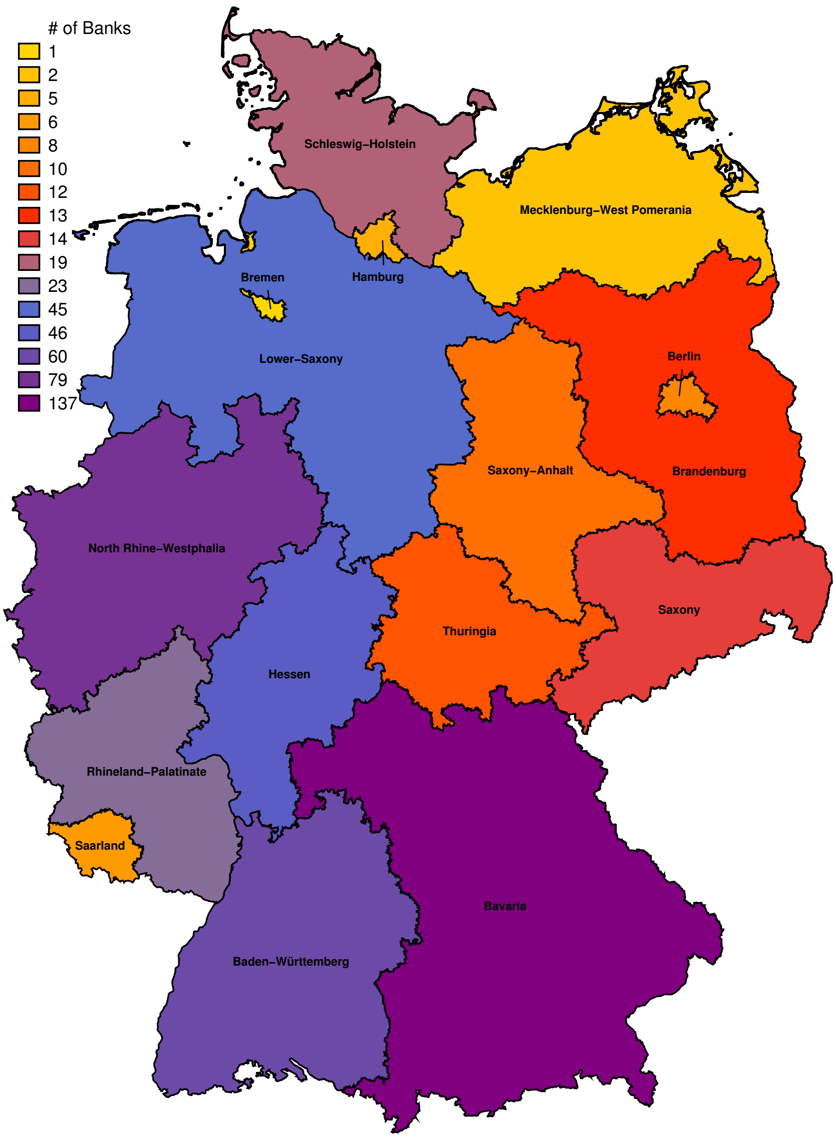

Figure 15: Geographical Distribution of NIR-Banks in Germany.

Note: This figure shows the geographical distribution of all NIR-banks in Germany, irrespective of whether the date of introduction was successfully collected. The location is determined based on the official location of a banks' headquarter. Own illustration. Data source: Self-collected data set.

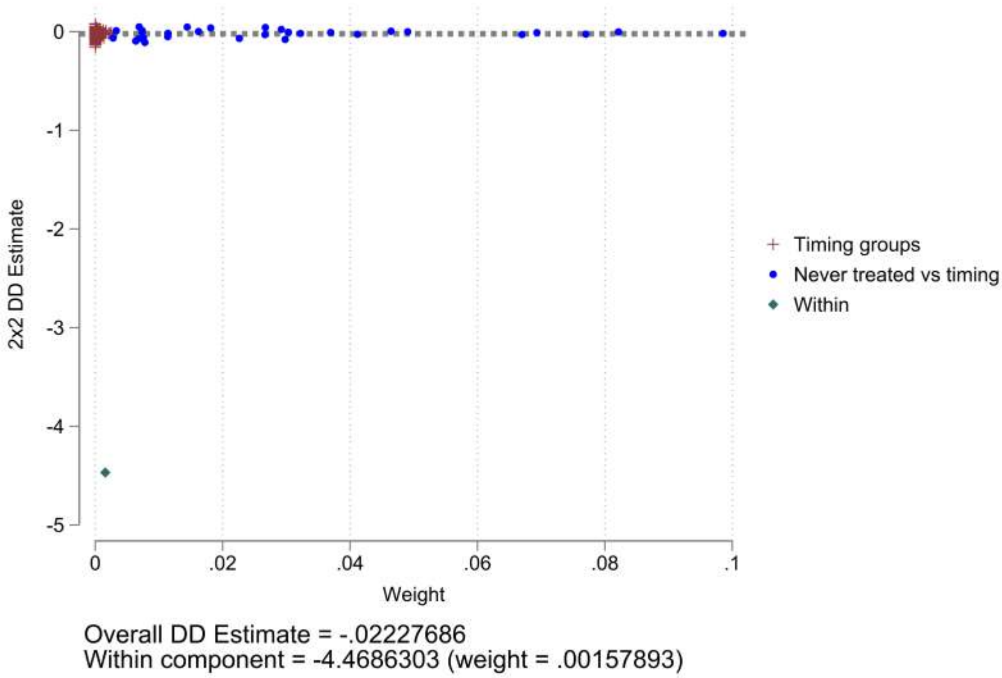

Figure 16: Graphical Representation of the Bacon Decomposition.

Note: 'Timing groups' refers to comparisons between earlier and later treated units. 'Never treated vs timing' refers to comparisons between never-treated and treated units. 'Within' refers to the within component of the estimator, which gives an idea about the variation due to the inclusion of control variables. Own Illustration. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

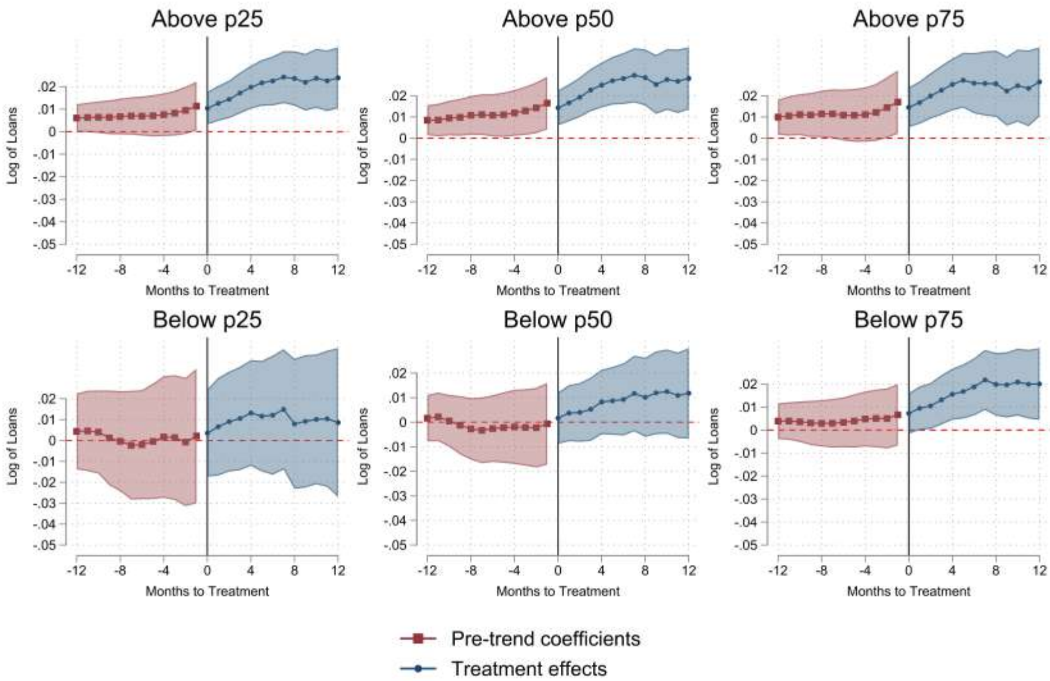

Figure 17: Event Study Plot of the Effects on Household Loans by Deposit Intensity.

Note: Deposit Intensity is defined as deposits over total assets. Results are obtained with the BJS estimator. Own illustration. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

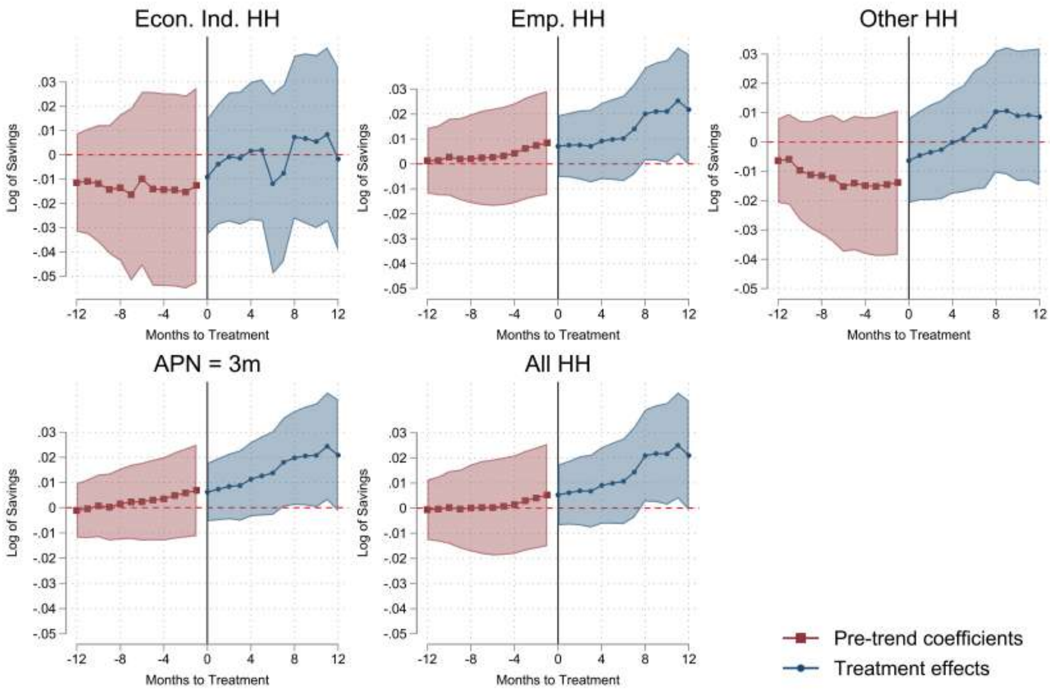

Figure 18: Event Study Plot of the Effects on Household Savings Deposits.

Note: Savings are broken down by household type and the agreed period of notice. Results are obtained with the BJS estimator. Own illustration. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

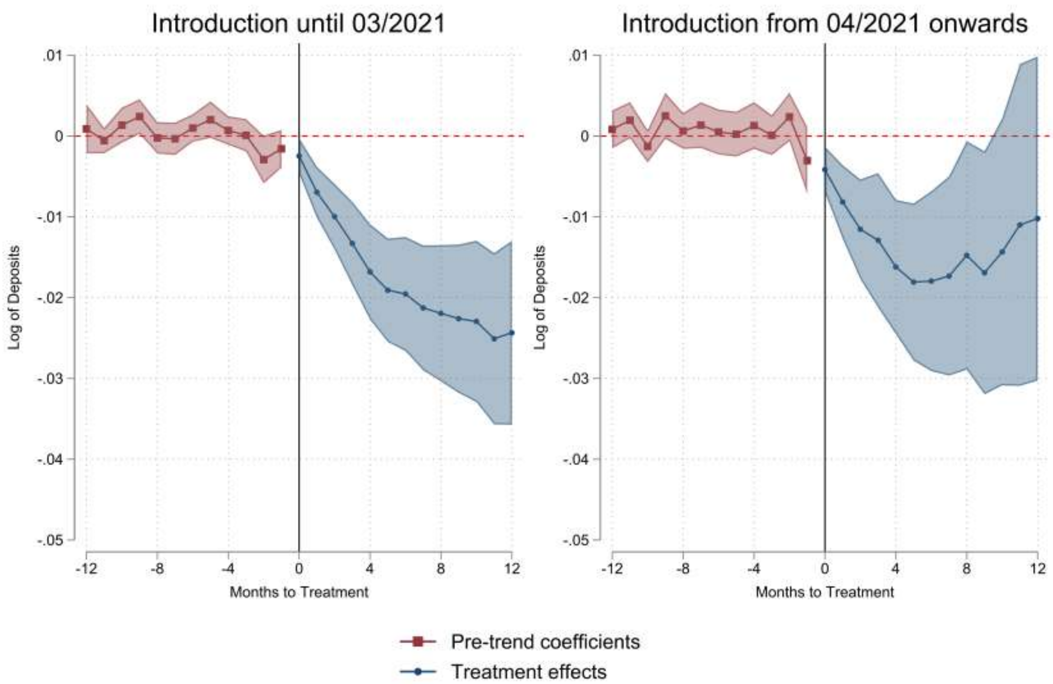

Figure 19: Event Study Plot of the Effects on Household Deposits with Sample Split.

Note: Results for this graph are obtained with the CS estimator. Own illustration. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

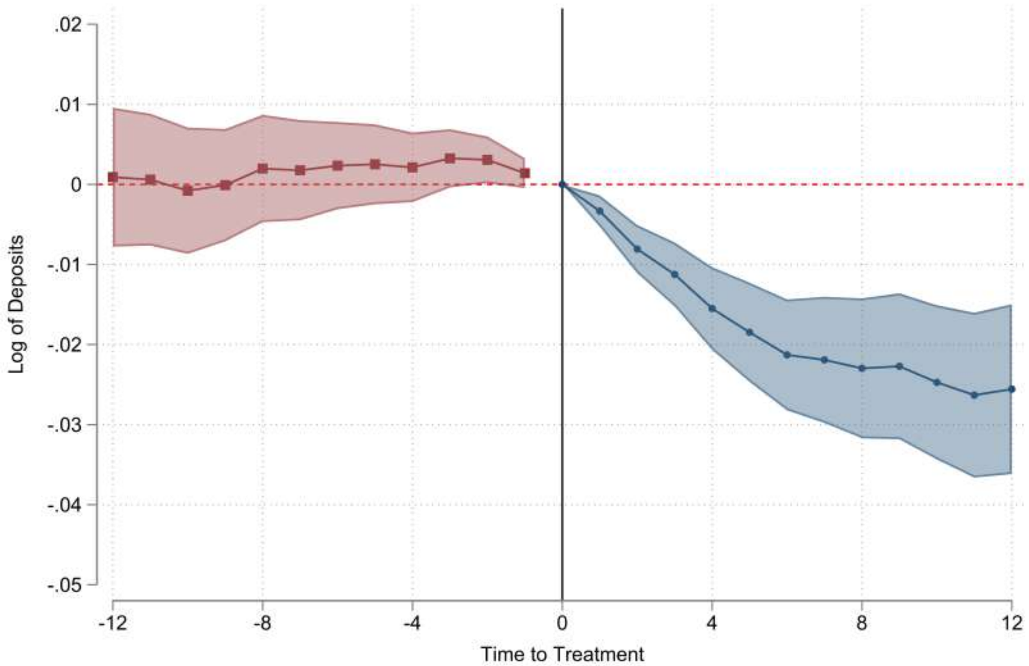

Figure 20: Event Study Plot of the Effects on Household Deposits at the Intensive Margin.

Note: The depicted coefficients are the non-normalized event study estimates as defined in De Chaisemartin and d'Haultfoeuille (2024). Own illustration. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

Table 1: Statistics For Bank Balance Sheet Variables

		05/2018						06/2022					
		N	*Mean*	*P25*	*P50*	*P75*	*SD*	*N*	*Mean*	*P25*	*P50*	*P75*	*SD*
NIR = 0	*Deposits (all dom. HH)*	627	441590	63776	196126	537044	813469	627	627800	97997	2785617	775707	1107072
	Deposits (econ. ind. HH)	626	71114	11043	34803	89236	103536	626	100573	17531	49165	133731	135175
	Deposits (emp. HH)	626	324098	45165	133069	381713	670467	626	472412	69186	204820	572777	928091
	Deposits (other HH)	627	47007	6188	15454	46092	126355	625	55907	7293	20254	56909	139353
	Deposits (gen. Gov.)	584	23306	1329	5446	21232	81405	584	33686	1592	6690	35704	66117
	Deposits (for. non-banks)	619	12894	481	1795	7278	83579	621	24532	576	2201	8511	220418
	Loans (all HH)	627	598039	98524	267321	707622	1247502	627	717109	125570	336157	897815	1298738
	Saving Deposits (all HH)	627	289975	46790	141737	375687	416611	627	276645	45530	131558	355521	396765
	Total Assets	627	1579397	208265	653071	1712560	3989032	627	1885403	271662	807678	2159761	3769763
NIR = 1	*Deposits (all dom. HH)*	283	1813683	175813	416646	1179250	7576178	283	2438751	254730	591152	1622184	8956252
	Deposits (econ. ind. HH)	283	315125	31333	75270	179764	1201430	283	424513	46063	105015	269149	1551336
	Deposits (emp. HH)	283	1250059	120458	294027	888521	4854204	283	1779532	174902	448695	1247821	6649780
	Deposits (other HH)	283	248499	14172	38364	111814	1912426	283	234706	17152	51378	133335	1177139
	Deposits (gen. Gov.)	272	65552	2755	10391	39658	317897	274	117307	3557	15815	62246	688441
	Deposits (for. non-banks)	283	97031	1194	4311	15892	959166	283	110821	1527	5179	19106	1025358
	Loans (all HH)	283	1659928	198290	538086	1380859	5469635	283	2033852	281710	673683	1757803	6741036
	Saving Deposits (all HH)	283	591029	96388	283773	713633	1049929	283	563672	93238	270062	663298	1063359
	Total Assets	283	5689574	491290	1331970	3425705	26197375	283	7848407	639526	1679469	4399526	40058664
Total	*Deposits (all dom. HH)*	910	868296	85094	258222	646355	4320457	910	1190986	126875	393834	914934	5141259
	Deposits (econ. ind. HH)	909	147082	14627	46121	107454	684434	909	201426	23085	65251	157563	884612
	Deposits (emp. HH)	909	612379	59565	181038	472563	2794919	909	879359	92274	282256	690529	3833146
	Deposits (other HH)	910	109669	7949	21992	63464	1074400	908	111634	9842	28276	76420	671601
	Deposits (gen. Gov.)	856	36730	1602	6974	24668	192191	858	60391	1904	8611	40783	394302
	Deposits (for. non-banks)	902	39292	632	2542	9296	542461	904	51545	801.5	3110	10948	602737
	Loans (all HH)	910	928275	117492	352740	832032	3254963	910	1126601	147496	450960	1034044	3953593
	Saving Deposits (all HH)	910	383600	56278	173993	436718	693508	910	365907	54648	179073	401817	690560
	Total Assets	910	2857617	272119	826650	1978017	15082922	910	3739832	347362	1077048	2542996	22698917

Deposits are defined in the BISTA as liabilities other than savings deposits- overnight money. Deposits are broken down into various subcategories, with the most relevant one for this paper being domestic households. Domestic households are again broken down into economically independent (self-employed), employed (wage and salary earners, including pensioners and unemployed) and other (housewives, infants, students etc.) households. Deposits (gen. Gov.) *depicts deposits held by the general government, while* Deposits (for. non-banks) *reports deposits held by foreign non-banks. These items will be used for robustness checks.*
Loans (all HH) *reports loans and advances of all domestic households and all maturities.* Saving Deposits (all HH) *reports savings deposits of all domestic households and all agreed period of notices.*
Note: The reporting universe comprises all domestic German banks (MFIs) with the status of deposit-taking institutions. The values, except for the number of banks, are reported in units of €1000, recorded by the end of the month and are rounded to the nearest integer.
Data Source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022 and 2023, author's calculations.

Table 2: Average Treatment Effect across all Banks and Time Periods.

	Deposits			Loans		
	CS	BJS	TWFE	CS	BJS	TWFE
Average Treatment Effect	-0.019	-0.026	-0.022	0.12	0.22	0.021
	(0.005)	(0.006)	(0.002)	(0.006)	(0.006)	(0.002)
Controls	✓	✓	✓	✓	✓	✓
Unit FE	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓
Observations	910	910	910	910	910	910

Note: Standard errors are clustered at the bank-level. Dependent variable in natural logarithm. BJS = estimator by Borusyak, Jaravel and Spiess (2024), CS = estimator by Callaway and Sant'Anna (2021), TWFE = two-way fixed effects. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

Table 3: Event Study Treatment Effects.

	Deposits			Loans		
	CS	BJS	TWFE	CS	BJS	TWFE
t=0	-0.003	-0.002	-0.004	0.001	0.009	0.003
	(0.001)	(0.004)	(0.001)	(0.001)	(0.004)	(0.001)
t=1	-0.008	-0.007	-0.009	0.002	0.012	0.005
	(0.001)	(0.004)	(0.001)	(0.001)	(0.004)	(0.001)
t=2	-0.011	-0.010	-0.012	0.003	0.014	0.007
	(0.002)	(0.005)	(0.002)	(0.001)	(0.004)	(0.002)
t=3	-0.013	-0.014	-0.015	0.004	0.016	0.009
	(0.002)	(0.005)	(0.002)	(0.002)	(0.005)	(0.002)
t=4	-0.017	-0.018	-0.019	0.005	0.019	0.011
	(0.003)	(0.005)	(0.003)	(0.002)	(0.005)	(0.003)
t=5	-0.019	-0.021	-0.022	0.007	0.020	0.013
	(0.003)	(0.006)	(0.003)	(0.003)	(0.005)	(0.003)
t=6	-0.019	-0.021	-0.023	0.008	0.021	0.014
	(0.003)	(0.006)	(0.003)	(0.004)	(0.006)	(0.004)
t=7	-0.020	-0.023	-0.024	0.010	0.023	0.015
	(0.004)	(0.006)	(0.004)	(0.005)	(0.006)	(0.004)
t=8	-0.020	-0.023	-0.025	0.010	0.022	0.015
	(0.004)	(0.006)	(0.004)	(0.006)	(0.006)	(0.005)
t=9	-0.021	-0.025	-0.026	0.011	0.020	0.014
	(0.004)	(0.007)	(0.004)	(0.007)	(0.006)	(0.005)
t=10	-0.021	-0.027	-0.028	0.012	0.022	0.015
	(0.005)	(0.007)	(0.005)	(0.007)	(0.007)	(0.006)
t=11	-0.022	-0.028	-0.029	0.012	0.021	0.015
	(0.006)	(0.007)	(0.005)	(0.008)	(0.007)	(0.006)
t=12	-0.022	-0.028	-0.029	0.013	0.022	0.016
	(0.006)	(0.007)	(0.006)	(0.008)	(0.007)	(0.006)
Controls	✓	✓	✓	✓	✓	✓
Unit FE	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓
Observations	910	910	910	910	910	910

Note: Standard errors are clustered at the bank-level. Dependent variable in natural logarithm. BJS = estimator by Borusyak, Jaravel and Spiess (2024), CS = estimator by Callaway and Sant'Anna (2021), TWFE = two-way fixed effects. Each point estimate can be interpreted as the average treatment effect across all NIR-banks k periods after treatment. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

Table 4: Event Study Pre-Trend Coefficients.

	Deposits			Loans		
	CS	BJS	TWFE	CS	BJS	TWFE
t= -1	-0.001	0.005	0.000	0.001	0.010	0.000
	(0.001)	(0.005)	(0.000)	(0.001)	(0.005)	(0.000)
t= -2	0.000	0.008	0.003	0.000	0.008	-0.002
	(0.001)	(0.005)	(0.001)	(0.001)	(0.005)	(0.001)
t= -3	0.001	0.009	0.004	0.001	0.007	-0.003
	(0.001)	(0.005)	(0.002)	(0.000)	(0.005)	(0.001)
t= -4	0.001	0.009	0.004	0.001	0.007	-0.003
	(0.001)	(0.004)	(0.002)	(0.000)	(0.005)	(0.001)
t= -5	0.001	0.009	0.004	0.001	0.006	-0.004
	(0.001)	(0.004)	(0.002)	(0.000)	(0.005)	(0.002)
t= -6	0.001	0.008	0.003	0.000	0.006	-0.004
	(0.001)	(0.004)	(0.002)	(0.000)	(0.004)	(0.002)
t= -7	0.000	0.008	0.002	0.000	0.006	-0.004
	(0.001)	(0.004)	(0.003)	(0.000)	(0.004)	(0.002)
t= -8	0.000	0.007	0.002	0.000	0.006	-0.005
	(0.001)	(0.003)	(0.003)	(0.000)	(0.004)	(0.002)
t= -9	0.002	0.007	0.002	0.000	0.06	-0.005
	(0.001)	(0.003)	(0.003)	(0.000)	(0.004)	(0.003)
t= -10	0.000	0.005	0.000	0.000	0.006	-0.004
	(0.001)	(0.003)	(0.003)	(0.000)	(0.004)	(0.003)
t= -11	0.001	0.004	0.000	0.000	0.006	-0.005
	(0.001)	(0.003)	(0.004)	(0.000)	(0.003)	(0.003)
t= -12	0.001	0.004	0.001	0.007	0.006	-0.005
	(0.001)	(0.002)	(0.004)	(0.004)	(0.003)	(0.003)
Controls	✓	✓	✓	✓	✓	✓
Unit FE	✓	✓	✓	✓	✓	✓
Time FE	✓	✓	✓	✓	✓	✓
Observations	910	910	910	910	910	910

Note: Standard errors are clustered at the bank-level. Dependent variable in natural logarithm. BJS = estimator by Borusyak, Jaravel and Spiess (2024), CS = estimator by Callaway and Sant'Anna (2021), TWFE = two-way fixed effects. Each point estimate can be interpreted as the average pre-trend coefficient across all NIR-banks k periods before treatment. Data source: Research Data and Service Centre (RDSC) of the Deutsche Bundesbank, BISTA 1999-2022, used in 2022-2025, author's calculations.

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