Banking on Deposit Relationships: Implications for Hold-Up Problems in the Loan Market

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Abstract

By lending to a firm, inside banks gain an informational advantage over outside banks, enabling them to hold up borrowers and extract informational rents. Using unique data on firm-bank deposit and lending relationships in Norway, we show that deposit relationships between firms and outside banks mitigate inside banks' informational advantage, thereby attenuating hold-up. This result holds using quasi-random variation in deposit relationships induced by the deposit insurance threshold, and is driven by the information provided by firms' deposit account activities to outside banks (not cross-selling). Overall, our paper offers the first evidence that deposit relationships impact lender competition.

JEL Classification: G21, D82, L10

Keywords: Deposit relationships, Hold-up problems, Lender competition, Lender switching, Information asymmetries

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1. Introduction

Theory suggests that, by lending to a firm, (incumbent) inside banks gain an informational advantage over (non-lender) outside banks (Diamond 1984; Rajan 1992; Sharpe 1990; von Thadden 2004). This impedes borrowers from switching to new lenders, as outside banks face a winner's curse, enabling inside banks to hold up borrowers and extract informational rents. In line with these theoretical predictions, empirical studies have found that inside banks' informational advantage discourages outside banks from competing, leading to hold-up problems and investment inefficiencies (Hale and Santos 2009; Houston and James 1996; Ioannidou and Ongena 2010; Schenone 2010).

In this paper, we use unique data on the deposit and lending relationships of all firm-bank pairs in Norway—a representative country in terms of hold-up problems in the loan market—to show that deposit relationships between firms and outside banks mitigate inside banks' informational monopoly, thereby attenuating hold-up problems. This arises from the information that outside banks gain by observing firms' deposit account activities, which mitigates the winner's curse that they face when competing with inside banks. To the best of our knowledge, our paper offers the first empirical evidence that deposit relationships impact lender competition, providing a novel perspective on the two-sidedness of the banking sector (i.e., the complementary between deposit-taking and lending, see Berlin and Mester 1999; Drechsler, Savov, and Schnabl 2021; Fama 1985; Kashyap, Rajan, and Stein 2002; Mester, Nakamura, and Renault 2007; Yanelle 1989).

Our study consists of two parts. In the first part, we provide two new insights into the structure of firm-bank relationships. First, we document that approximately 20% of firms has more deposit than lending relationships. This can be the case, for example, if a firm has loans and deposits at one bank (the "inside" bank), and deposits but no loans at another bank (the "outside" bank). Second, we uncover that about 40% of firms that switch lenders had a deposit relationship with their new (outside) lender at least one year before switching. Our paper is the first to document these patterns, which enhance our understanding of the structure of firm-bank relationships and highlight the importance of deposit relationships in lender switching and, more broadly, lender competition.

In the second part of our study, we formally analyze the role of deposit relationships in lender competition. We start by analyzing whether having a deposit relationship with (non-lender) outside banks affects the probability that firms switch lenders. Theoretically, if deposit relationships reduce outside banks' informational disadvantage, firms that have a deposit relationship with outside banks should have a higher probability of receiving outside bids from those banks and, hence, switching (Rajan 1992; Sharpe 1990). Building on the empirical framework of Bird, Karolyi, and Ruchti (2019), we find that firms that have a deposit relationship with outside banks are around 8 percentage points (pp) more likely to switch to those lenders in the following year, relative to firms without such a relationship. This result holds after controlling for firm as well as (inside and outside) bank-by-time fixed effects and is economically significant, corresponding to about 50% of the unconditional likelihood of switching lenders.

We then study whether having a pre-existing deposit relationship with outside banks affects the loan offers that firms receive upon switching to those bank, as this relates to informational hold-up and switching costs. Theoretically, if deposit relationships reduce outside banks' informational disadvantage, outside banks should bid more aggressively on loans offered to firms with a prior deposit relationship (Rajan 1992; Sharpe 1990). To examine this, we employ the matching approach of Ioannidou and Ongena (2010)—designed to compare loan terms offered to switching versus comparable non-switching firms—and extend it to compare the loan terms offered to *switching* firms *with* a prior deposit relationship versus comparable *switching* firms *without* a prior deposit relationship. Our matching approach not only accounts for differences across lenders, borrowers, loan contract characteristics, relationship characteristics, and macroeconomic conditions, but also for the proprietary credit rating assigned by banks to firms. The latter is important as it ensures that we compare the loan conditions offered to switchers with versus without a prior deposit relationship that have precisely the same credit risk according to their new (outside) lender.[1]

Our findings are threefold. First, consistent with existing evidence on hold-up problems in

[1]As discussed below, our results are also robust to a within-firm estimation approach that compares the loan conditions on switching and non-switching loans obtained by the *same* firm in the same year, mitigating potential concerns that our results could be biased by unobserved firm-specific time-varying characteristics.

the loan market, we find that interest rates on new loans granted by outside banks to switching firms are on average 80 basis points (bp) lower than rates on comparable non-switching loans granted to existing borrowers. This result is economically relevant, as it compares to an average loan rate of 517 bp, and quantitatively aligns with the 90 bp loan rate discount estimated by Ioannidou and Ongena (2010) and Bonfim, Nogueira, and Ongena (2021) using Bolivian and Portuguese data, respectively.

Second, and more importantly, we uncover significant heterogeneity in the loan rate discount offered by outside banks to switching firms with versus without a prior deposit relationship. On average, the discount offered to switching firms with a prior deposit relationship is 170 bp compared to 50 bp for switching firms without a prior deposit relationship. Consistent with our hypothesis, this indicates that outside banks bid more aggressively on loans to firms with a prior deposit relationship. Furthermore, we show that having a *prior* deposit relationship with the outside bank matters, as our results also hold when comparing switchers with a prior deposit relationship to switchers that start a deposit relationship with the new lender at the time of the switch.

Third, we show that outside banks also offer better non-price lending conditions to switching firms with prior deposit relationship. Specifically, switchers with a prior deposit relationship are offered larger loan amounts and are more likely to receive credit lines, without being subject to different collateral requirements. Taken together, our results show that having a deposit relationship with (non-lender) outside banks improves firms' probability of switching to those lenders and the loan offers that firms receive from those lenders.

We posit that these results can be attributed to the fact that deposit relationships reduce outside banks' informational disadvantage vis-à-vis inside banks, leading to increased lender competition. This conjecture is based on two insights. First, theoretical studies on informational hold-up have highlighted that outside banks have an informational disadvantage, which deters them from making outside bids and hence hinders firms from switching to new lenders (Hauswald and Marquez 2006; Rajan 1992; Sharpe 1990). Second, several empirical studies have shown that banks can obtain valuable information from firms' deposit account activity—which is private, continuous, timely, hard information that cannot easily

be manipulated—to monitor firms' creditworthiness (Mester, Nakamura, and Renault 2007; Norden and Weber 2010; Puri, Rocholl, and Steffen 2017).[2] Hence, we conjecture that information obtained from firms' deposit account activity could mitigate the winner's curse that outside banks face in competing with inside banks, thereby attenuating hold-up problems in the loan market.

We provide several pieces of evidence that support this conjecture. First, we show that our results are stronger for deposit relationships that promote information flow between firms and outside banks. In particular, our results are more pronounced for longer, deeper, and broader deposit relationships, and for transaction accounts (which typically contain detailed payment data).[3] This holds for the probability of switching lenders as well as the loan rate discount offered upon switching lenders, and is consistent with the idea that deposit relationships reduce information asymmetries between firms and outside banks.

Second, theory suggests that outside banks are less willing to bid on loans to firms for which their informational disadvantage is more pronounced (Broecker 1990; Rajan 1992). Hence, we would expect that deposit relationships are more relevant in cases where information asymmetries are greater. Consistent with this, we find that deposit relationships are more important for single-bank borrowers and borrowers that maintained a longer lending relationship with their inside banks, which are the borrowers that are more locked in and face more difficulties switching lenders (Farinha and Santos 2002; Degryse and Ongena 2008; Schenone 2010). In addition, we find that our results are stronger for younger firms and firms operating in areas with higher bank competition, which further supports our conjecture that deposit relationships between firms and outside banks mitigate information asymmetries and adverse selection.

Third, in the spirit of Weitzner and Howes (2021), we show that deposit relationships improve outside banks' screening capability. In particular, we show that the initial credit rating assigned by outside banks to switching firms with a prior deposit relationship is a

[2]Banking industry reports confirm that, apart from the information reported in firms' financial statements and credit registers, firms' payment data are the most important source of information used by banks to evaluate (potential) borrowers' creditworthiness (e.g., McKinsey 2019).

[3]As explained below, we measure deposit relationship length as the number of years during which a firm and bank maintained a deposit relationship, deposit relationship depth as the share of deposits that a firm holds at a bank compared to the firms' total deposits, and deposit relationship scope as the number of deposit products underlying the deposit relationship. Transaction accounts are identified as accounts with near-zero interest rates (i.e., below 0.25% per annum).

better predictor of future loan performance than the initial credit rating assigned by those banks to switching firms without a prior deposit relationship. Given that the credit rating assigned at the time of the switch only captures information used in a bank's screening process (not its monitoring process), this result provides further evidence that deposit relationships mitigate information asymmetries between firms and outside banks (Jaffee and Russell 1976).

Our results are robust to a series of additional tests. First, a potential concern is that deposit relationships between firms and (outside) banks are not randomly assigned. To resolve this concern, we exploit the corporate deposit insurance threshold to achieve identification through a regression discontinuity design (RDD). We first show that the probability that a firm opens a deposit account at an outside bank sharply increases around the deposit insurance threshold, as firms have an incentive to split deposits across banks to ensure that the amount deposited at each bank is fully insured (Cucic et al. 2024; De Roux and Limodio 2023; Iyer, Puri, and Ryan 2016). Using this threshold-based variation, we employ a fuzzy RDD and show that, consistent with our baseline results, having a deposit relationship with outside banks significantly increases firms' probability of switching lenders.

Second, we rule out alternative channels. A potential concern is that our results may instead be explained by the role of deposits as a means of cross-selling (Basten and Juelsrud 2023; Qi 2024), collateral (Uchida 2003), or bank funding (Berlin and Mester 1999; Kashyap, Rajan, and Stein 2002). To illustrate that this is not the case, we show that our results do not depend on the deposit rate that the switching firms earn at the outside bank, the switching firms' deposit-to-loan ratio at the outside bank, or the ratio of the switching firms' deposits compared to the outside banks' total deposits (which serves as a proxy for the firms' potential funding benefit or withdrawal risk). In addition, to further mitigate potential concerns about the role of cross-selling strategies, we show that switching firms do not earn significantly different deposit rates at outside banks, which is inconsistent with the "loss-leader" (or "bargain-then-ripoff") strategies typically used in cross-selling (Basten and Juelsrud 2023; Klemperer 1987).

Third, if having a deposit relationship with outside banks increases firms' outside options and lender competition, we would expect inside banks to improve the loan conditions of

borrowers that start a deposit relationship with outside banks (Rajan 1992). In line with this conjecture, we find that inside banks reduce borrowers' loan rates by around 30 bp after the borrowers start a deposit relationship with outside banks. This reduction in loan rates is smaller than the loan rate discount that firms could obtain from switching lenders, but provides further evidence that deposit relationships with outside banks are in fact beneficial to borrowers as they mitigate hold-up problems.

Fourth, a potential concern is that the more favorable loan conditions obtained by switchers with a prior deposit relationship are offset by worse loan conditions over the course of the new lending relationship, for instance because switchers with a prior deposit relationship may be more likely to be subject to hold-up problems at the new bank (Ioannidou and Ongena 2010; Sharpe 1990). This does not seem to be the case, as we find that new loans granted by the outside bank to switchers with and without a prior deposit relationship have a similar loan rate cycle. Finally, our results are robust to alternative empirical specifications and measurement choices, including a more restrictive definition of lender switching than the original definition proposed by Ioannidou and Ongena (2010).

Overall, our paper shows that deposit relationships can mitigate outside banks' informational disadvantage vis-à-vis inside banks, thereby reducing hold-up problems. This finding provides a novel perspective on the complementarity between deposit-taking and lending (Berlin and Mester 1999; Drechsler, Savov, and Schnabl 2021; Kashyap, Rajan, and Stein 2002; Fama 1985; Mester, Nakamura, and Renault 2007; Yanelle 1989), and to the best of our knowledge offers the first evidence that deposit relationships affect lender competition.

Related Literature Our paper bridges the literature on deposit relationships and lender competition in the banking sector, thereby contributing to several strands of research. First, our paper contributes to the literature on informational hold-up in the loan market (Agarwal and Hauswald 2010; Diamond 1984; Hale and Santos 2009; Hauswald and Marquez 2006; Houston and James 1996; Ioannidou and Ongena 2010; Rajan 1992; Santos and Winton 2008; Sharpe 1990; von Thadden 1995, 2004).[4] In the theoretical model of Sharpe (1990),

[4]This literature is related to the broader literature on hold-up problems, which argues that—due to the fact that relationship-specific assets have a lower value in alternative uses—sunk investments in such assets give one party more ex-post bargaining power (Grossman and Hart 1986; Hart and Moore 1990; Klein, Crawford, and Alchian 1978; Williamson 1979).

information acquired by an incumbent (inside) bank as part of its lending relationship with a borrower creates an "informational monopoly" which hinders the borrower from receiving competitive loan offers elsewhere. If a high quality ("good") borrower tries to switch to an uninformed (non-lender) outside bank, it would get pooled with low quality ("bad") firms and offered a higher loan rate. In an extended version of Sharpe's model, von Thadden (2004) however shows that outside banks can offer competitively lower rates using "optimal randomization" to borrowers that are—at least to them—observably identical so that, in equilibrium, occasional switching occurs. Consistent with theory, empirical studies have shown that inside banks' informational advantage creates a hold-up problem, and that public information disclosure is critical in mitigating this issue (e.g., Bird, Karolyi, and Ruchti 2019; Cahn, Girotti, and Salvadè 2024; Saunders and Steffen 2011; Schenone 2010).

By showing that deposit relationships can mitigate outside banks' informational disadvantage, our paper extends the existing literature on informational hold-up, which has focused exclusively on the role of lending relationships. Our findings therefore provide a novel perspective on the two-sidedness of the banking sector, and imply that deposit market reforms that aim to reduce depositor stickiness could mitigate hold-up problems in the loan market.[5] In addition, by uncovering that outside banks offer significantly better loan conditions to firms with a prior deposit relationship, our findings imply that hold-up problems may be more pronounced than previous papers have suggested (e.g., Bonfim, Nogueira, and Ongena 2021; Ioannidou and Ongena 2010; Liaudinskas 2023).[6]

Second, we contribute to the literature on bank relationships (for an overview, see Boot 2000; Degryse, Ioannidou, and Ongena 2015). This literature has primarily focused on lending relationships, and how such relationships affect bank lending (Beck et al. 2018; Berger and Udell 1995; Berger et al. 2024; Bharath et al. 2011; Boot and Thakor 2000; Bolton et al. 2016; Dahiya, Saunders, and Srinivasan 2003; Degryse and Van Cayseele 2000; Degryse and Ongena 2005; Petersen and Rajan 1994, 1995). Few papers have studied deposit

[5] An example is the implementation of Directive 2014/92/EU on the comparability of fees related to payment accounts, payment account switching and access to payment accounts with basic features in the European Union. The objective of this directive is to reduce the administrative burden and switching costs associated with opening deposit accounts, which could ultimately contribute to increased lender competition according to our findings.

[6] Assuming that the loan terms offered to switchers with a prior deposit relationship are closest to the potential loan terms offered in a frictionless market with perfect information, our findings imply that informational hold-up may be more pronounced than previously thought.

relationships, and those that have almost exclusively focus on how banks can use information from firms' deposit account activity to monitor *existing* borrowers' creditworthiness and prevent loan defaults (Agarwal et al. 2018; Black 1975; Fama 1985; Hibbeln et al. 2020; Mester, Nakamura, and Renault 2007; Norden and Weber 2010; Puri, Rocholl, and Steffen 2017).[7,8] Our contribution to this literature is twofold. Firstly, we provide novel stylized facts about the structure of firm-bank relationships. Secondly, we show that deposit relationships can impact lender competition by providing outside banks a screening mechanism that mitigates their informational disadvantage vis-à-vis inside banks.

Finally, our paper relates to the relevance of information sharing between financial intermediaries (Doblas-Madrid and Minetti 2013; Marquez 2002; Padilla and Pagano 1997; Pagano and Jappelli 1993), particularly the debate on open banking (Alok et al. 2024; Babina et al. 2024; Ghosh, Vallee, and Zeng 2024; Goldstein, Huang, and Yang 2023; He, Huang, and Zhou 2023; Nam 2023; Parlour, Rajan, and Zhu 2022). While recent research suggests that open banking enhances lender competition through the sharing of borrowers' payment data, our findings imply that deposit relationships enabled outside banks to use such data to improve their competitive position even before open banking initiatives were introduced.[9]

The remainder of the paper is structured as follows: Section 2 documents new stylized facts about the structure of firm-bank relationships. Section 3 explains the data sources and methodology used in our empirical analysis. Section 4 presents the results, and Section 5 concludes.

2. Firm-bank relationships: New insights

We start our analysis by providing novel insights into the structure of firm-bank relationships using unique data covering all deposit and loan accounts for the universe of Norwegian firms. These data are collected and maintained by the Norwegian Tax Administration (*Skatteetaten*)

[7]The idea that borrowers' checking accounts contain useful information about borrowers' financial health has been referred to as the "checking account hypothesis" (Nakamura 1992).

[8]There is also a small literature on the role of deposit relationships in bank runs (e.g., Chernykh and Mityakov 2022; Haddad, Hartman-Glaser, and Muir 2023; Iyer and Puri 2012; Iyer, Puri, and Ryan 2016; Iyer et al. 2019) and cross-selling (e.g., Basten and Juelsrud 2023; Qi 2024).

[9]Interestingly, after the launch of open banking in the US, which mandates banks to share customers' transaction history with rivals upon customers' request, banks rapidly voiced concerns against the reform, illustrating the value of such information for banks and its role in lender competition (The Financial Times 2024).

as a basis for corporate taxation and, hence, are essentially free of measurement error. For every firm-bank-account, the data record the end-of-year outstanding loan (deposit) amount and interest paid (received) on the account during the year. We aggregate this firm-bank-account-year level data to the firm-bank-year level in order to track all firm-bank lending and deposit relationships at a yearly frequency for the period 2000-2019. We define a firm and a bank to have a lending (deposit) relationship in a given year if the outstanding loan (deposit) amount or the interest paid (received) is larger than zero (as in Basten and Juelsrud 2023, also see Table A1 for variable definitions). In doing so, we also account for bank mergers and acquisitions that took place during our sample period.[10] This yields a dataset that comprises 180 banks and 241,466 firms for a total of 511,879 unique firm-bank relationships over the period 2000-2019.

We start by analyzing the cross-section of firm-bank relationships over our sample period. Figure 1 shows the proportion of firm-bank relationships that comprises (1) both a deposit and a lending relationship, (2) only a lending relationship, or (3) only a deposit relationship. This figure is based on the sample of firms that, in a given year, has at least one lending relationship (meaning that we omit firms that do not use bank credit, either because of financial constraints or lack of credit demand). As expected, we observe that the majority of firm-bank relationships (around 70%) consists of both a deposit and a lending relationship. More interestingly, we observe that approximately 5% of firm-bank relationships consists exclusively of a lending relationship and around 15-20% of firm-bank relationships consists exclusively of a deposit relationship. The latter observation indicates that it is common for firms to have deposit relationships with (non-lender) outside banks.[11]

We observe a similar pattern when we analyze the data at the firm-year instead of firm-bank-year level. In Figure 2, we compare firms' total number of deposit relationships to

[10]When bank A absorbs bank B, bank A typically acquires the information that bank B collected on its clients in the years before the merger. Moreover, the clients of bank B that decide to stay with bank A after the merger do not incur switching costs. Therefore, the clients of bank B that stay with bank A after the merge are treated as continuing bank relationships.

[11]Although the objective of our paper is not to explain why firms have deposit relationships with banks from which they do not borrow, Table O.B1 in the Online Appendix offers some insights into this matter. We find that firm-specific, bank-specific, and institutional factors play a role, consistent with prior research (e.g., d'Avernas et al. 2023; De Roux and Limodio 2023; Drechsler, Savov, and Schnabl 2017; Iyer et al. 2019). For instance, we find that firms seem to have deposit relationships with banks from which they do not borrow in order to ensure that their deposits are covered by the corporate deposit insurance scheme (Cucic et al. 2024; De Roux and Limodio 2023; Iyer et al. 2019) and access a broader range of deposit services and payment solutions (d'Avernas et al. 2023), among others. As explained below, we control for these factors in our analysis to mitigate potential concerns about omitted variable bias.

firms' total number of lending relationships (for the sample of firms with at least one lending relationship, as before). First, the figure shows that most firms have only one lending relationship. As previous papers find that banks' capability to capture borrowers increases when borrowers have fewer bank relationships (Farinha and Santos 2002; Degryse and Ongena 2008; Schenone 2010), this is an indication of hold-up in the Norwegian loan market. Second, in line with Figure 1, we observe that around 20% of firms has more deposit than lending relationships.[12] This can be the case, for instance, if a firm has a deposit relationship with two different banks, and a lending relationship with only one of those two banks.

In Figure 3, we track firm-bank relationships over time, and focus on firms that switch to a new (outside) lender. We find that it is common for firms to switch to new (outside) lenders with which they had a prior deposit relationship. Specifically, up to 40% of switching firms had a deposit relationship with their new lender at least one year before switching. Focusing on the switching firms that had a prior deposit relationship with their new lender, Figures O.A2–O.A4 in the Online Appendix show the distribution of the length, depth, and scope of the prior deposit relationships, respectively. We measure deposit relationship length as the number of years during which a firm and bank maintained a deposit relationship; deposit relationship depth as the share of deposits that a firm holds at a bank compared to the firm's total deposits; and deposit relationship scope as the number of deposit products underlying the deposit relationship. Figure O.A2 shows that about 50% of switching firms had a prior deposit relationship of at least seven years. This suggests that many firms that switch lenders had maintained strong deposit relationships with those (outside) lenders before switching. Clearly, this relates to our first observation as the firms that have deposit relationships with (outside) banks from which they do not borrow may, in fact, be firms that do not *yet* have lending relationships with those banks.

Our paper is the first to document these patterns for the corporate banking sector.[13] These insights improve our understanding of the structure of firm-bank relationships, and suggest

[12]This pattern is also reflected in Figure O.A1 in the Online Appendix, which shows the distribution of the total number of lending and deposit relationships of firms with at least one lending relationship. We can observe that around 15% of firms has more than one lending relationship while around 30% of firms has more than one deposit relationship.

[13]Although our data only cover firm-bank relationships in Norway, evidence from previous papers suggests that this pattern is not limited to Norway. For instance, using survey data covering 20 countries, Ongena and Smith (2000) document that approximately 10% of firms in their data sample has a bank relationship that only involves non-lending related activities.

that deposit relationships play an important role in lender switching. In the next sections, we formally analyze this by examining whether having a deposit relationship with (non-lender) outside banks affects the probability that firms switch lenders, the loan conditions that firms are offered by outside banks, and the potential mechanism behind these effects.

3. Data and methodology

3.1. Data, definitions, and summary statistics

3.1.1. Data

Building on the preliminary evidence presented in Section 2, we now provide a detailed description of the data sources and methodology used in our empirical analysis.

Our empirical analysis requires detailed data on firm-bank relationships and loan contracts. The former are obtained from the Norwegian Tax Administration, which tracks the deposit and lending relationships of all firm-bank pairs in Norway from 2000 to 2019, as explained in Section 2. The latter are retrieved from the credit register administered by the Financial Supervisory Authority of Norway (*Finanstilsynet*). These data, which are available at a yearly frequency for the period 2014-2019, allow us to retrieve loan exposures for every firm-bank pair. The dataset is at the firm-bank level, but contains detailed information on the underlying loan agreements, such as the total loan amount, average interest rate, loan collateralization rate, loan type (i.e., whether the loan agreement includes a credit line or not), and loan status (i.e., the proportion of loans written off). In addition, the data contain a proprietary credit rating—assigned by lenders to borrowers—which varies between zero and one, with values closer to one indicating a higher credit risk.

We also obtain firm-specific information from the Norwegian Register of Business Enterprises (*Brønnøysundregistrene*). Firms operating in Norway are required to disclose their financial statements at this register at the end of each year. We use these data to obtain information about general firm characteristics (such as industry and location) and firms' income statement and balance sheet items (such as total assets, leverage, and profitability). We exclude firms from the financial and insurance sector, the public administration sector, the education sector, and activities of extra-territorial entities. We also restrict our sample

to (private and public) limited liability companies, which account for approximately 90% of private sector employment in Norway.

3.1.2. Definitions

In our analysis, we use the definition of lender switching proposed by Ioannidou and Ongena (2010), which imposes two conditions for a new loan to be classified as a switching loan. First, the new loan should be obtained from a bank with which the firm did not have a lending relationship during the previous twelve months. Second, the firm must have had at least one lending relationship in the previous twelve months with at least one other bank. This condition assumes that key inside information becomes stale within one year (but our results are robust to assuming different time horizons for key inside information to become stale, as discussed in robustness tests below). New loans that do not satisfy these two conditions are non-switching loans. We refer to the bank from which the firm obtains the new loan as the outside bank, and to the bank from which the firm borrowed before switching as the inside bank.[14] Table A1 contains definitions for all variables used in the paper.

As explained in the previous section, our dataset is structured at the firm-bank level (rather than the loan level); to maintain consistency with the paper from Ioannidou and Ongena (2010), we adopt their terminology and refer to "switching loans". For some of our analyses that use loan terms as outcome variable, we mitigate potential concerns about this aggregation by showing that our findings hold if we restrict our sample to firm-bank relationships with a single underlying loan (for which we essentially observe unaggregated loan terms).

3.1.3. Summary statistics

Our final dataset comprises 115 banks and 72,224 firms for a total of 98,655 unique firm-bank relationships over the period 2014-2019. Panel A of Table 1 reports descriptive statistics

[14] Following Ioannidou and Ongena (2010), our definition of switching does not differentiate between firms that "move" between banks and firms that "add" a lending relationship. A first reason is that we focus on the potential heterogeneity in the conditions under which a firm obtains a loan from another bank (and not from an existing lender). A second reason is that differentiating between "movers" and "adders" based on whether they have or do not have other outstanding loans at the time of the switch does not necessarily provide a meaningful distinction. For instance, "adders" could be classified as "movers" if, at the time of the switch, their inside loans expired and were not renewed until after they got a loan from an outside bank. Likewise, "movers" could be classified as "adders" if their inside loans happened to expire a few months after the switch.

for the data sample used in our empirical analysis. We observe that approximately 20% of firms has a deposit relationship with at least one (non-lender) outside bank, in line with the statistics from Figure 2 discussed earlier. Further, Panel A shows that the average probability that a firm switches lenders in a given year is around 16%.

Panel B of Table 1 reports differences in means, median, and standard deviation for firms with and without an outside deposit relationship, and Panel C for switching and non-switching loans. Both panels also indicate whether the differences in mean, median, and standard deviation between the two groups are statistically significant. Panel B shows that the average probability of switching lenders is larger for firms with outside deposit relationship (20%) compared to firms without outside deposit relationship (15%). Panel C further shows that—based on our definition of lender switching—our dataset yields 10,630 switching loans to switchers with prior deposit relationship and 28,741 switching loans to switchers without prior deposit relationship. Taken together, this implies that approximately 8% of the loan originations are switching loan instances, a percentage that is comparable to the one reported in previous papers (e.g., Degryse, Ioannidou, and von Schedvin 2016; Ioannidou and Ongena 2010).[15] The average interest rate for switching loans with a prior deposit relationship is approximately 400 bp, which is 120 bp lower than non-switching loans and 149 bp lower than switching loans for switchers without a prior deposit relationship. Further, compared to switchers without a prior deposit relationship, switchers with a prior deposit relationship tend to obtain loans that are on average larger, with a higher collateralization rate, and more likely to contain a credit line. An important difference between switchers with and without a prior deposit relationship is, obviously, the fact that the former group had a deposit relationship with their new (outside) lender before switching. Panel C shows that, for switching firms with a prior deposit relationship, the average length of the prior deposit relationship equals about seven years. Panels B and C also show that the firms in the different sub-samples can differ along other factors (such as size or leverage), but our empirical strategy explained below is designed to ensure that our conclusions are not biased by any of those confounding factors.

[15]Table O.A1 in the Online Appendix also shows that the distribution of switchers with and without a prior deposit relationship across industries is similar.

3.2. Empirical strategy

3.2.1. The probability of switching lenders

In the first part of our empirical analysis, we investigate whether having a prior deposit relationship with outside banks affects the probability that firms switch lenders. Theory suggests that, if deposit relationships reduce outside banks' informational disadvantage, firms that have a deposit relationship with outside banks should have a higher probability of receiving outside bids from those banks and, hence, switching lenders (Rajan 1992; Sharpe 1990). Building on the empirical framework of Bird, Karolyi, and Ruchti (2019), we test this conjecture based on the following linear probability model:

$$Switch_{i,t} = \alpha + \beta\, Outside\ deposit\ relationship_{i,t-1} + \gamma X_{i,j,t} + \eta_i + \delta_{j,t} + \epsilon_{i,j,t} \qquad (1)$$

where $Switch_{i,t}$ is a dummy variable equal to one if a firm i switched to a new lender in year t. $Outside\ deposit\ relationship_{i,t-1}$ is a dummy variable equal to one if firm i had a deposit relationship with at least one (non-lender) outside bank in year $t-1$. $X_{i,j,t}$ is a vector of control variables, which includes both firm and firm-bank variables. Firm controls include firms' size, leverage ratio, EBIT to total assets, fixed assets to total assets, and legal structure (i.e., a dummy equal to one for publicly listed firms). Firm-bank controls include the loan interest, loan amount, proportion of loan collateralized, a dummy variable equal to one for credit lines, and the (proprietary) credit rating assigned by the bank to the borrower, which captures banks' private information about the borrower. More precisely, controlling for firm-bank specific variables (especially the credit rating assigned by the bank to the borrower) mitigates concerns that our results are biased by confounding factors that are observable to the bank but unobservable to the econometrician. In the most saturated regression models, we include firm and bank-by-time fixed effects which are represented by η_i and $\delta_{j,t}$, respectively. The former control for firm-specific time-invariant unobserved heterogeneity, while the latter control for bank-specific time-varying unobserved heterogeneity. The error term, $\epsilon_{i,j,t}$, is clustered at the firm level. The coefficient of interest is β, which captures the effect of having an outside deposit relationship on firms' probability of switching lenders the next year. Given the use of high-dimensional fixed effects, we estimate Equation (1) via OLS, but our results

hold if we use a logit model with less granular fixed effects.

3.2.2. Outside banks' loan offers

In the second part of our empirical analysis, we study whether having a prior deposit relationship with new (outside) lenders affects the loan offers that switching firms receive from those lenders upon switching. Theoretically, if deposit relationships reduce outside banks' informational disadvantage, outside banks should bid more aggressively on loans offered to switching firms with a prior deposit relationship compared to switching firms without such a relationship (Rajan 1992; Sharpe 1990).

To test this conjecture, we apply two distinct matching approaches, which we explain in more detail in the two subsections below. In a first approach, we follow Ioannidou and Ongena (2010) and match switching loans from switchers (with and without prior deposit relationship) to similar non-switching loans from non-switchers. The latter serve as counterfactuals for the loan offers that switchers would have received from their inside banks for non-switching loans, and allow us to analyze how prior deposit relationships affect the loans terms offered by outside banks compared to the counterfactual loans terms offered by inside banks. A potential drawback of this approach is its reliance on matching switchers with non-switchers, and these two groups could differ along important unobservable dimensions (such as growth opportunities). To address this concern, we implement a second—more restrictive—matching approach which directly compares the loan terms offered by outside banks on *switching* loans from switchers *with* prior deposit relationship to similar *switching* loans from switchers *without* prior deposit relationship.

3.2.2.1. Comparing switchers with non-switchers

In principle, an ideal counterfactual for the loan terms offered to a firm for a switching loan would be the loan terms offered to the firm for a non-switching loan, but unfortunately we do not have data on (unsuccessful) loan applications. In our first approach, we therefore follow Ioannidou and Ongena (2010) and use a strict matching procedure to derive the (counterfactual) loan terms offered to firms for a non-switching loan. Based on the counterfactuals

obtained from the matching procedure, we then analyze how prior deposit relationships affect outside banks' loan offers on switching loans.

Our first matching approach approximates the inside bank's (unsuccessful) offer using comparable loans that the inside bank granted in the same year to other observably similar firms. Figure A1a in the Appendix provides a visualization of this matching strategy. In an alternative but similar matching strategy, we take into account the possible impact of bank characteristics on the inside and outside offers by comparing the loan terms on switching loans to the loan terms of comparable (non-switching) loans that the switcher's outside bank granted in the same year to observably similar existing borrowers. This matching strategy is depicted in Figure A1b in the Appendix. In our main analysis, we focus on the loan rate of switching loans (as in Sharpe 1990), but we also report results on other loan terms.

Following Ioannidou and Ongena (2010), we match loans on the year of origination, firm characteristics (region, industry, legal structure, size), and loan characteristics (loan amount, type, collateralization, and credit rating). Matching on the year in which the loan is granted ensures that loans are granted under similar macroeconomic conditions; matching on region, industry, legal structure, and size, ensures that firms are comparable in terms of fundamental firm-specific dimensions; matching on loan amount, type, and collateralization ensures that loan contracts are comparable in terms of key loan terms; and matching on credit rating ensures that borrowers are comparable according to banks' credit risk assessment. As mentioned earlier, we match switching loans either with other non-switching loans from the firm's inside banks or the firm's outside bank. Table O.C1 in the Online Appendix provides an overview of the variables used in the matching procedure.

As in Bonfim, Nogueira, and Ongena (2021), we employ coarsened exact matching which requires fewer assumptions and possesses more attractive statistical properties than other matching models, such as propensity score matching (Iacus, King, and Porro 2012). Categorical covariates are matched exactly, and continuous covariates are coarsened using Surges' formula.[16] In matching the switching and non-switching loans, we allow for replacement

[16]Figure O.B1 in the Online Appendix provides balance diagnostics supporting the validity of our matching approach. This figure depicts the standardized mean differences of the continuous variables used in the five matching strategies applied in Table 3, and shows that the standardized mean differences of the different variables are generally between -20% and 20%, indicating that the variables are well-balanced.

(i.e., we retain any matched pair that satisfies the matching criteria, meaning that one non-switching loan can be matched with multiple switching loans, and vice versa). Replacement allows for better matches and less bias, although it comes at the expense of precision. Robustness tests confirm that our results are insensitive to the matching model or set of matching variables used.

Our empirical strategy proceeds in three steps. First, we match each switching loan with all similar non-switching loans granted to other comparable firms by the switcher's inside or outside banks at the time of the switch. Second, we calculate the spreads between the rates on the switching loans and each matched loan. Third, we regress these spreads on a constant and a dummy variable equal to one if the switcher and the outside bank had a prior deposit relationship. The corresponding regression model is:

$$R_{i,j,t} - R_{m(i,j,t)} = \alpha + \beta Prior\ deposit\ relationship_{i,j,t} + \epsilon_{i,j,t} \tag{2}$$

where $R_{i,j,t}$ represents the loan rate on switching loans granted by bank j to firm i in year t and $R_{m(i,j,t)}$ the loan rate on its matched counterfactual. In this regression model, we adjust the point estimates by weighting each switching loan observation by one over the total number of comparable non-switching loans in order to account for the multiplicity of switching loans. The constant represented by α captures the average difference in loan rates obtained by switchers compared to non-switchers, and β captures the effect of having a prior deposit relationship on the loan rate obtained by switchers. A significantly negative coefficient estimate for α would suggest that the rates on switching loans are on average lower than the rates on comparable non-switching loans (indicating that switchers receive a loan rate discount). A significantly negative coefficient estimate for β would suggest that outside banks offer larger loan rate discounts to switchers with versus without prior deposit relationship.[17]

[17]An alternative method is to split the matched sample into two sub-samples: one sample of switching loans from switchers with a prior deposit relationship and the matched non-switching loans, and another sample of switching loans from switchers without a prior deposit relationship and the matched non-switching loans. Then, we could regress the spreads on a constant for the two sub-samples, in order to derive the average loan rate discount for the two types of switchers. The estimates of this alternative method are reported in Table O.E5 in the Online Appendix, and are in line with the results we obtain from estimating Equation (2). Further, as mentioned before, a potential concern could be that our data are aggregated at the firm-bank-time level. To mitigate that this aggregation could bias our results, we show that our results hold if we restrict our sample to firm-bank relationships with a single underlying loan product (for which we essentially observe unaggregated loan terms). The results based on this restricted sample are reported in Table O.E6 in the Online Appendix and are comparable to our baseline results.

3.2.2.2. Comparing switchers with switchers

As mentioned earlier, a potential concern with the empirical strategy explained above is that we match switching loans from switchers with non-switching loans from non-switchers. This could lead to biased results if switchers differ from non-switchers (e.g., in terms of growth opportunities), and these differences are somehow related with the probability that a firm has a prior deposit relationship with outside banks. To address this concern, we implement an alternative strategy based on directly matching switching loans granted by the same outside lender to switchers with and without a prior deposit relationship. First, we match each switching loan granted by the outside banks to switchers with a prior deposit relationship with all similar switching loans granted by the outside banks to other comparable switchers without a prior deposit relationship. Second, we calculate the spreads between the rates on the switching loans granted to switchers with a prior deposit relationship and each matched loan granted to switchers without a prior deposit relationship. Third, we regress the spreads on a constant. The corresponding regression model is:

$$R_{i,j,t} - R_{m(i,j,t)} = \alpha + \epsilon_{i,j,t} \tag{3}$$

where $R_{i,j,t}$ is the loan rate on switching loan granted by bank j to switchers with a prior deposit relationship and $R_{m(i,j,t)}$ is the loan rate for matched (counterfactual) switching loans granted by the same bank in the same year to switchers without a prior deposit relationship. A significantly negative coefficient estimate for α would suggest that the rates on switching loans granted to switchers with a prior deposit relationship are on average lower than the rates on similar switching loans granted to switchers without such a relationship.

4. Results

4.1. Deposit relationships and the probability of switching lenders

We first assess whether having a deposit relationship with (non-lender) outside banks influences firms' propensity to switch lenders using the linear probability model outlined in Equation (1). Table 2 reports the results. Across the different columns, we gradually saturate the model with

more stringent fixed effects. The results consistently show that having a deposit relationship with (non-lender) outside banks significantly increases firms' probability of switching lenders the next year. Column I for instance indicates that, if a firm had a deposit relationship with an outside bank in year $t-1$, the firm is 4.5 pp more likely to switch lenders in year t. This effect is economically significant as the unconditional probability of switching in our data sample is 16%. The magnitude of the effect increases to around 8 pp in Columns II to V as we saturate our model with firm and bank-by-time fixed effects. This change in magnitude suggests that firm and lender characteristics are associated with both the likelihood of having outside deposit relationships and the incidence of lender switching (a point to which we return in Section 4.3). Overall, the results in Table 2 are consistent with our conjecture that having an outside deposit relationship increases firms' outside options and hence firms' probability of switching lenders.[18] Moreover, as explained in Section 4.4.2 below, this result holds using quasi-random variation in deposit relationships between firms and outside banks induced by the deposit insurance threshold, mitigating potential endogeneity concerns.

4.2. Deposit relationships and outside banks' loan offers

We next examine whether having a pre-existing deposit relationship with outside banks affects the loan conditions that firms receive upon switching to those banks. To do so, we use the matching model outlined in Equation (2). The results are presented in Table 3, which also includes the list of variables used in each matching procedure, the corresponding number of switching and non-switching loans, the total number of observations, and the coefficient estimates of α and β. Standard errors clustered at the firm level are reported in parentheses.

We apply five matching strategies. In Column I, we compare the loan rate of switchers with a prior deposit relationship and switchers without a prior deposit relationship to the loan rate of non-switchers made by firms' inside banks, conditional on the specified matching

[18] Note that, in principle, if outside banks are more likely to bid on loans to firms with which they have a deposit relationship, we should not observe cases in which a firm that has an outside deposit relationship with Bank X ultimately switches lenders to Bank Y with which it does not have an outside deposit relationship. Our data sample contains 28,741 switching loan instances. For 10,630 of these observations, the switching firm had an outside deposit relationship and switched to the bank with which it had an outside deposit relationship. In contrast, for only 283 of these observations, the switching firm had an outside deposit relationship and switched to another bank with which it did not have an outside deposit relationship. The small number of observations in the last scenario confirms that outside banks are more likely to bid on loans to firms with which they have a deposit relationship, consistent with our conjecture.

variables. This corresponds to the matching strategy depicted in Figure A1a. Matching on the ten variables listed in Column I of Table 3, we are left with 4,688 matched observations, corresponding to 1,868 unique switching loans paired with 3,194 unique non-switching loans (meaning that each switching loan is matched with approximately 2.5 comparable non-switching loans). From the 1,868 switching loans, 30% of switching firms had a prior deposit relationship with their new (outside) lender.

In Column I, the coefficient estimate of the constant term suggests that, on average, switchers receive a loan rate discount of nearly 80 bp. The next row indicates that switchers with a prior deposit relationship obtain an additional loan rate discount of 82 bp, for a total loan rate discount of 162 bp. This result highlights that outside banks offer much better loan conditions to switching firms that had a prior deposit relationship. For comparison, Table A2 in the Appendix shows that, if we were to omit the role of prior deposit relationships in the loan pricing of switching loans, we would estimate that switching firms receive an average loan rate discount of 80 to 100 bp. This estimate is quantitatively similar to the loan rate discount estimated by previous paper (e.g., Ioannidou and Ongena 2010), but clearly omits important heterogeneity related to the role of deposit relationships in lender switching.[19]

In Columns II to V, instead of matching using comparable loans of the switchers' inside banks, we match using comparable loans of the switchers' outside banks, which corresponds to the matching strategy depicted in Figure A1b. This is our preferred matching strategy, as it compares loans given to switchers and non-switchers by the same bank during the same year. Therefore, the loan rate differences between switching and non-switching loans cannot be attributed to unobserved heterogeneity with respect to the inside and the outside banks (such as differences in funding costs). In the rest of the paper, we will refer to the matching strategy in Column II as our baseline matching approach. Based on the matching strategy in Column II, we find that switchers receive an average loan rate discount of 48 bp, with an additional loan rate discount of 120 bp for switchers that had a prior deposit relationship with their new (outside) lender, consistent with our earlier results.

[19]Ioannidou and Ongena (2010) and Bonfim, Nogueira, and Ongena (2021) estimate a loan rate discount of approximately 90 bp for switching firms in Bolivia and Portugal, respectively. Relative to the baseline loan rate, our estimated loan rate discount of 80 bp is slightly larger than theirs, which could be due to more pronounced hold-up problems in Norway. One observation in line with this argument is that Norwegian firms have fewer lending relationships than firms in Bolivia and Portugal for instance, which increases banks' capability to capture borrowers (Farinha and Santos 2002; Degryse and Ongena 2008; Schenone 2010).

In Columns III to V, we implement alternative matching strategies to ensure that our results are not sensitive to our baseline matching procedure. In Column III, we also match on a deposit relationship dummy, to ensure that we compare loan rates offered by an outside bank to switching firms with (without) a deposit relationship to loan rates offered by the outside bank to comparable existing borrowers with (without) a deposit relationship. In Column VI, we not only match on the credit rating that the switching firms obtain from their new banks, but also the firms' most recent rating from their inside banks prior to the switch. A potential advantage of this approach is that the inside banks' ratings might be more informative (as the inside bank may know the firm better), which could help better approximate the inside banks' unobserved offer to the switcher. Finally, Column V applies a strategy similar to column IV but matches on the inside banks' most recent loan rate instead of its credit rating. Compared to Column IV, the advantage of this approach is that, unlike credit ratings, loan rates do not affect banks' loan loss provisioning (and are therefore less likely to be manipulated).[20] In addition, the inside banks' loan rate should also control for the effect of the strength of switchers' relationships with their inside banks (as switchers with strong relationships with their inside banks are more exposed to hold-up and thus receive worse inside offers). Despite these methodological differences, the results in Columns III to V are quantitatively similar to our baseline results, indicating that outside banks offer an additional loan rate discount of 120 to 144 bp to switchers with a prior deposit relationship.

A potential concern about the results reported in Table 3 is that the matching strategies rely on comparisons of switchers with non-switchers. However, switchers could differ in their growth opportunities and other unobserved characteristics, which might explain the observed discounts on switching loans. In Column I of Table 4 we address this concern by matching switchers that have a prior deposit relationship with similar switchers that do not have a deposit relationship with the outside bank, using our baseline matching variables. This matching strategy significantly reduces our estimation sample to 87 observations. Nevertheless, the results show that outside banks offer a 58 bp larger loan rate discount to switchers with versus without a prior deposit relationship, and this result is statistically and economically

[20]Research has shown that banks (especially those with low capital buffers) may manipulate credit ratings to lower their risk-weighted assets (e.g., Plosser and Santos 2018), which would reduce the informativeness of credit ratings.

significant. It is important to stress that our matching variables include the credit rating that the outside bank assigned to the switchers. Thus, even if a bank estimates the credit risk of two switching firms to be equal, the switching firm that had a prior deposit relationship receives a lower loan rate than the switching firm that did not have such a relationship.

A further concern could be that, even within switchers, firms that have a (prior) deposit relationship with the new lender could differ from firms that do not have a deposit relationship in ways that cannot be observed. To address this concern, in Column II of Table 4 we refine our matching approach even further and match switchers that had a deposit relationship with the new bank prior to switching to other (comparable) switchers that started a deposit relationship with the new bank in the year of the switch. This matching strategy reduces our sample further, to 40 observations. Nevertheless, we still find that switchers with a prior deposit relationship obtain a loan rate that is 62 bp lower than the loan rate of switchers without a prior deposit relationship. In other words, having a *prior* deposit relationship with the outside banks matters.

In summary, our results show that having a deposit relationship with outside banks increases firms' propensity to switch lenders as well as the loan conditions that firms receive upon switching lenders. Below, we examine the potential mechanisms underlying these findings, and the implications that can be drawn from this.

4.3. Mechanisms

In this section, we examine the potential mechanisms underlying our results. On the one hand, theoretical papers on informational hold-up have argued that outside banks face an informational disadvantage vis-à-vis inside banks, which deters them from making outside bids (Broecker 1990; Rajan 1992; Sharpe 1990). On the other hand, there is ample empirical evidence that banks can use information from firms' deposit accounts—which is private, continuous, timely, hard information that cannot easily be manipulated—to monitor existing borrowers' creditworthiness and prevent loan defaults (e.g., Agarwal et al. 2018; Black 1975; Fama 1985; Hibbeln et al. 2020; Mester, Nakamura, and Renault 2007; Norden and Weber 2010; Puri, Rocholl, and Steffen 2017). This is supported by industry reports,

which state that, apart from the information obtained from firms' financial statements and credit registers, payment data are the most important source of information for banks to evaluate (potential) borrowers' creditworthiness (McKinsey 2019).[21] We therefore conjecture that deposit relationships between firms and outside banks can mitigate outside banks' informational disadvantage, thereby increasing lender competition and reducing hold-up in the loan market. Below, we provide several pieces of evidence that support this conjecture.

4.3.1. The information flow of deposit relationships

If deposit relationships mitigate outside banks' informational disadvantage, our results should be stronger for deposit relationships that promote information flow between firms and outside banks. To test this conjecture, we extend our previous analyses in order to exploit heterogeneity in the information flow of the underlying deposit relationships.

We draw on prior literature and construct four firm-bank relationship variables that capture information flow (e.g., see Bharath et al. 2011; Hibbeln et al. 2020; Norden and Weber 2010; Petersen and Rajan 1994). First, we focus on the length of the deposit relationship, measured as the number of years during which the switching firm and outside bank maintained a deposit relationship. Second, we use the scope of the deposit relationship, measured as the number of deposit products underlying the relationship. Third, we construct a measure of deposit relationship depth, which we compute as the share of deposits held by the switching firm at the outside banks compared to the firms' total deposits. Finally, we use an indicator variable that equals one if the deposit relationship comprises a transaction account, which we define as deposit accounts that earn near-zero interest (i.e., below 0.25% per annum).[22] Overall, the reasoning is that longer, deeper, and broader deposit relationships, especially those containing payment transactions, should promote information flow.

We start by exploiting heterogeneity in firms' propensity to switch lenders. To do so, we extend Equation (1) by adding interaction terms between the outside deposit relationship variable and each of the four relationship measures of information flow listed above. The

[21] A report by McKinsey (2019) states that "payments generate roughly 90 percent of banks' useful customer data."

[22] Based on this definition, approximately 75% of deposit relationships in our sample comprises a transaction account, which is in line with statistics reported by Chernykh and Mityakov (2022) for corporate deposit relationships in the Russia, for instance. Unreported results also show that our findings are robust to using different thresholds to identify transaction accounts.

results are presented in Table 5. All regressions include firm controls, firm-bank controls, firm fixed effects, and bank-by-time fixed effects. In line with our baseline results from Table 2, we find that firms with an outside deposit relationship are significantly more likely to switch lenders. In addition, consistent with our conjecture, for the average firm in our sample, we find that the probability of switching lenders is higher for longer, deeper, and broader deposit relationships, and for relationships comprising a transaction account. For instance, Column I indicates that increasing the length of the outside deposit from 1 to 2 years increases the firms' probability of switching lenders by 0.6 pp, and Column IV indicates that deposit relationships comprising a transaction account increase firms' probability of switching by 3 pp.

We then turn to the loan conditions offered by outside banks to switching firms. We extend Equation (2) by adding interaction terms between the prior deposit relationship variable and each of the four relationship measures of information flow listed above. This allows us to compare the loan rate discount offered to switching firms with a long versus short prior deposit relationship, for instance. The results are presented in Table 6. Across the different columns, the coefficient estimates of the constant indicate that switchers without a deposit relationship receive a loan rate discount of approximately 50 bp, which accords with our estimates from Table 3. Further, in line with the idea that prior deposit relationships mitigate outside banks' informational disadvantage, we find that the loan rate discount is larger for switchers with a prior deposit relationship, especially if the outside bank could obtain valuable information from the prior deposit relationship. More specifically, we find that the loan rate discount of the average switcher with a prior deposit relationship is increasing in the length, depth, and scope of their deposit relationship, and larger for deposit relationships comprising a transaction account. Column II, for instance, shows that each one-unit increase in the number of deposit products underlying the prior deposit relationship is associated with a 21 bp larger loan rate discount, while transaction accounts are associated with a 67 bp larger loan rate discount.[23]

[23]Note that, when we add an interaction term with the depth of the prior deposit relationship in Column III, the baseline coefficient estimate of *Prior deposit relationship* becomes insignificant. This suggests that the mere existence of a deposit relationship is not enough; the deposit relationship should have sufficient depth for the firm to obtain a larger loan rate discount than firms without prior deposit relationship at the outside bank. This also implies that maintaining numerous deposit relationships with multiple outside banks may not be an optimal strategy, as doing so would limit the depth of each deposit relationship, reducing the information flow for the outside banks.

Overall, Tables 5 and 6 imply that our baseline results are stronger for deposit relationships that promote information flow between firms and outside banks, which is consistent with our conjecture that deposit relationships mitigate outside banks' informational disadvantage.

4.3.2. Deposit relationships and outside banks' informational disadvantage

Theory suggests that outside banks are less willing to bid on loans to firms for which their informational disadvantage is more pronounced (Broecker 1990; Hauswald and Marquez 2006; Rajan 1992). This means that, if deposit relationships mitigate outside banks' informational disadvantage, we would expect deposit relationships to be more important for firms for which the inside bank has a greater informational monopoly or, more generally, firms with greater information asymmetries.

To test this conjecture, we exploit four sources of heterogeneity. First, we test whether deposit relationships are more important for single-bank borrowers and borrowers that maintained longer lending relationship with their previous (inside) banks, as these borrowers are more locked in by inside banks and face more difficulties switching lenders (Farinha and Santos 2002; Ioannidou and Ongena 2010; Santos and Winton 2008; Schenone 2010). Second, we exploit heterogeneity in firms' age as information asymmetries are more severe for young firms (Beck et al. 2018; Petersen and Rajan 1995). Finally, we exploit heterogeneity in bank competition based on the notion that competition increases adverse selection problems (Boot and Thakor 2000; Degryse and Ongena 2005; Stiglitz and Weiss 1981). For each of these sources of heterogeneity, we create a dummy variable which equals one if the outside banks' informational disadvantage would be more pronounced. This means that we create four dummy variables, which equal one for single-bank borrowers, borrowers with long inside bank relationships, young firms, and firms operating in regions with high bank competition.[24] The cutoff used to create the last three dummy variables is based on the sample median of the corresponding variables.

We start by extending Equation (1) by adding interaction terms between the outside deposit relationship variable and each of the four dummy variables explained above. These

[24]We measure local bank competition using a loan-based Herfindahl-Hirschman Index.

interaction terms allow us to assess whether the likelihood of switching lenders is larger for firms with outside deposit relationship for which the outside banks' informational disadvantage is more (versus less) pronounced. The results are presented in Table 7. All regressions include firm controls, firm-bank controls, firm fixed effects, and bank-by-time fixed effects. In line with our conjecture, we find that having an outside deposit relationship is significantly more important for borrowers for which the outside banks' informational disadvantage is more pronounced. Column II for instance shows that, on average, firms with an outside deposit relationship are 8 pp more likely to switch lenders the next year, and this effect increases to nearly 12 pp for firms that maintained a long relationship with their (previous) inside bank. Similarly, Columns III and IV show that the impact of having an outside deposit relationship on firms' probability of switching lenders is larger for young (informationally opaque) firms and firms that operate in areas with high bank competition.

We exploit the same sources of heterogeneity for the analysis on the loan rates offered by outside banks to switching firms. As before, we extend Equation (2) by adding an interaction term between the prior deposit relationship variable and each of the four dummy variables explained above. The results are presented in Table 8. In line with our baseline results, the coefficient estimate of the constant is significantly negative, indicating that switching firms with prior deposit relationship receive a loan rate discount. Further, consistent with our conjecture that deposit relationships reduce outside banks' informational disadvantage, we find that the effect of having a prior deposit relationship on switching firms' loan rate discount is significantly larger for firms with greater information asymmetries. For instance, Columns I and II show that having a prior deposit relationship increases the loan rate discount obtained by single-bank borrowers and borrowers that maintained a long inside bank relationship by 23 and 80 bp, respectively (although the coefficient estimate of single-bank borrower interaction is less precise). Columns III and IV show similar results for young (informationally opaque) firms and firms that operate in areas with high bank competition.

In sum, Tables 7 and 8 show that our results are stronger if outside banks' informational disadvantage is more pronounced. This is in line with our hypothesis that deposit relationships mitigate the winner's curse that outside banks face in competing with inside banks.

4.3.3. Deposit relationships and outside banks' screening capability

If deposit relationships provide relevant information about firms' creditworthiness, then outside banks should have better screening capabilities for firms with pre-existing deposit relationships. To test this hypothesis, we extend the approach from Weitzner and Howes (2021) to analyze how the credit rating of outside banks assigned to switchers predicts the switchers' future loan performance, and whether this differs for switchers with versus without a prior deposit relationship. Given that only a small fraction of loans are written off, we do not apply a matching strategy; instead, we use all switching loan instances and estimate the following linear probability model:

$$\begin{aligned} \textit{Loan default}_{i,j,t+3} =& \alpha + \delta_1 \textit{Prior deposit relationship}_{i,j,t} + \delta_2 \textit{Credit rating}_{i,j,t} + \\ & \delta_3 (\textit{Prior deposit relationship} \times \textit{Credit rating})_{i,j,t} + \gamma X_{i,j,t} + \epsilon_{i,j,t} \end{aligned} \tag{4}$$

where the outcome variable is a dummy variable equal to one if the new (outside) lender writes off the switching loan within the first three years after the switch. $\textit{Prior deposit relationship}_{i,j,t}$ is a dummy variable equal to one if the switcher had a prior deposit relationship with the new (outside) lender, and zero otherwise. $\textit{Credit rating}_{i,j,t}$ is the credit rating assigned by the new lender to the switcher at the time of the switch, and varies between zero and one, with higher values corresponding to a higher probability of default (and hence a worse credit rating). Since we use the credit rating assigned at the time of the switch, this variable only captures information used in the outside bank's screening process, not its monitoring process. $X_{i,j,t}$ is a vector of control variables, which consists of the variables used in our baseline matching approach (i.e., the loan amount, the loan type, the proportion of the loan collateralized, firm size, bank fixed effects, time fixed effects, firm sector fixed effects, firm legal type fixed effects, and firm locality fixed effects). The error term, $\epsilon_{i,j,t}$, is clustered at the firm level. In this regression model, δ_1 captures the potential difference in loan defaults between switchers with versus without a prior deposit relationship, δ_2 captures outside banks' (average) screening capability, and δ_3 captures the potential difference in outside banks' screening capability for switchers with versus without a prior deposit relationship.

The results are presented in Table 9. In Columns I and II, we report the results from

estimating Equation (4) without the interaction term between *Prior deposit relationship* and *Credit rating*. These results show that the credit ratings assigned by outside banks to switching firms are statistically and economically significant predictors of the firms' future loan default, even after controlling for a rich set of firm and firm-bank covariates (consistent with Weitzner and Howes 2021). For instance, the coefficient estimates in Column I indicate that a one standard deviation increase in the assigned credit rating corresponds to a 2 pp increase in the future default probability, corresponding to 30% of its standard deviation. More interestingly, when we add the interaction term in Columns III and VI, we find that the relationship between switchers' credit rating and future loan performance is much stronger for switchers with prior deposit relationship, consistent with the idea that deposit relationships improve outside banks' screening capabilities. In addition, we find a substantial rise in Adjusted R-squared values from 0.092 in Column I to 0.110 in Column III (an increase of nearly 20%), which offers further support that deposit relationships improve the precision of outside banks' credit risk assessment.

4.4. Extensions

4.4.1. Other loan terms

Our baseline analysis focuses on how prior deposit relationships affect the loan rates offered by outside banks to switching firms. In Table A3 in the Appendix, we show that prior deposit relationships also affect non-pricing loan terms. Specifically, we estimate the effect on the loan amount, the probability that the loan agreement contains a credit line, and the proportion of the loan that is collateralized. For brevity, Table A3 only reports the results using the matching variables used in the baseline matching approach. The loan rate is now included in the matching variables, while the outcomes of interest are excluded from the matching variables used in the corresponding models.

We first focus on the coefficient estimates of the constant term across the three columns of Table A3. These estimates indicate that, on average, switching loans have smaller loan amounts, a lower probability of containing a credit line, and a lower collateralization rate, which is consistent with findings from Bonfim, Nogueira, and Ongena (2021) for example.

Turning to our main coefficient of interest, Columns I and II indicate that switchers with a prior deposit relationship receive larger loan amounts and are more likely to receive a credit line compared to switchers without a prior deposit relationship, which is in line with the notion that having a prior deposit relationship improves switching firms' loan conditions. Column III further shows that the collateral requirements of switching loans do not depend on whether the switcher had a prior deposit relationship with the new (outside) lender. Overall, outside banks seem to offer better pricing and non-pricing loan terms to switchers with a prior deposit relationship.

4.4.2. RDD estimation

Ideally, to assess how outside deposit relationships affect firms' propensity to switch lenders, one would randomly assign deposit relationships between firms and outside banks. The difference in the probability of switching lenders would then be attributable to the outside deposit relationships. We attempt to get close to this ideal setting by exploiting the deposit insurance threshold to achieve identification through a regression discontinuity design (RDD).

The RDD estimator does not require perfect randomization in treatment assignment, but only a sharp change in the probability of treatment induced by a threshold of a continuous assignment variable. In that case, a sufficient condition to obtain a valid causal estimate of the treatment effect is that the continuity assumption holds, which requires that (1) all possible confounders are continuous at the threshold defining the treatment assignment rule and (2) there is no manipulation of the threshold by the treatment group.

The deposit insurance threshold for corporate deposits in Norway is NOK 2,000,000 per account holder, per bank (which is around USD 180,000) and has remained constant over our sample period. Conditional on exceeding this threshold at a given bank, the probability that a firm opens a deposit account at a (non-lender) outside bank sharply increases, as firms have an incentive to ensure that the amount deposited at each bank is fully insured (e.g., see Cucic et al. 2024; De Roux and Limodio 2023; Iyer, Puri, and Ryan 2016).

To exploit this threshold effect in a fuzzy regression discontinuity design, we first verify that outside deposit relationships are assigned stochastically with a discontinuity at the NOK

2,000,000 cutoff. Figure A2 in the Appendix plots the probability that a firm has a deposit relationship with a (non-lender) outside bank for firms with deposits NOK 155,000 below and above the deposit insurance threshold.[25] This figure confirms that there is a significant discontinuity (jump) in the probability of outside deposit relationships once a firm's total deposits cross the deposit insurance threshold. For example, the probability that a firm has an outside deposit relationship is approximately 37% for firms with total deposits below the threshold compared to 41% for firms with total deposits above the threshold.

Consequently, if the continuity assumption holds, as we confirm in tests reported in the Online Appendix, we can use the corporate deposit insurance threshold in a fuzzy regression discontinuity design. Specifically, we estimate the following two-equation system:

First stage:

$$\begin{aligned} \textit{Outside deposit relationship}_{i,t} = & \alpha_0 + \alpha_1(1\{\textit{Deposits} > \text{NOK } 2,000,000\}_{i,t}) + \\ & f(\textit{Deposits}_{i,t}) + \delta X_{i,t} + \epsilon_{i,t} \end{aligned} \tag{5}$$

Second stage:

$$\textit{Switch}_{i,t+1} = \beta_0 + \beta_1 \widehat{\textit{Outside deposit relationship}}_{i,t} + g(\textit{Deposits}_{i,t+1}) + \theta X_{i,t+1} + \upsilon_{i,t+1} \tag{6}$$

where i and t correspond to firm and year, respectively.[26] Equation (5) is our first stage equation that models the propensity to have an outside deposit relationship as a function of whether a firm's total deposits exceed the deposit insurance threshold. $1\{\textit{Deposits} > \text{NOK } 2,000,000\}_{i,t}$ is an indicator variable that equals one if firm i has total deposits exceeding NOK 2,000,000 in year t, and $\textit{Outside deposit relationship}_{i,t}$ is an indicator variable that equals one if a firm i has an outside deposit relationship in year t (as defined in Section 3.2.1). The function $f(\textit{Deposits}_{i,t})$ represents local polynomial control functions of the running variable, which is the deposit balance near the deposit insurance threshold. The coefficient of interest in Equation (5) is α_1, which captures the discontinuity in firms' propensity to have an outside deposit relationship conditional on having deposits exceeding the deposit insurance threshold. If exceeding the deposit insurance threshold increases firms' propensity

[25] This bandwidth corresponds to the CER-optimal bandwidth used in our RDD estimation with triangular kernel and first-order polynomial, as explained below.

[26] We conduct this analysis at the firm level as this corresponds with the level of the running variable.

to split deposits across banks in order to ensure their deposits at each bank are fully insured, we would expect α_1 to be significantly positive.

Equation (6) is our second stage equation that models firms' propensity to switch lenders as a function of threshold-driven variation in outside deposit relationships. As in Equation (5), the function $g(Deposits_{i,t+1})$ represents local polynomial control functions of firms' total deposits, which ensures that our coefficient estimate of β_1 is estimated using variation in the propensity to have an outside deposit relationship from firms around the deposit insurance threshold. β_1 thus captures the local average treatment effect of having an outside deposit relationship on firms' probability of switching lenders.[27] In robustness test reported in the Online Appendix, we include covariates, $X_{i,t+1}$, to control for a variety of firm characteristics.[28] The standard errors, $\upsilon_{i,t+1}$, are clustered at the firm level.

Table A4 in the Appendix reports the robust RDD estimates (with robust variance estimator as in Calonico, Cattaneo, and Titiunik 2014). Following recent work in the applied econometrics literature, we employ local linear or quadratic polynomial control functions (Gelman and Imbens 2019), and estimate these using a triangular kernel in a CER-optimal bandwidth (Calonico, Cattaneo, and Titiunik 2014; Calonico, Cattaneo, and Farrell 2020). Results reported in the Online Appendix show that our results also hold using linear and quadratic polynomial control functions with a uniform or epanechnikov kernel.

Columns I and III of Table A4 report the first stage results using linear and quadratic polynomial control functions, respectively. These estimates indicate that exceeding the NOK 2,000,000 deposit insurance threshold is associated with a discontinuity in the probability of having an outside deposit relationship of approximately 3.6 to 3.7 pp. This results is statistically as well as economically significant as the baseline probability of having an outside deposit relationship is around 20%. Columns II and IV report the corresponding second stage results. The RDD estimates from the second stage regressions (which need to be interpreted as local average treatment effects) imply that having an outside deposit relationship increases firms' propensity to switch lenders by approximately 28 pp, which is

[27] Note that we do not make the common treatment effect assumption necessary to estimate average treatment effects but instead maintain a weaker set of assumptions required to interpret our estimates as local average treatment effects for firms with deposit balances near the NOK 2,000,000 deposit insurance threshold (Hahn, Todd, and Van der Klaauw 2001).

[28] In principle, the inclusion of control variables should not change the estimated RDD parameters since other covariates should be balanced around the threshold, which we show to be the case in the Online Appendix.

statistically and economically significant.

As mentioned earlier, an important condition for these estimates to be valid is that the continuity assumption underlying our RDD estimator holds. In the Online Appendix, we provide evidence supporting this assumption. Our RDD estimates therefore mitigate potential endogeneity concerns related to our baseline results and support the conclusion that having a deposit relationship with outside banks increases firms' propensity to switch lenders.

4.4.3. Alternative channels

In this section we explore alternative channels that could be driving our results. In particular, we analyze whether our results can instead be explained by the role of deposits as a means of cross-selling (Basten and Juelsrud 2023; Qi 2024), collateral for loans (Uchida 2003), or bank funding (Berlin and Mester 1999; Diamond and Dybvig 1983; Kashyap, Rajan, and Stein 2002). First, to analyze the role of deposits as a means of cross-selling, we test whether our results depend on the deposit rate that switching firms earn at the outside bank. Second, to analyze the potential role of deposits as a form of collateral, we test whether our results depend on switching firms' deposit-to-loan ratio. Third, to assess the role of deposits as a source of bank funding (or withdrawal risk), we test whether our results depend on the switching firms' depositor size, measured as a switching firm's deposits held at the outside bank compared to the outside bank's total deposits.

Tables A5 and A6 in the Appendix present the results for the probability of switching lenders and loan rate discount obtained upon switching lenders, respectively. The interaction terms with the deposit rate, deposit-to-loan ratio, and depositor size variables are statistically insignificant (except the coefficient estimate in Column III of Table A5 but the economic magnitude of this coefficient estimate is negligible).[29] In general, these results imply that our results cannot be attributed to any of the alternative channels explained above.

To further rule out that our results may be driven by cross-selling strategies, we analyze the deposit rates offered by outside banks. In general, cross-selling strategies are based on "loss-leader" or "bargain-then-ripoff" strategies (Klemperer 1995). In practice, this typically

[29]The standard deviation of the depositor size variable equals 0.02, meaning that a one standard deviation in depositor size of firms with an outside deposit relationship is associated with a 0.4 pp increase in their probability of switching lenders.

means that banks initially offer attractive deposit terms, especially to depositors that could be converted to borrowers, after which these depositors are offered worse loans terms, allowing the banks to recoup their initial losses (Basten and Juelsrud 2023). In our setting, we find that outside banks offer significantly lower (rather than higher) loan rates to switching firms with versus without a prior deposit relationship, which is hard to reconcile with the loss-leader strategy explained above. Nevertheless, we adapt Equation (2) to test whether switching firms that had a prior deposit relationship with their new lender earn significantly different deposit rates than other (comparable) firms at that lender. The results are reported in Table A7 in the Appendix. Panels A and B of this table respectively show that, on average, switching firms do not receive significantly different deposit rates either in the year they obtain a switching loan from the outside bank (i.e., upon switching lenders) or in the year they initially started their deposit relationship with the outside bank (i.e., before switching lenders), which is inconsistent with cross-selling strategies.

4.4.4. Inside banks' response

Our main analysis focuses on the role of deposit relationships between firms and outside banks from the perspective of the outside banks. We now turn our attention to the inside banks and study how they react when their borrowers start a deposit relationship with outside banks. Theoretically, it is unclear whether and how inside banks would respond. On the one hand, by reducing the informational disadvantage of outside banks, having an outside deposit relationship could increase firms' outside options and hence increase lender competition (Hauswald and Marquez 2006; Rajan 1992; Sharpe 1990). For instance, using its outside loan offers, the firm could renegotiate its loan contract with the inside bank in order to obtain better loan conditions. On the other hand, research has shown that obtaining credit from an outside bank can decrease inside banks' willingness to lend to a firm, due to concerns about indebtedness and coordination problems (Bolton and Scharfstein 1996; Degryse, Ioannidou, and von Schedvin 2016). Anticipating this, inside banks might react by cutting credit.

To test these opposing predictions, we analyze how the loan terms offered by a firm's inside

bank change after the firm starts a deposit relationship with another outside bank (without necessarily obtaining credit from the outside bank). We proceed in three steps. First, we identify borrowers that start a deposit relationship with outside banks and match the loans of those borrowers with all similar loans granted to other comparable borrowers at the same inside bank in the same year. We match on inside bank and borrower identity as well as the matching variables used in our baseline matching approach (see Section 4.2). Second, we calculate the difference between the change in interest rate or loan amounts of loans granted by inside banks to borrowers that started a deposit relationship with outside banks and each matched loan. Third, we regress the difference on a constant. The corresponding regression model is:

$$\Delta Y_{i,j,t} - \Delta Y_{m(i,j,t)} = \alpha + \epsilon_{i,j,t} \tag{7}$$

where $\Delta Y_{i,j,t}$ is the change in interest rate or loan amount of loans granted by inside banks to borrowers that started a deposit relationship with outside banks in year t, and $\Delta Y_{m(i,j,t)}$ is the change in interest rate or loan amount of matched loans without an outside deposit relationship. α and $\epsilon_{i,j,t}$ represent a constant and the error term, respectively.

The results are reported in Table A8 in the Appendix. Panels A and B show the results for changes in interest rates and loan amounts from year t to year $t+1$, respectively. Column I shows that inside banks decrease the loan rates of borrowers that start an outside deposit relationship by 30 bp (compared to similar borrowers that did not start an outside deposit relationship). In Column II, we do not find significant changes in the amount of credit offered by inside banks to firms that start an outside deposit relationship.

Overall, Table A8 shows that firms obtain lower loan rates from their inside banks after starting a deposit relationship with outside banks. This reduction in loan rates is smaller than the loan rate discount that firms could obtain from switching to outside banks, but this result accords with the idea that having an outside deposit relationship increases lender competition. Moreover, this result provides further evidence that having a deposit relationship with outside banks is in fact beneficial for borrowers as it mitigates hold-up problems.

4.4.5. Loan rate cycle

Our analysis shows that outside banks offer better loan conditions to switchers with a prior deposit relationship than switchers without a prior deposit relationship. A potential concern could be that this analysis is based on the loan rates offered at the time of the switch, and does not take into account potential differences in the loan rates offered over the course of the new lending relationships. For instance, over time, the new lender might more rapidly raise the loan rate of switchers with a prior deposit relationship, which could offset the benefit from the lower loan rate obtained at the time of the switch.

To empirically examine this, we follow the approach of Ioannidou and Ongena (2010) and analyze switchers' loan rate cycle at the new lender. Specifically, we trace switchers over time at their new lender, and compute the spread between the loan rate on the switching loan and the loan rate on future loans that the switchers obtain from their new lender after the switch. This means that we compare loans from the same lender to the same borrower over the course of the new lending relationship. In addition to matching on bank and borrower identity, we also match on the variables used in our baseline matching model, including borrowers' credit rating and loan conditions (meaning that we only compare the loans to switchers that remained with the new lender and whose rating did not change after the switch).

Using this sample, we create two sub-samples based on switchers with and without a prior deposit relationship (at the time of the switch), and we group the corresponding matches of each sub-sample into four one-year periods after the switch. For each sub-sample and each of these four groups, we then regress the spreads on a constant and time dummies (allowing the spreads to depend on other time-specific conditions). The results are presented in Table O.E1 in the Online Appendix, which reports the coefficient estimates of the constant.[30] The results suggest that the loan rate cycle of switchers with and without a prior deposit relationship is similar. For both sub-samples, we find that the new lender gradually increases the loan rate over the course of the lending relationship (as in Ioannidou and Ongena 2010). For instance, four years after the switch, the loan rate of switchers without a prior deposit relationship is

[30] Note that there are more observations in the second than in the first year after the switch, as there are more firms in our sample that take out a new loan from their new (outside) lender two years after the switch.

17 bp higher than at the time of the switch, compared to 16 bp for switchers with a prior deposit relationship. Overall, this suggests that our baseline results are not attributable to differences in the loan rate cycle of switchers with and without a prior deposit relationship.

4.4.6. Within-firm matching approach

In our baseline analysis, we apply two matching strategies to analyze the loan conditions offered by outside banks to switching firms. In the first one, we compare the loan conditions obtained by switching firms with and without a prior deposit relationship to the loan conditions obtained by comparable non-switching firms. In the second one, we compare the loan conditions obtained by switching firms with a prior deposit relationship to the loan conditions obtained by comparable switching firms without a prior deposit relationship. Both approaches enable us to assess whether switchers with a prior deposit relationship receive different loan conditions than switchers without such a relationship, although the second approach is more restrictive than the first one.

In this robustness test, we apply a third matching strategy that is based on comparing the loan conditions on switching and non-switching loans obtained by the same firm in the same year. This within-firm analysis is similar to the first approach applied in our main analysis, but instead of matching a switching loan from a switching firm with a comparable non-switching loan from a non-switching firm, we match a switching loan from a switching firm with a concurrent non-switching loan from that switching firm (also see Bonfim, Nogueira, and Ongena 2021). This approach mitigates that our results are driven by unobserved firm-specific time-varying characteristics in the year of the lender switch.

The results are presented in Table O.E2 in the Online Appendix. The matching variables used in the within-firm matching approach correspond to the ones used in our baseline matching strategy (see Section 4.2). The results from the within-firm matching approach indicate that, on average, outside banks offer a loan rate discount of approximately 50 bp on switching loans. This loan rate discount increases to 150 bp for switchers with prior deposit relationship, which is quantitatively similar to our baseline results.

4.4.7. Alternative definition of lender switching

Our baseline analysis employs the operational definition of lender switching from Ioannidou and Ongena (2010). According to this definition, a firm switches lenders if it obtains a loan from a bank with which it did not have a lending relationship during the previous twelve months, which relies on the assumption that key information becomes inadequate within twelve months (as explained in Section 3.1.2). One could however be concerned about the validity of this assumption. For instance, a firm could have obtained a loan from an outside bank in year $t-2$, but we would still consider a loan obtained in year t to be a switching loan. This could be particularly problematic if firms that have a prior deposit relationship with outside banks are more likely to be firms that obtained credit from those banks at an earlier point in time.

To mitigate this concern, we re-estimate our results using a stricter definition of lender switching. Specifically, we assume the following two conditions for a new loan to be classified as a switching loan. First, the new loan should be obtained from a bank with which the firm *never* had a lending relationship before.[31] This condition is much stricter than our previous condition and ensures that we are focusing on truly "new" lending relationships. Second, as before, the firm must have had at least one lending relationship in the previous twelve months with at least one other bank.

The results based on this alternative definition are presented in Tables O.E3 and O.E4 in the Online Appendix and are very comparable to our baseline results from Tables 2 and 3, respectively. The coefficient estimates in Table O.E3 are smaller than the ones from Table 2, but the economic magnitudes are in fact comparable as the average probability of switching lenders decreases to around 10% when we employ our stricter definition of lender switching. Taken together, our results are robust to a stricter definition of lender switching.

[31] To be precise, based on the deposit and loan account data from the Norwegian Tax Administration, we only classify a new loan as a switching loan if the firm and the bank did not have a prior lending relationship since the year 2000.

5. Conclusion

By lending to a firm, (incumbent) inside banks gain an informational advantage over (non-lender) outside banks (Diamond 1984; Rajan 1992; Sharpe 1990; von Thadden 2004). This informational advantage makes it difficult for borrowers to switch lenders, as outside banks face a winner's curse in competing with the inside banks, which in turn allows the inside banks to hold up borrowers and extract informational rents.

Using unique data on all firm-bank deposit and lending relationships in Norway, our paper shows that deposit relationships between firms and outside banks mitigate inside banks' informational monopoly, thereby attenuating hold-up problems in the loan market. To show this, our paper comprises two parts. In the first part, we uncover new stylized facts about the structure of firm-bank relationships, and document that it is common for firms that switch lenders to have pre-existing deposit relationships with their new (outside) lenders. This suggests that deposit relationships between firms and outside banks play an important role in lender switching. In the second part of our paper, we formally show that having a deposit relationship with outside banks significantly improves firms' propensity to switch lenders and loan conditions received from those lenders upon switching. Consistent with informational hold-up theory, these effects are due to the fact that firms' deposit account activity provides valuable information to outside banks, leading to increased lender competition.

By connecting the literature on deposit relationships with lender competition, our findings shed new light on the two-sidedness of the banking sector, with important implications for our understanding of hold-up problems in the loan market. Our results for instance imply that reducing information asymmetries, e.g. through open banking initiatives, or reducing depositor stickiness, e.g. through deposit market reforms, are critical to facilitate lender switching and mitigate hold-up problems.

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Figure 1. The structure of firm-bank relationships

This figure shows the proportion of firm-bank relationships that consists of both a deposit and a lending relationship in blue, only a deposit relationship in red, and only a lending relationship in green. The sample comprises all firm-bank deposit and lending relationships of firms with at least one lending relationship operating in Norway between 2000 and 2019.

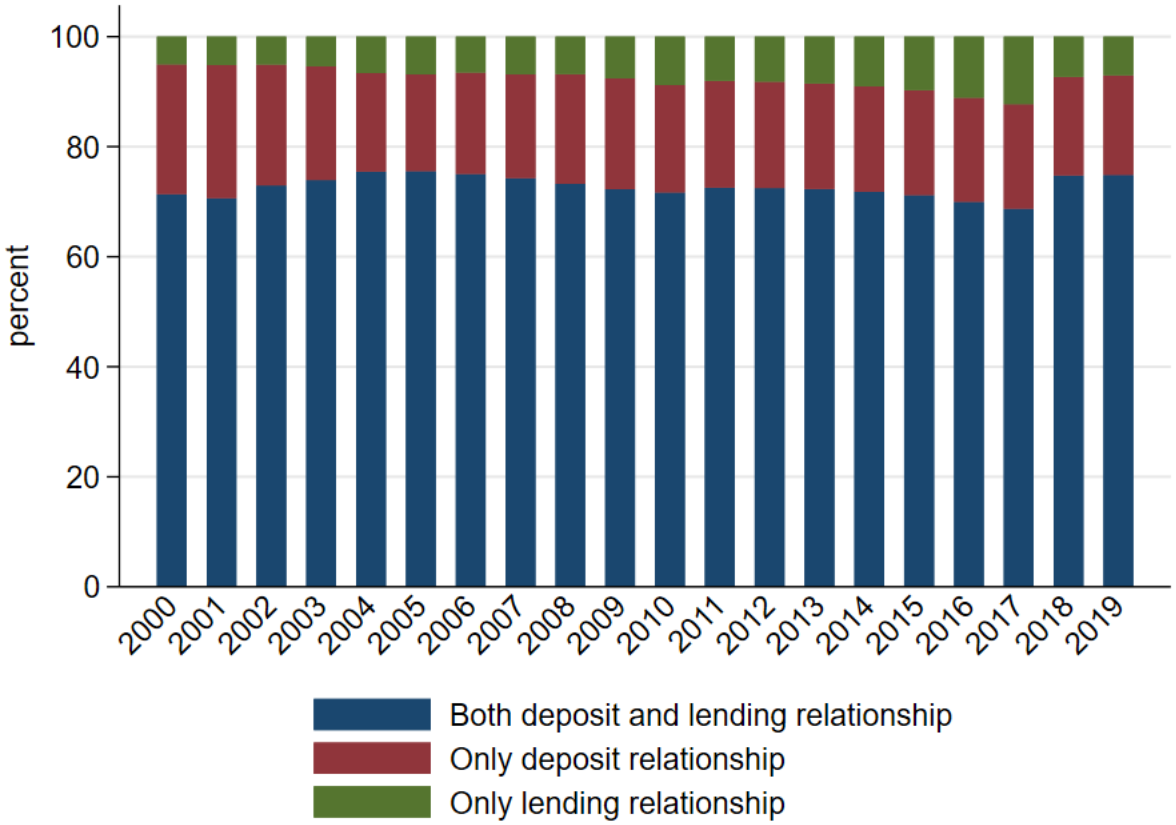


Figure 2. The number of lending and deposit relationships per firm

This figure shows the proportion of firms that has as many deposit relationships as lending relationships in blue, more deposit relationships than lending relationships in red, and fewer deposit relationships than lending relationships in green. The sample comprises all firms with at least one lending relationship operating in Norway between 2000 and 2019.

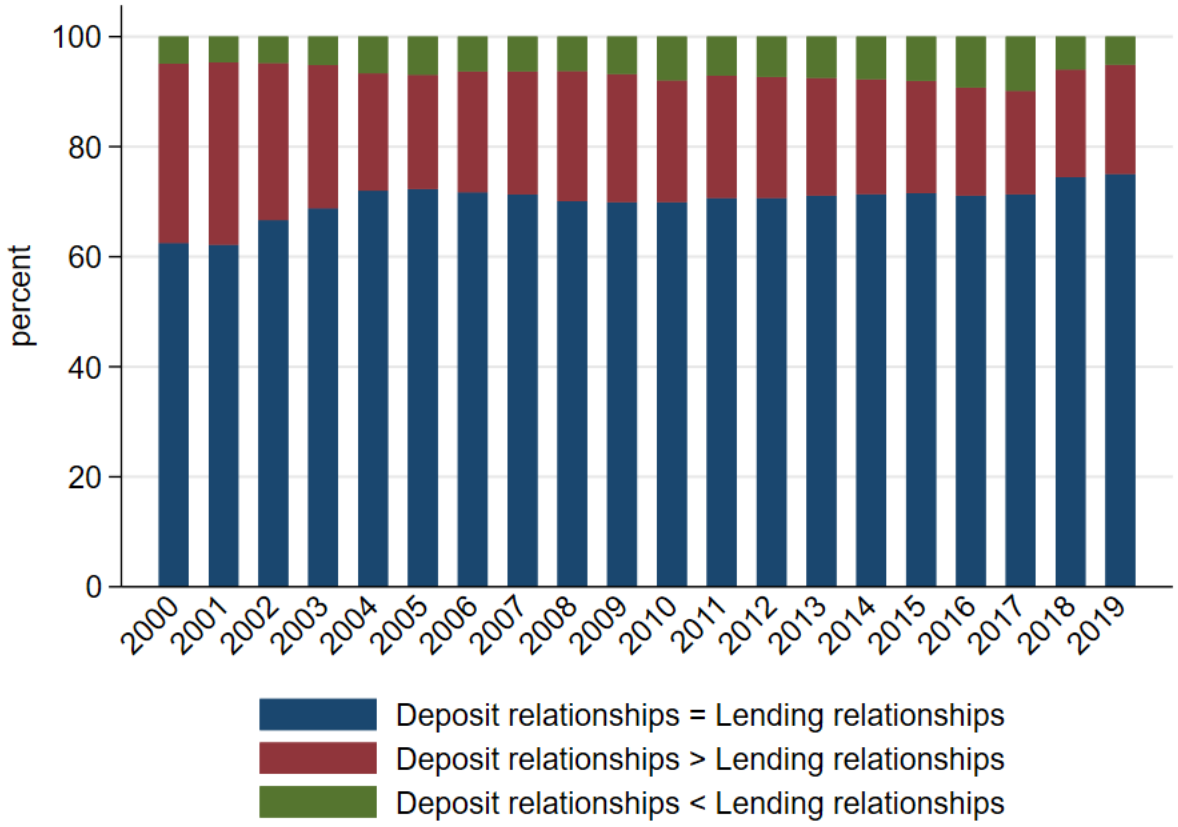


Figure 3. The proportion of switching firms that had a pre-existing deposit relationship with their new lender

This figure shows the proportion of switching firms that had a deposit relationship with their new (outside) lender prior to switching in blue, and the proportion of switching firms that did not have a deposit relationship with their new (outside) lender prior to switching in red. Following the definition from Ioannidou and Ongena (2010), a loan is classified as a switching loan if it satisfies the following two conditions: (1) the loan should be obtained from a bank with which the firm did not have a lending relationship during the previous twelve months, and (2) the firm must have had at least one lending relationship in the previous twelve months with at least one other bank. The sample comprises all switching firms operating in Norway between 2000 and 2019.

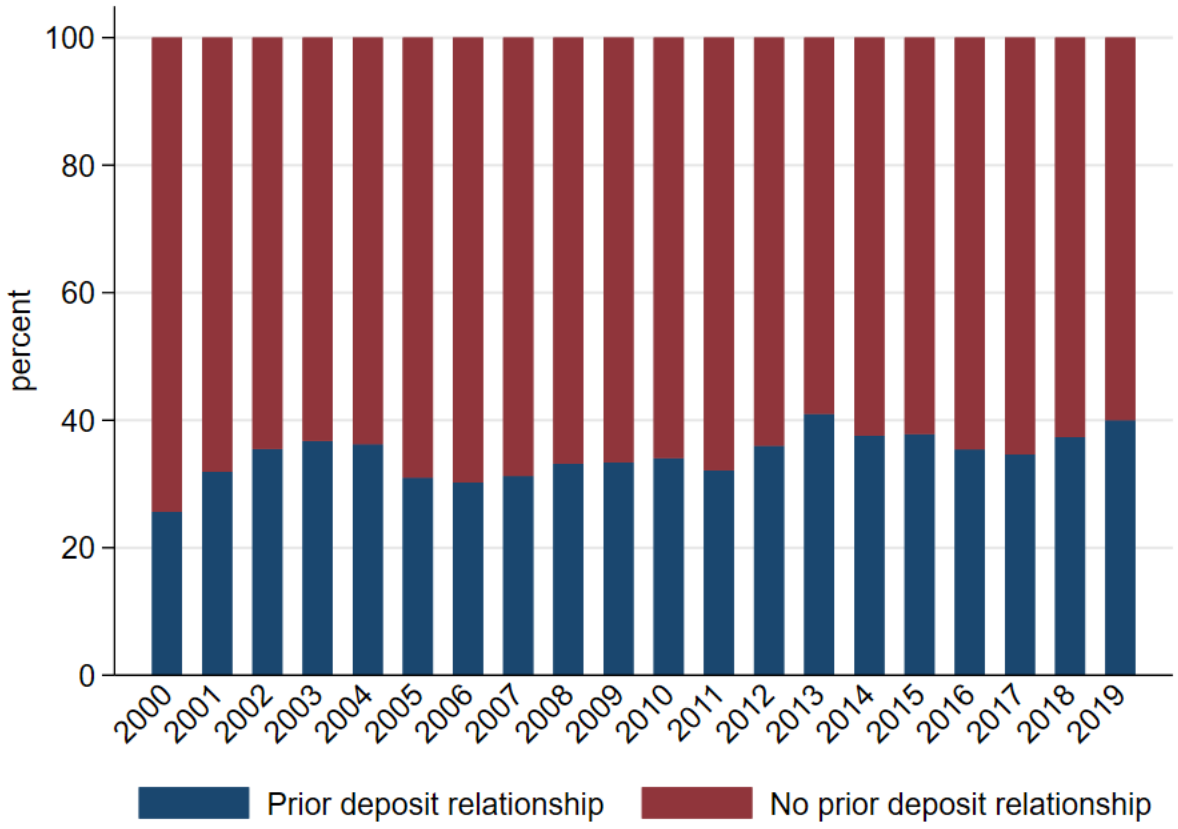


Table 1. Summary statistics

The sample contains all firms with at least one lending relationship operating in Norway between 2014 and 2019. Panel A reports summary statistics for the mail variables used in our empirical analysis. In Panels B and C, means, medians and standard deviations are compared across sub-samples. In Panel B, the comparison group is the group of firms without an outside deposit relationship. In Panel C, the comparison group is the group of non-switching firms. Differences in means are assessed using the Student's t-test; differences in medians are assessed using the Wilcoxon–Mann–Whitney test for continuous variables and Pearson's chi-square test for categorical variables; differences in standard deviations are assessed using Levene's test. In Panels B and C, *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Panel A	Total sample (N=333,379)				
	Mean	Median	SD	P5	P95
Outside deposit relationship	0.196	0.000	0.397	0.000	1.000
Switch	0.155	0.000	0.362	0.000	1.000
Loan rate (%)	5.174	4.850	3.326	0.000	10.350
ln(Loan amount)	13.213	13.122	1.979	10.159	16.524
Credit line	0.471	0.000	0.499	0.000	1.000
Proportion of loan collateralized (%)	145.029	92.821	258.170	0.000	440.285
Credit rating	0.027	0.008	0.088	0.002	0.089
Public company	0.002	0.000	0.043	0.000	0.000
Size	8.622	8.505	1.722	6.033	11.856
Age	14.673	12.000	12.688	1.000	35.000
Debt/TA (%)	81.822	74.277	59.446	30.188	151.425
EBIT/TA (%)	2.902	5.471	32.023	-40.000	38.742
Fixed assets/TA (%)	32.051	24.301	27.581	0.469	86.480

Panel B	Firms with outside deposit relationship (N=65,331)			Firms without outside deposit relationship (N=268,048)		
	Mean	Median	SD	Mean	Median	SD
Switch	0.195***	0.000	0.396***	0.145	0.000	0.352
Loan rate (%)	5.234***	4.800***	3.644***	5.159	4.855	3.244
ln(Loan amount)	13.335***	13.154***	2.134***	13.183	13.122	1.938
Credit line	0.414***	0.000	0.493***	0.485	0.000	0.500
Proportion of loan collateralized (%)	133.938***	88.919***	240.173***	147.732	93.779	262.299
Credit rating	0.025***	0.006***	0.090***	0.027	0.008	0.087
Public company	0.004***	0.000	0.062***	0.001	0.000	0.036
Size	8.910***	8.745	1.864***	8.552	8.455	1.678
Age	15.848***	13.000	14.156***	14.390	12.000	12.290
Debt/TA (%)	80.804***	74.359***	57.010***	82.071	74.257	60.022
EBIT/TA (%)	2.478***	5.246***	32.400	3.005	5.525	31.930
Fixed assets/TA (%)	34.608***	28.252***	27.650***	31.427	23.867	27.300

(Table 1 continued)

Panel C	Switchers with prior deposit relationship (N=10,630)			Switchers without prior deposit relationship (N= 18,111)			Non-switchers (N=304,638)		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
Prior deposit relationship length	7.181***	6.000***	5.761***	0.000***	0.000***	0.000***	4.803	2.000	5.729
Loan rate (%)	4.001***	3.879***	3.689***	5.486***	4.700***	4.360***	5.196	4.900	3.232
ln(Loan amount)	13.517***	13.528***	2.300***	12.594***	12.571***	1.946***	13.239	13.132	1.961
Credit line	0.701***	1.000***	0.458***	0.212***	0.000	0.408***	0.479	0.000	0.500
Proportion of loan collateralized (%)	153.762*	97.714***	295.916***	82.417***	64.485***	191.554***	148.447	95.363	259.723
Credit rating	0.023***	0.008	0.077***	0.021***	0.004***	0.081***	0.026	0.007	0.087
Public company	0.004***	0.000	0.064***	0.002	0.000	0.044	0.001	0.000	0.038
Size	9.037***	8.907***	1.714	8.931	8.775***	1.654***	8.463	8.341	1.718
Age	16.531***	14.000***	13.725***	14.696***	12.000**	12.795	14.278	11.000	12.618
Debt/TA (%)	74.971***	70.814***	46.222***	78.850***	74.989***	46.174***	82.467	73.984	63.031
EBIT/TA (%)	4.768***	6.446***	28.629***	4.059***	5.590	28.018***	2.758	5.560	33.498
Fixed assets/TA	30.373***	22.777*	26.322***	32.831***	25.622***	27.062***	31.839	23.646	27.983

Table 2. Deposit relationships and the probability of switching lenders

This table reports how outside deposit relationships affect firms' probability of switching lenders, based on the following regression model:

$$Switch_{i,t} = \alpha + \beta Outside\ deposit\ relationship_{i,t-1} + \gamma X_{i,j,t} + \eta_i + \delta_{j,t} + \epsilon_{i,j,t}$$

where $Switch_{i,t}$ is a dummy variable equal to one if a firm i switched to a new lender in year t. $Outside\ deposit\ relationship_{i,t-1}$ is a dummy variable equal to one if firm i had a deposit relationship with at least one (non-lender) outside bank in year $t-1$. $X_{i,j,t}$ is a vector of firm and firm-bank control variables. Firm controls include firms' size, leverage ratio, EBIT to total assets, fixed assets to total assets, and a dummy variable equal to one for public companies. Firm-bank controls include the loan rate, loan amount, the proportion of loan collateralized, the probability of default, and a dummy variable equal to one for credit lines. η_i and $\delta_{j,t}$ are firm and bank-by-time fixed effects, respectively. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

	I	II	III	IV	V
	Switch	Switch	Switch	Switch	Switch
Outside deposit relationship$_{t-1}$	0.045***	0.101***	0.081***	0.080***	0.080***
	(0.002)	(0.004)	(0.004)	(0.004)	(0.004)
Observations	320,484	307,300	307,300	307,300	307,297
Adjusted R-squared	0.026	0.190	0.211	0.215	0.219
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	Yes	Yes	Yes
Time FE	No	No	Yes	Yes	No
Bank FE	No	No	No	Yes	No
Bank × Time FE	No	No	No	No	Yes

Table 3. Deposit relationships and outside banks' loan offers

This table reports how prior deposit relationships affect the loan rate discount offered by outside banks to switching firms, based on the following matching approach: First, we match each switching loan with all similar non-switching loans granted to other comparable firms by the switcher's inside or outside banks at the time of the switch. Second, we calculate the spreads between the rates on the switching loans and each matched loan. Third, we use the calculated spreads to estimate the following regression model:

$$R_{i,j,t} - R_{m(i,j,t)} = \alpha + \beta Prior\ deposit\ relationship_{i,j,t} + \epsilon_{i,j,t}$$

where $R_{i,j,t}$ represents the loan rate on switching loans granted by bank j to firm i in year t and $R_{m(i,j,t)}$ the loan rate on its matched counterfactual. α is the constant and $Prior\ deposit\ relationship_{i,j,t}$ is a dummy variable equal to one if the switcher and the new (outside) lender had a prior deposit relationship. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. We weigh each observation by one over the total number of comparable matched loans per switching loan. Across the different columns, we report the variables used in the matching procedure. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Matching variables	I	II	III	IV	V
	Loan rate	Loan rate	Loan rate	Loan rate	Loan rate
Year	Yes	Yes	Yes	Yes	Yes
Inside bank	Yes				
Outside bank		Yes	Yes	Yes	Yes
Credit rating	Yes	Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes
Legal structure	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes
Loan amount	Yes	Yes	Yes	Yes	Yes
Loan type	Yes	Yes	Yes	Yes	Yes
Proportion of loan collateralized	Yes	Yes	Yes	Yes	Yes
Deposit relationship			Yes		
Prior credit rating from inside banks				Yes	
Loan rate on prior inside loans					Yes
Number of switching loans	1,871	2,273	2,047	1,999	743
Number of non-switching loans	3,205	3,659	3,300	3,331	1,080
Number of observations	4,674	5,330	4,773	4,701	1,317
Proportion of switching loans with a prior deposit relationship	30%	30%	30%	32%	30%
Constant	-0.798***	-0.483***	-0.410***	-0.469***	-0.577***
	(0.087)	(0.064)	(0.067)	(0.070)	(0.096)
Prior deposit relationship	-0.821***	-1.210***	-1.438***	-1.203***	-1.159***
	(0.189)	(0.163)	(0.176)	(0.170)	(0.241)

Table 4. Deposit relationships and outside banks' loan offers: Comparing switchers to switchers

This table reports how prior deposit relationships affect the loan rate discount offered by outside banks to switching firms, based on the following matching approach: First, we match each switching loan of firms with a prior deposit relationship to all similar switching loans of firms without a prior deposit relationship granted by the switchers' new (outside) lender at the time of the switch. Second, we calculate the spreads between the rates on the switching loans granted to switchers with a prior deposit relationship and each matched loan granted to switchers without a prior deposit relationship. Third, we use the calculated spreads to estimate the following regression model:

$$R_{i,j,t} - R_{m(i,j,t)} = \alpha + \epsilon_{i,j,t}$$

where $R_{i,j,t}$ represents the loan rate on switching loans granted by bank j to firm i in year t and $R_{m(i,j,t)}$ the loan rate on its matched counterfactual. α is the constant. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. We weigh each observation by one over the total number of comparable matched loans per switching loan. Across the different columns, we report the variables used in the matching procedure. The set of baseline matching variables includes firm size, sector, region, legal structure, credit rating, loan amount, loan collateralization, and loan type, as explained in Section 4.2. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Matching variables	I Loan rate	II Loan rate
Year	Yes	Yes
Outside bank	Yes	Yes
Baseline matching variables	Yes	Yes
Comparison	Switchers with a deposit relationship prior to switching vs. Other switchers	Switchers with a deposit relationship prior to switching vs. Other switchers with a deposit relationship after switching
Number of switching loans with prior deposit relationship	74	39
Number of switching loans without prior deposit relationship	72	31
Number of observations	87	40
Constant	-0.573**	-0.623**
	(0.278)	(0.280)

Table 5. Deposit relationships and the probability of switching lenders: Heterogeneity in the information flow of deposit relationships

This table reports how outside deposit relationships affect firms' probability of switching lenders, based on the following regression model:

$$Switch_{i,t} = \alpha + \beta_1 Outside\ deposit\ relationship_{i,t-1} + \beta_2(H_{i,t-1} \times Outside\ deposit\ relationship_{i,t-1}) + \gamma X_{i,j,t} + \eta_i + \delta_{j,t} + \epsilon_{i,j,t}$$

where $Switch_{i,t}$ is a dummy variable equal to one if a firm i switched to a new lender in year t. $Outside\ deposit\ relationship_{i,t-1}$ is a dummy variable equal to one if firm i had a deposit relationship with at least one (non-lender) outside bank in year $t-1$. $H_{i,t-1}$ corresponds to the length, depth, or scope of the outside deposit relationship, or an indicator variable equal to one if the outside deposit relationship comprises a transaction account, as explained in Section 4.3.1. $X_{i,j,t}$ is a vector of firm and firm-bank control variables. Firm controls include firms' size, leverage ratio, EBIT to total assets, fixed assets to total assets, and a dummy variable equal to one for public companies. Firm-bank controls include the loan rate, loan amount, the proportion of loan collateralized, the probability of default, and a dummy variable equal to one for credit lines. η_i and $\delta_{j,t}$ are firm and bank-by-time fixed effects, respectively. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

	I Switch	II Switch	III Switch	IV Switch
Outside deposit relationship$_{t-1}$	0.058***	0.028***	0.056***	0.076***
	(0.007)	(0.007)	(0.005)	(0.004)
Outside deposit relationship$_{t-1}$ × Deposit relationship length$_{t-1}$	0.009***			
	(0.002)			
Outside deposit relationship$_{t-1}$ × Deposit relationship length$^2_{t-1}$	-0.001***			
	(0.000)			
Outside deposit relationship$_{t-1}$ × Deposit relationship scope$_{t-1}$		0.025***		
		(0.003)		
Outside deposit relationship$_{t-1}$ × Deposit relationship depth$_{t-1}$			0.045***	
			(0.007)	
Outside deposit relationship$_{t-1}$ × Transaction account$_{t-1}$				0.034***
				(0.006)
Observations	307,297	307,297	307,297	307,297
Adjusted R-squared	0.219	0.219	0.219	0.219
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Bank × Time FE	Yes	Yes	Yes	Yes

Table 6. Deposit relationships and outside banks' loan offers: Heterogeneity in the information flow of deposit relationships

This table reports how prior deposit relationships affect the loan rate discount offered by outside banks to switching firms, based on the following matching approach: First, we match each switching loan with all similar non-switching loans granted to other comparable firms by the switcher's outside banks at the time of the switch. Second, we calculate the spreads between the rates on the switching loans and each matched loan. Third, we use the calculated spreads to estimate the following regression model:

$$R_{i,j,t} - R_{m(i,j,t)} = \alpha + \beta_1 \textit{Prior deposit relationship}_{i,j,t} + \beta_2 (H_{i,j,t} \times \textit{Prior deposit relationship}_{i,j,t}) + \epsilon_{i,j,t}$$

where $R_{i,j,t}$ represents the loan rate on switching loans granted by bank j to firm i in year t and $R_{m(i,j,t)}$ the loan rate on its matched counterfactual. α is the constant and $\textit{Prior deposit relationship}_{i,j,t}$ is a dummy variable equal to one if the switcher and the new (outside) lender had a prior deposit relationship. $H_{i,j,t}$ corresponds to the length, depth, or scope of the prior deposit relationship, or an indicator variable equal to one if the prior deposit relationship comprises a transaction account, as explained in Section 4.3.1. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. We weigh each observation by one over the total number of comparable matched loans per switching loan. Across the different columns, we report the variables used in the matching procedure. The set of baseline matching variables includes firm size, sector, region, legal structure, credit rating, loan amount, loan collateralization, and loan type, as explained in Section 4.2. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Matching variables	I	II	III	IV
	Loan rate	Loan rate	Loan rate	Loan rate
Year	Yes	Yes	Yes	Yes
Outside bank	Yes	Yes	Yes	Yes
Baseline matching variables	Yes	Yes	Yes	Yes
Number of switching loans	2,273	2,273	2,273	2,273
Number of non-switching loans	3,659	3,659	3,659	3,659
Observations	5,330	5,330	5,330	5,330
Proportion of switching loans with a prior deposit relationship	30%	30%	30%	30%
Constant	-0.483***	-0.483***	-0.483***	-0.483***
	(0.064)	(0.064)	(0.064)	(0.065)
Prior deposit relationship	-0.936***	-0.659**	-0.253	-0.636*
	(0.322)	(0.318)	(0.246)	(0.324)
Prior deposit relationship × Deposit relationship length$_{t-1}$	-0.158*			
	(0.096)			
Prior deposit relationship × Deposit relationship length$^2_{t-1}$	0.011*			
	(0.005)			
Prior deposit relationship × Deposit relationship scope$_{t-1}$		-0.207**		
		(0.093)		
Prior deposit relationship × Deposit relationship depth$_{t-1}$			-2.325***	
			(0.426)	
Prior deposit relationship × Transaction account$_{t-1}$				-0.663**
				(0.326)

Table 7. Deposit relationships and the probability of switching lenders: Heterogeneity in outside banks' informational disadvantage

This table reports how outside deposit relationships affect firms' probability of switching lenders, based on the following regression model:

$$Switch_{i,t} = \alpha + \beta_1 Outside\ deposit\ relationship_{i,t-1} + \beta_2 (H_{i,t-1} \times Outside\ deposit\ relationship_{i,t-1}) + \gamma X_{i,j,t} + \eta_i + \delta_{j,t} + \epsilon_{i,j,t}$$

where $Switch_{i,t}$ is a dummy variable equal to one if a firm i switched to a new lender in year t. $Outside\ deposit\ relationship_{i,t-1}$ is a dummy variable equal to one if firm i had a deposit relationship with at least one (non-lender) outside bank in year $t-1$. $H_{i,t-1}$ corresponds to a dummy variable equal to one for single-bank borrowers, borrowers with long inside bank relationships, young firms, or firms operating in regions with high bank competition, as explained in Section 4.3.2. $X_{i,j,t}$ is a vector of firm and firm-bank control variables. Firm controls include firms' size, leverage ratio, EBIT to total assets, fixed assets to total assets, and a dummy variable equal to one for public companies. Firm-bank controls include the loan rate, loan amount, the proportion of loan collateralized, the probability of default, and a dummy variable equal to one for credit lines. η_i and $\delta_{j,t}$ are firm and bank-by-time fixed effects, respectively. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

	I Switch	II Switch	III Switch	IV Switch
Outside deposit relationship$_{t-1}$	0.073***	0.077***	0.074***	0.075***
	(0.004)	(0.004)	(0.004)	(0.004)
Outside deposit relationship$_{t-1}$ × Single-bank borrower$_{t-1}$	0.011**			
	(0.005)			
Outside deposit relationship$_{t-1}$ × Long inside relationship$_{t-1}$		0.040***		
		(0.008)		
Outside deposit relationship$_{t-1}$ × Young firm$_{t-1}$			0.014**	
			(0.007)	
Outside deposit relationship$_{t-1}$ × High bank competition$_{t-1}$				0.012***
				(0.004)
Observations	307,297	307,297	307,297	307,297
Adjusted R-squared	0.221	0.220	0.219	0.219
Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Bank × Time FE	Yes	Yes	Yes	Yes

Table 8. Deposit relationships and outside banks' loan offers: Heterogeneity in the information flow of deposit relationships

This table reports how prior deposit relationships affect the loan rate discount offered by outside banks to switching firms, based on the following matching approach: First, we match each switching loan with all similar non-switching loans granted to other comparable firms by the switcher's outside banks at the time of the switch. Second, we calculate the spreadrop ds between the rates on the switching loans and each matched loan. Third, we use the calculated spreads to estimate the following regression model:

$$R_{i,j,t} - R_{m(i,j,t)} = \alpha + \beta_1 Prior\ deposit\ relationship_{i,j,t} + \beta_2(H_{i,j,t} \times Prior\ deposit\ relationship_{i,j,t}) + \epsilon_{i,j,t}$$

where $R_{i,j,t}$ represents the loan rate on switching loans granted by bank j to firm i in year t and $R_{m(i,j,t)}$ the loan rate on its matched counterfactual. α is the constant and $Prior\ deposit\ relationship_{i,j,t}$ is a dummy variable equal to one if the switcher and the new (outside) lender had a prior deposit relationship. $H_{i,j,t}$ corresponds to a dummy variable equal to one for single-bank borrowers, borrowers with long inside bank relationships, young firms, or firms operating in regions with high bank competition, as explained in Section 4.3.2. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. We weigh each observation by one over the total number of comparable matched loans per switching loan. Across the different columns, we report the variables used in the matching procedure. The set of baseline matching variables includes firm size, sector, region, legal structure, credit rating, loan amount, loan collateralization, and loan type, as explained in Section 4.2. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Matching variables	I Loan rate	II Loan rate	III Loan rate	IV Loan rate
Year	Yes	Yes	Yes	Yes
Outside bank	Yes	Yes	Yes	Yes
Baseline matching variables	Yes	Yes	Yes	Yes
Number of switching loans	2,273	2,273	2,273	2,273
Number of non-switching loans	3,659	3,659	3,659	3,659
Observations	5,330	5,330	5,330	5,330
Proportion of switching loans with a prior deposit relationship	30%	30%	30%	30%
Constant	-0.422***	-0.470***	-0.472***	-0.756***
	(0.143)	(0.093)	(0.073)	(0.156)
Prior deposit relationship	-1.029***	-1.075***	-1.011***	-0.742***
	(0.237)	(0.163)	(0.251)	(0.153)
Prior deposit relationship × Single-bank borrower$_{t-1}$	-0.233			
	(0.323)			
Prior deposit relationship × Long inside bank relationship$_{t-1}$		-0.808**		
		(0.376)		
Prior deposit relationship × Young firm$_{t-1}$			-0.421*	
			(0.245)	
Prior deposit relationship × High bank competition$_{t-1}$				-0.811***
				(0.265)

Table 9. Deposit relationships and outside bank' screening capability

This table reports how prior deposit relationships affect outside banks' screening capabilities, based on the following regression model:

$$Loan\ default_{i,j,t+3} = \alpha + \delta_1 Prior\ deposit\ relationship_{i,j,t} + \delta_2 Credit\ rating_{i,j,t} + \delta_3 (Prior\ deposit\ relationship \times Credit\ rating)_{i,j,t} + \gamma X_{i,j,t} + \epsilon_{i,j,t}$$

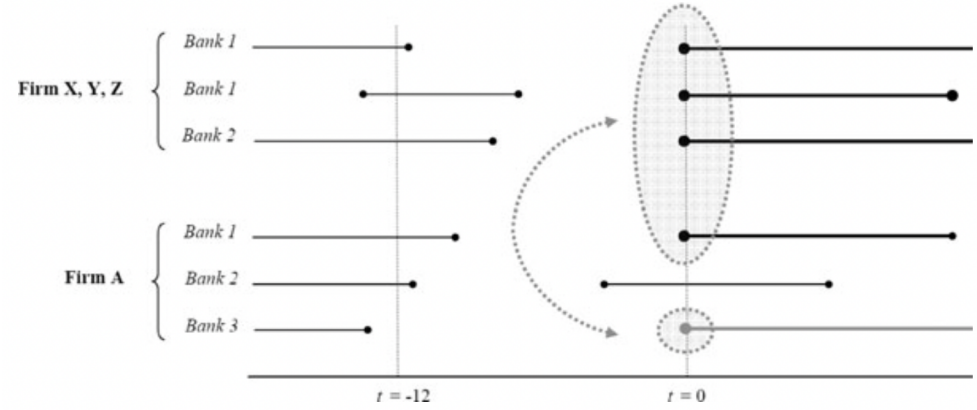
where *Loan default* is a dummy variable equal to one if the new (outside) lender writes off the switching loan within the first three years after the switch. *Prior deposit relationship* is a dummy variable equal to one if the switcher and the new (outside) lender had a prior deposit relationship. *Credit rating* is the credit rating assigned by the new (outside) lender to the switcher at the time of the switch, and varies between zero and one, with higher values corresponding to a higher probability of default. $X_{i,j,t}$ is a vector of control variables, which include the loan amount, loan type, the proportion of the loan collateralized, firm size, bank fixed effects, time fixed effects, firm sector fixed effects, firm legal type fixed effects, and firm locality fixed effects. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. All variables are defined in Table A1 in the Appendix. The sample comprises all switching firms in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

	I	II	III	IV
	Loan default	Loan default	Loan default	Loan default
Credit rating	0.290***	0.294***	0.196***	0.197***
	(0.034)	(0.034)	(0.036)	(0.036)
Prior deposit relationship			-0.004***	-0.007***
			(0.001)	(0.002)
Prior deposit relationship × Credit rating			0.268***	0.272***
			(0.076)	(0.076)
Number of observations	28,741	28,740	28,741	28,740
Adjusted R-squared	0.092	0.100	0.110	0.118
Controls	No	Yes	No	Yes

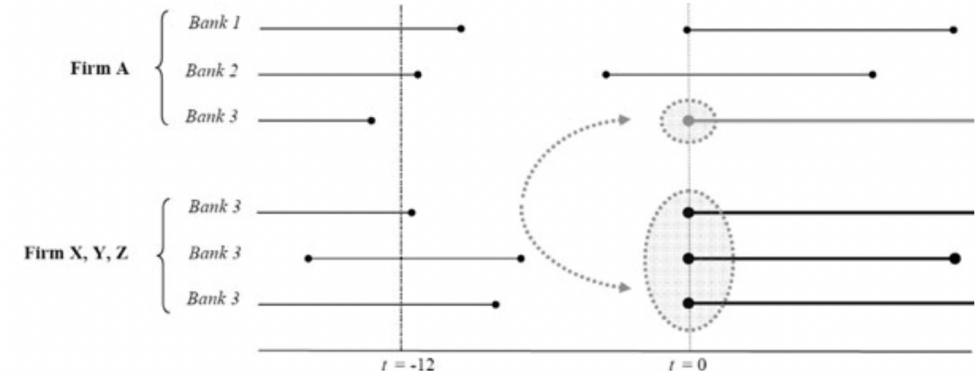
Appendix

Figure A1. Matching strategy

The top figure displays the matching strategy that compares the loan rate of switching loans to the loan rate of comparable non-switching loans from the switcher's inside banks at the time of the switch. The bottom figure displays the matching strategy that compares the loan rate of switching loans to the loan rate of comparable non-switching loans that the switcher's outside bank originates at the time of the switch. In both figures, the loan granted by Bank 3 to Firm A is the switching loan; all other loans are non-switching loans. Source: Ioannidou and Ongena (2010).



(a) Switching versus non-switching loans at the switcher's inside bank



(b) Switching versus non-switching loans at the switcher's outside bank

Figure A2. The probability of having an outside deposit relationship around the deposit insurance threshold

This figure presents a bin scatter of the probability of having an outside deposit relationship for firms with deposits NOK 155,000 below and above the corporate deposit insurance threshold. The bandwidth is computed using a uniform kernel with first order local polynomial. The error bands correspond to a 95% confidence interval.

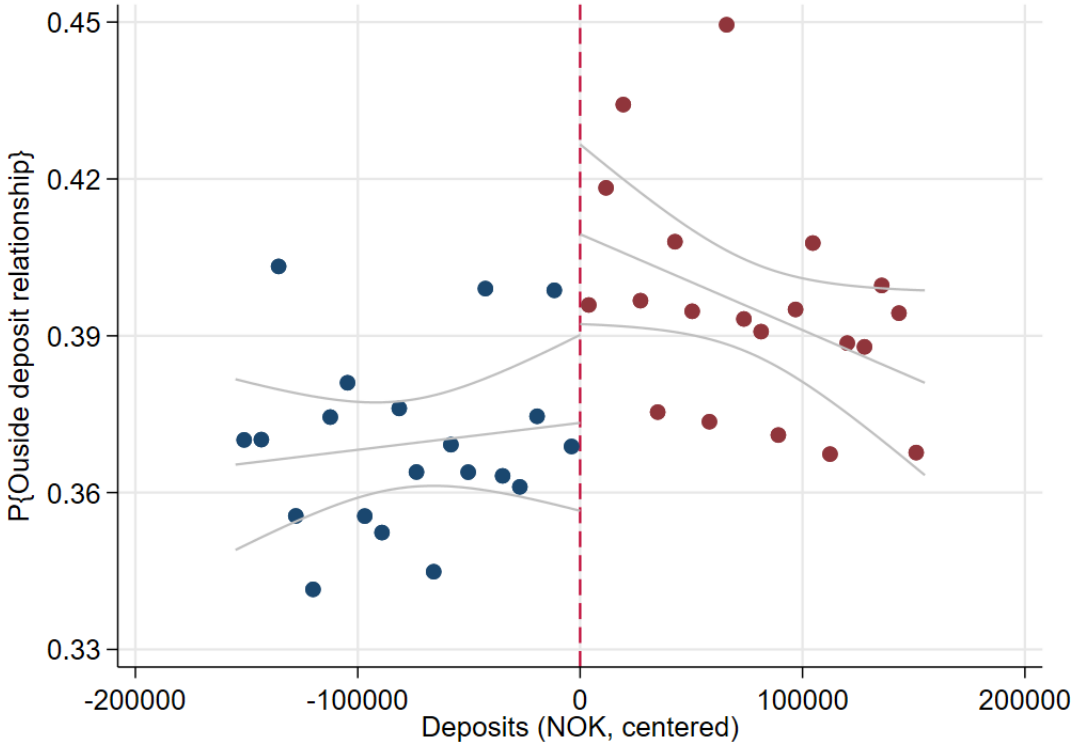


Table A1. Variable definitions

Variable	Description
Firm size	The logarithm of a firm's total assets.
Firm age	The number of years since the foundation of a firm.
Firm debt/TA	The ratio of debt to total assets.
Firm EBIT/TA	The ratio of earnings before interest and taxes (EBIT) to total assets.
Firm fixed assets/TA	The ratio of fixed assets to total assets.
Firm region	Categorical variable capturing the locality where a firm is registered.
Firm industry	Categorical variable capturing the industry in which a firm operates (based on 1-digit SIC code).
Firm legal structure	Categorical variable capturing whether a firms is a private or a public limited-liability company.
Loan amount	Total outstanding loan amount at the end of the year.
Loan rate	The amount of interest due as a proportion of the amount borrowed.
Loan type	Indicator variable equal to one if a loan agreement contains a credit line, zero otherwise.
Proportion of loan collateralized	The ratio of collateral value to loan value.
Credit rating	The probability of default assigned by a bank to a borrower.
Deposit amount	Total outstanding deposit amount at the end of the year.
Deposit rate	The amount of interest due as a proportion of the amount deposited.
Lending relationship	Indicator variable equal to one if the end-of-year outstanding loan amount or the interest paid for a given firm-bank pair is larger than zero, zero otherwise.
Deposit relationship	Indicator variable equal to one if the end-of-year outstanding deposit amount or the interest received for a given firm-bank pair is larger than zero, zero otherwise.
Switch	Indicator variable equal to one if a firm switched lenders in a given year, zero otherwise. Following Ioannidou and Ongena 2010, a loan is classified as a switching loan if it satisfies the following two conditions: (1) the loan should be obtained from a bank with which the firm did not have a lending relationship during the previous twelve months, and (2) the firm must have had at least one lending relationship in the previous twelve months with at least one other bank.
Outside deposit relationship	Indicator variable equal to one if a firm had a deposit relationship with (non-lender) outside banks from which it did not obtain credit in a given year, zero otherwise.

Table A2. Outside banks' loan offers to switching firms

This table reports the estimated loan rate discount offered by outside banks to switching firms, based on the following matching approach: First, we match each switching loan with all similar non-switching loans granted to other comparable firms by the switcher's inside or outside banks at the time of the switch. Second, we calculate the spreads between the rates on the switching loans and each matched loan. Third, we use the calculated spreads to estimate the following regression model:

$$R_{i,j,t} - R_{m(i,j,t)} = \alpha + \epsilon_{i,j,t}$$

where $R_{i,j,t}$ represents the loan rate on switching loans granted by bank j to firm i in year t and $R_{m(i,j,t)}$ the loan rate on its matched counterfactual. α is the constant. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. We weigh each observation by one over the total number of comparable matched loans per switching loan. Across the different columns, we report the variables used in the matching procedure. The set of baseline matching variables includes firm size, sector, region, legal structure, credit rating, loan amount, loan collateralization, and loan type, as explained in Section 4.2. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Matching variables	I Loan rate	II Loan rate	III Loan rate	IV Loan rate	V Loan rate
Year	Yes	Yes	Yes	Yes	Yes
Inside bank	Yes				
Outside bank		Yes	Yes	Yes	Yes
Baseline matching variables	Yes	Yes	Yes	Yes	Yes
Deposit relationship			Yes		
Prior credit rating from inside banks				Yes	
Loan rate on prior inside loans					Yes
Number of switching loans	1,868	2,273	2,047	1,999	743
Number of non-switching loans	3,194	3,659	3,300	3,331	1,080
Number of observations	4,674	5,330	4,773	4,701	1,317
Constant	-1.058*** (0.079)	-0.807*** (0.063)	-0.795*** (0.067)	-0.813*** (0.068)	-0.904*** (0.095)

Table A3. Deposit relationships and outside banks' loan offers: Other loan terms

This table reports how prior deposit relationships affect the loan terms offered by outside banks to switching firms, based on the following matching approach: First, we match each switching loan with all similar non-switching loans granted to other comparable firms by the switcher's outside banks at the time of the switch. Second, we calculate the difference between the loan terms on the switching loans and each matched loan. Third, we use the calculated differences to estimate the following regression model:

$$R_{i,j,t} - R_{m(i,j,t)} = \alpha + \beta Prior\ deposit\ relationship_{i,j,t} + \epsilon_{i,j,t}$$

where $R_{i,j,t}$ represents the loan rate on switching loans granted by bank j to firm i in year t and $R_{m(i,j,t)}$ the loan rate on its matched counterfactual. α is the constant and $Prior\ deposit\ relationship_{i,j,t}$ is a dummy variable equal to one if the switcher and the new (outside) lender had a prior deposit relationship. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. We weigh each observation by one over the total number of comparable matched loans per switching loan. Across the different columns, we report the variables used in the matching procedure. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Matching variables	I ln(Loan amount)	II Credit line	III Loan collateralization
Year	Yes	Yes	Yes
Outside bank	Yes	Yes	Yes
Credit rating	Yes	Yes	Yes
Region	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Legal structure	Yes	Yes	Yes
Size	Yes	Yes	Yes
Loan rate	Yes	Yes	Yes
Loan amount	Yes		Yes
Loan type	Yes	Yes	
Proportion of loan collateralized		Yes	Yes
Number of switching loans	2,170	2,639	976
Number of non-switching loans	4,215	4,468	1,349
Number of observations	3,270	11,390	2,444
Proportion of switching loans with a prior deposit relationship	60%	36%	28%
Constant	-0.627*** (0.115)	-0.084*** (0.007)	-25.928*** (3.334)
Prior deposit relationship	0.995*** (0.156)	0.112*** (0.014)	9.961 (10.743)

Table A4. Deposit relationships and the probability of switching lenders: RDD estimation

This table reports how outside deposit relationships affect firms' probability of switching lenders, using a discontinuity in firms' probability of having an outside deposit relationship around the deposit insurance threshold. Columns I and III report the first stage results, estimated using the following regression model:

$$Outside\ deposit\ relationship_{i,t} = \alpha_0 + \alpha_1(1\{Deposits > \text{NOK } 2,000,000\}_{i,t}) + f(Deposits_{i,t}) + \epsilon_{i,t}$$

Columns II and IV report the corresponding second stage results, estimated using the following regression model:

$$Switch_{i,t+1} = \beta_0 + \beta_1 \widehat{Outside\ deposit}\ relationship_{i,t} + g(Deposits_{i,t+1}) + \upsilon_{i,t+1}$$

where $Switch_{i,t+1}$ is a dummy variable equal to one if a firm i switched to a new lender in year $t+1$. $Outside\ deposit\ relationship_{i,t}$ is a dummy variable equal to one if firm i had a deposit relationship with at least one (non-lender) outside bank in year t. $1\{Deposits > \text{NOK } 2,000,000\}_{i,t}$ is an indicator variable that equals one if firm i has total deposits exceeding NOK 2,000,000 in year t. The functions $f(Deposits_{i,t})$ and $g(Deposits_{i,t+1})$ represent local polynomial control functions of the running variable, which is the deposit balance near the deposit insurance threshold. $\epsilon_{i,t}$ and $\upsilon_{i,t+1}$ are the error terms, which are clustered at the firm level. The order of the local polynomial, kernel, bandwidth selection are indicated at the bottom of the table. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

	I	II	III	IV
	Outside deposit relationship	Switch	Outside deposit relationship	Switch
1{Deposits > NOK 2,000,000}	0.036***		0.037***	
	(0.011)		(0.013)	
RD estimate		0.278*		0.279*
		(0.151)		(0.190)
Observations	76,348	76,348	72,434	72,434
Observations left of cutoff	44,640	44,640	41,994	41,994
Observations right of cutoff	31,708	31,708	30,440	30,440
Kernel	Triangular	Triangular	Triangular	Triangular
Order polynomial	1	1	2	2
Bandwidth selection	CER	CER	CER	CER

Table A5. Deposit relationships and the probability of switching lenders: Alternative channels

This table reports how outside deposit relationships affect firms' probability of switching lenders, based on the following regression model:

$$Switch_{i,t} = \alpha + \beta_1 Outside\ deposit\ relationship_{i,t-1} + \beta_2 (H_{i,t-1} \times Outside\ deposit\ relationship_{i,t-1}) + \gamma X_{i,j,t} + \eta_i + \delta_{j,t} + \epsilon_{i,j,t}$$

where $Switch_{i,t}$ is a dummy variable equal to one if a firm i switched to a new lender in year t. $Outside\ deposit\ relationship_{i,t-1}$ is a dummy variable equal to one if firm i had a deposit relationship with at least one (non-lender) outside bank in year $t-1$. $H_{i,t-1}$ corresponds to the deposit rate that switching firms earn at the outside bank, the switching firms' deposit-to-loan ratio, or the switching firms' depositor size measured as switching firms' deposits held at the outside bank compared to the outside bank's total deposits, as explained in Section 4.4.3. $X_{i,j,t}$ is a vector of firm and firm-bank control variables. Firm controls include firms' size, leverage ratio, EBIT to total assets, fixed assets to total assets, and a dummy variable equal to one for public companies. Firm-bank controls include the loan rate, loan amount, the proportion of loan collateralized, the probability of default, and a dummy variable equal to one for credit lines. η_i and $\delta_{j,t}$ are firm and bank-by-time fixed effects, respectively. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

	I Switch	II Switch	III Switch
Outside deposit relationship$_{t-1}$	0.061***	0.061***	0.059***
	(0.004)	(0.004)	(0.004)
Outside deposit relationship$_{t-1}$ × Deposit rate$_{t-1}$	0.001		
	(0.006)		
Outside deposit relationship$_{t-1}$ × Deposit-to-loan ratio$_{t-1}$		0.000	
		(0.000)	
Outside deposit relationship$_{t-1}$ × Depositor size$_{t-1}$			0.202***
			(0.072)
Observations	307,297	307,297	307,297
Adjusted R-squared	0.260	0.260	0.260
Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Bank × Time FE	Yes	Yes	Yes

Table A6. Deposit relationships and outside banks' loan offers: Alternative channels

This table reports how prior deposit relationships affect the loan rate discount offered by outside banks to switching firms, based on the following matching approach: First, we match each switching loan with all similar non-switching loans granted to other comparable firms by the switcher's outside banks at the time of the switch. Second, we calculate the spreads between the rates on the switching loans and each matched loan. Third, we use the calculated spreads to estimate the following regression model:

$$R_{i,j,t} - R_{m(i,j,t)} = \alpha + \beta_1 Prior\ deposit\ relationship_{i,j,t} + \beta_2 (H_{i,j,t} \times Prior\ deposit\ relationship_{i,j,t}) + \epsilon_{i,j,t}$$

where $R_{i,j,t}$ represents the loan rate on switching loans granted by bank j to firm i in year t and $R_{m(i,j,t)}$ the loan rate on its matched counterfactual. α is the constant and $Prior\ deposit\ relationship_{i,j,t}$ is a dummy variable equal to one if the switcher and the new (outside) lender had a prior deposit relationship. $H_{i,j,t}$ corresponds to the deposit rate that switching firms earn at the outside bank, the switching firms' deposit-to-loan ratio, or the switching firms' depositor size measured as switching firms' deposits held at the outside bank compared to the outside bank's total deposits, as explained in Section 4.4.3. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. We weigh each observation by one over the total number of comparable matched loans per switching loan. Across the different columns, we report the variables used in the matching procedure. The set of baseline matching variables includes firm size, sector, region, legal structure, credit rating, loan amount, loan collateralization, and loan type, as explained in Section 4.2. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Matching variables	I Loan rate	II Loan rate	III Loan rate
Year	Yes	Yes	Yes
Outside bank	Yes	Yes	Yes
Baseline matching variables	Yes	Yes	Yes
Number of switching loans	2,273	2,273	2,273
Number of non-switching loans	3,659	3,659	3,659
Observations	5,330	5,330	5,330
Proportion of switching loans with a prior deposit relationship	30%	30%	30%
Constant	-0.477*** (0.065)	-0.483*** (0.064)	-0.483*** (0.064)
Prior deposit relationship	-1.195*** (0.172)	-1.225*** (0.167)	-1.171*** (0.169)
Prior deposit relationship × Deposit rate$_{t-1}$	-0.068 (0.225)		
Prior deposit relationship × Deposit-to-loan ratio$_{t-1}$		0.003 (0.006)	
Prior deposit relationship × Depositor size$_{t-1}$			-2.770 (2.001)

Table A7. Deposit relationships and outside banks' deposit offers

This table reports the deposit rate discount offered by outside banks to switching firms, based on the following matching approach: First, we match each switching firm with all similar non-switching firms by the switcher's outside banks, either at the time that the switching firm obtained a switching loan from the outside bank (Panel A) or at the time that the switching firm started a deposit relationship with the outside bank (Panel B). Second, we calculate the spreads between the deposits rates of switching firms and each matched firm. Third, we use the calculated spreads to estimate the following regression model:

$$R_{i,j,t} - R_{m(i,j,t)} = \alpha + \epsilon_{i,j,t}$$

where $R_{i,j,t}$ represents the deposit rate granted by bank j to switching firm i in year t and $R_{m(i,j,t)}$ the deposit rate on its matched counterfactual. α is the constant. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. We weigh each observation by one over the total number of comparable matched firms per switching firm. Across the different columns, we report the variables used in the matching procedure. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Matching variables	I Deposit rate	II Deposit rate	III Deposit rate	IV Deposit rate	V Deposit rate
Year	Yes	Yes	Yes	Yes	Yes
Inside bank	Yes				
Outside bank		Yes	Yes	Yes	Yes
Region	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes
Legal structure	Yes	Yes	Yes	Yes	Yes
Size	Yes	Yes	Yes	Yes	Yes
Deposit amount	Yes	Yes	Yes	Yes	Yes
Number of deposit products	Yes	Yes	Yes	Yes	Yes
Loan relationship dummy			Yes		
Uninsured deposits dummy				Yes	
Number of deposit relationships					Yes
Panel A	Year of lender switch				
Number of observations	1,455	1,564	1,243	1,447	545
Constant	0.000 (0.015)	0.001 (0.015)	0.007 (0.016)	0.003 (0.015)	-0.021 (0.022)
Panel B	Year of deposit switch				
Number of observations	426	610	284	598	200
Constant	0.003 (0.033)	0.006 (0.022)	0.025 (0.027)	0.006 (0.022)	-0.010 (0.037)

Table A8. Inside banks' response to deposit relationships between firms and outside banks

This table reports how outside deposit relationships affect inside banks' loan offers, based on the following matching approach: First, we identify borrowers that start a deposit relationship with outside banks and match the loans of those borrowers with all similar loans granted to other comparable borrowers at the same inside bank in the same year. Second, we calculate the difference between the change in interest rate or loan amounts of loans granted by inside banks to borrowers that started a deposit relationship with outside banks and each matched loan. Third, we use the calculated differences to estimate the following regression model:

$$\Delta Y_{i,j,t} - \Delta Y_{m(i,j,t)} = \alpha + \epsilon_{i,j,t}$$

where $\Delta Y_{i,j,t}$ is the change in interest rate or loan amount of loans granted by inside banks to borrowers that started a deposit relationship with outside banks in year t, and $\Delta Y_{m(i,j,t)}$ is the change in interest rate or loan amount of matched loans without an outside deposit relationship. α is the constant. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. Across the different columns, we report the variables used in the matching procedure. The set of baseline matching variables includes firm size, sector, region, legal structure, credit rating, loan amount, loan collateralization, and loan type, as explained in Section 4.2. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Matching variables	I ΔLoan rate$_{[t,t+1]}$	II Δln(Loan amount)$_{[t,t+1]}$
Year	Yes	Yes
Inside bank	Yes	Yes
Firm	Yes	Yes
Baseline matching variables	Yes	Yes
Loan amount	Yes	
Loan rate		Yes
Number of observations	818	1,242
Constant	-0.302*	0.038
	(0.166)	(0.061)

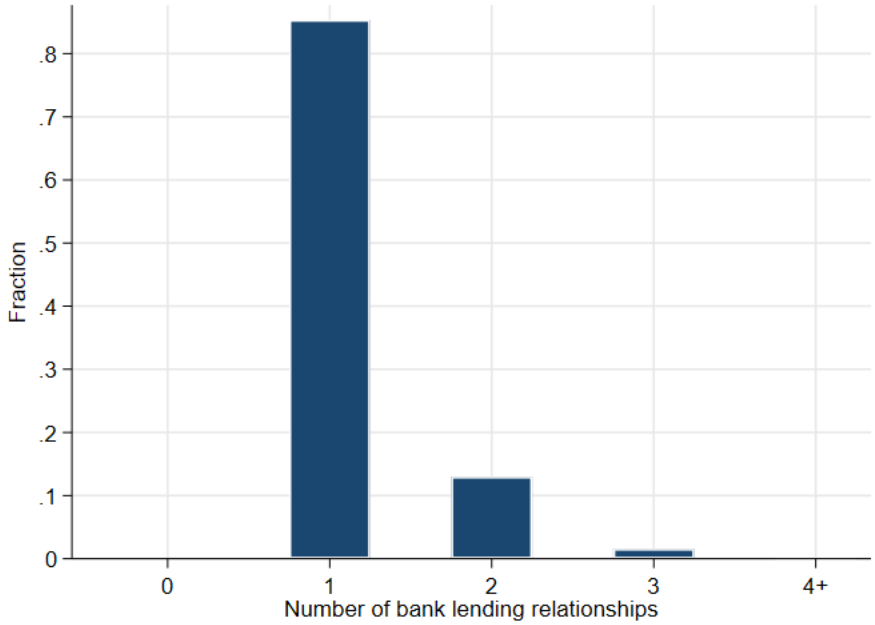
ONLINE APPENDIX

Banking on Deposit Relationships: Implications for Hold-Up Problems in the Loan Market

Jin Cao, Emilia Garcia-Appendini, and Cédric Huylebroek

Figure O.A1. The distribution of the number of lending and deposit relationships per firm

This figure shows the distribution of the number of lending relationships per firm in the top figure (in blue), and the distribution of the number of deposit relationships per firm in the bottom figure (in red). The sample comprises all firms with at least one lending relationship operating in Norway between 2000 and 2019.



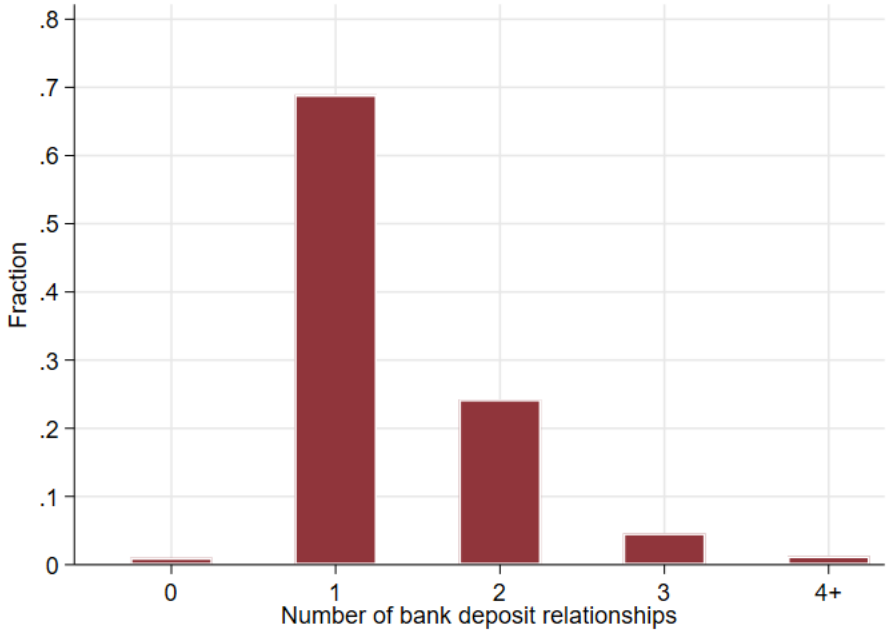


Figure O.A2. The distribution of prior deposit relationship length between switching firms and their new lender

This figure shows the distribution of deposit relationship length of switchers that had a deposit relationship with their new (outside) lender prior to switching. The length of the prior deposit relationship is measured as the number of years during which the firm and the bank maintained a deposit relationship. Following the definition from Ioannidou and Ongena (2010), a loan is classified as a switching loan if it satisfies the following two conditions: (1) the loan should be obtained from a bank with which the firm did not have a lending relationship during the previous twelve months, and (2) the firm must have had at least one lending relationship in the previous twelve months with at least one other bank. The sample comprises all switching firms with prior deposit relationship operating in Norway between 2000 and 2019.

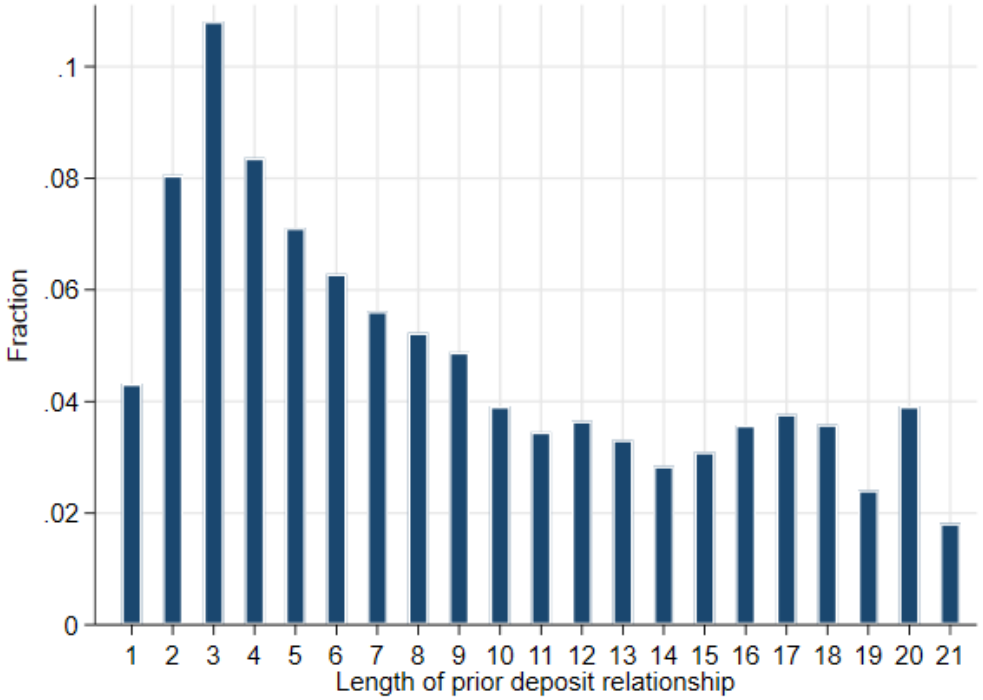


Figure O.A3. The distribution of prior deposit relationship depth between switching firms and their new lender

This figure shows the distribution of deposit relationship depth of switchers that had a deposit relationship with their new (outside) lender prior to switching. The depth of the prior deposit relationship is measured as the share of deposits held by the switchers at the outside bank compared to the total deposits held by the switchers. Following the definition from Ioannidou and Ongena (2010), a loan is classified as a switching loan if it satisfies the following two conditions: (1) the loan should be obtained from a bank with which the firm did not have a lending relationship during the previous twelve months, and (2) the firm must have had at least one lending relationship in the previous twelve months with at least one other bank. The sample comprises all switching firms with prior deposit relationship operating in Norway between 2000 and 2019.

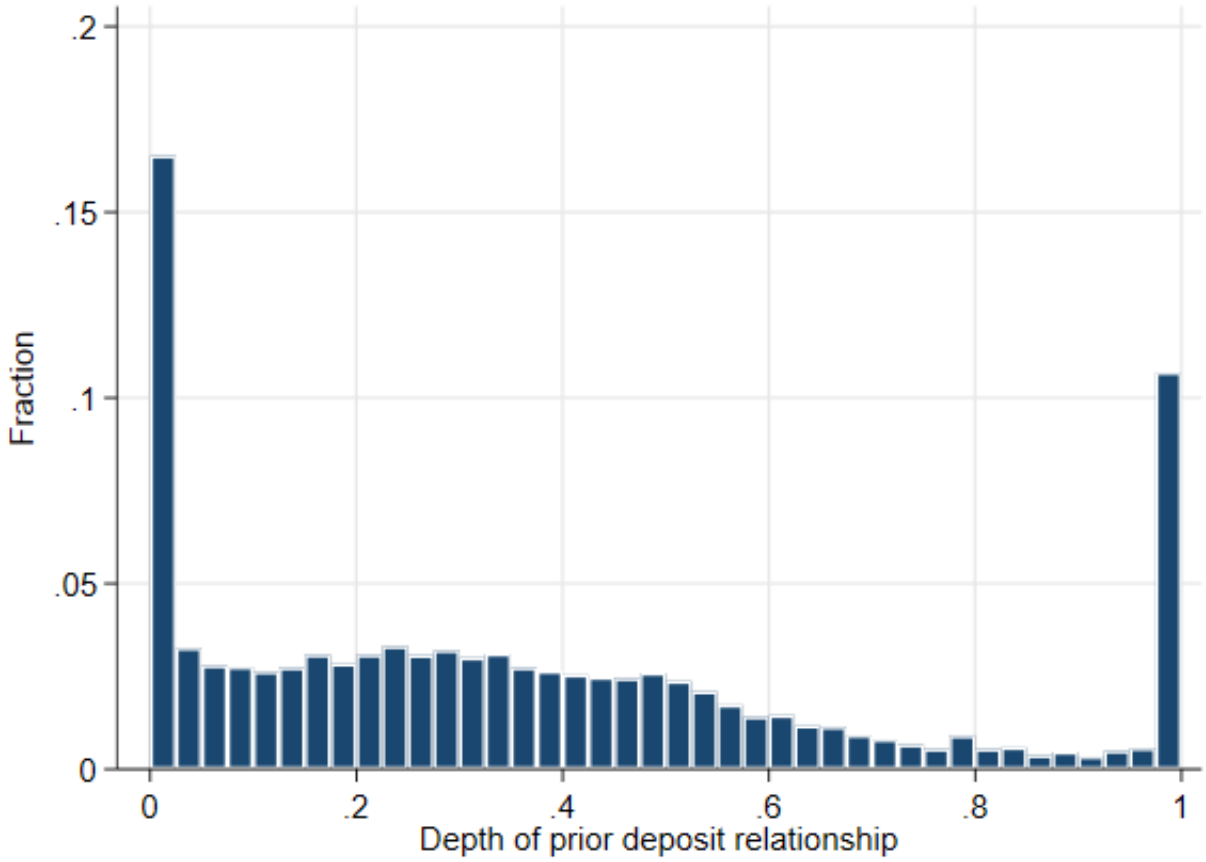


Figure O.A4. The distribution of prior deposit relationship scope between switching firms and their new lender

This figure shows the distribution of deposit relationship scope of switchers that had a deposit relationship with their new (outside) lender prior to switching. The scope of the prior deposit relationship is measured as the number of deposit products underlying the deposit relationship. Following the definition from Ioannidou and Ongena (2010), a loan is classified as a switching loan if it satisfies the following two conditions: (1) the loan should be obtained from a bank with which the firm did not have a lending relationship during the previous twelve months, and (2) the firm must have had at least one lending relationship in the previous twelve months with at least one other bank. The sample comprises all switching firms with prior deposit relationship operating in Norway between 2000 and 2019.

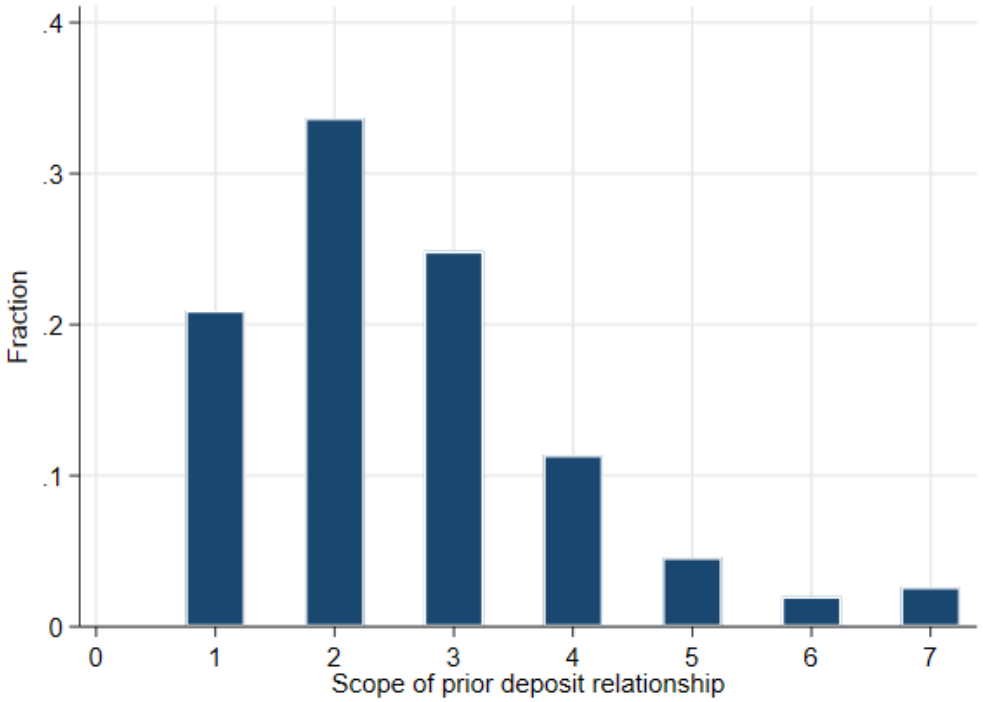


Table O.A1. The percentage of non-switching and switching loan instances across sectors

This table reports the percentage of switching and non-switching loan instances across sectors. Following the definition from Ioannidou and Ongena (2010), a loan is classified as a switching loan if it satisfies the following two conditions: (1) the loan should be obtained from a bank with which the firm did not have a lending relationship during the previous twelve months, and (2) the firm must have had at least one lending relationship in the previous twelve months with at least one other bank. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019.

	Switchers with prior deposit relationship	Switchers without prior deposit relationship	Non-switchers
Accommodation services	0.03	0.03	0.05
Agriculture	0.02	0.02	0.02
Business services	0.05	0.05	0.05
Construction	0.28	0.28	0.24
Cultural activity and entertainment	0.01	0.01	0.02
Electricity	0.01	0.01	0.01
Health and social services	0.03	0.03	0.04
Industry	0.11	0.12	0.10
Information and communication	0.03	0.03	0.03
Wholesale and retail trade	0.24	0.24	0.26
Mining and extraction	0.01	0.01	0.01
Other services	0.01	0.01	0.02
Professional and scientific services	0.08	0.07	0.09
Transport and storage	0.08	0.08	0.07
Water supply	0.01	0.01	0.01

Online Appendix O.B

In Section 2 of our paper we document that it is common for firms to have deposit relationships with (outside) banks from which they do not borrow. Although the objective of our paper is not to explain the reasons behind such deposit relationships, below we shed some light on this matter by analyzing potential factors that influence firms' propensity to have outside deposit relationships.

The results, presented in Table O.B1, highlight the relevance of firm-specific, bank-specific, and institutional factors. First, Column I shows that the propensity to have an outside deposit relationship is larger for firms with larger deposit amounts. Several potential explanations exist for this result. For one, firms may maintain deposit accounts at multiple banks to ensure that their deposits are covered by the corporate deposit insurance scheme (Cucic et al. 2024; De Roux and Limodio 2023; Iyer et al. 2019), which covers up to NOK 2,000,000 per account holder, per bank in Norway. Consistent with this, Column II shows that firms with deposits above the deposit insurance threshold are 2 percentage point more likely to have outside deposit relationships. Further, maintaining deposit accounts at multiple banks may also enable firms to access a broader range of deposit services, such as specialized investment opportunities or unique payment solutions, and enable firms to better manage their cash flows and ensure they have access to funds when needed (d'Avernas et al. 2023; Lu, Song, and Zeng 2024). In line with this idea, Columns III and IV show that firms' propensity to have an outside deposit relationship is positively related to banks' deposits-to-loans ratio as well as banks' IT expenses to total assets, which proxies for the quality of banks' deposit and payment services. Finally, Column V indicates that firms are more likely to have deposit relationships with outside banks if they are located in municipalities with higher deposit market competition, highlighting the role of bank competition (Drechsler et al. 2024).[a]

[a] As explained in our paper, we control for the above-mentioned factors to mitigate potential concerns about omitted variable bias.

Table O.B1. Factors that influence firms' propensity to have deposit relationships with outside banks

This table reports the factors that influence firms' propensity to have deposit relationships with outside banks, based on the following regression model:

$$Outside\ deposit\ relationship_{i,t} = \alpha + \beta F_{i,(j,)t} + \gamma X_{i,j,t} + \eta_i + \delta_t + \omega_t + \epsilon_{i,j,t}$$

where $Outside\ deposit\ relationship_{i,t-1}$ is a dummy variable equal to one if firm i has a deposit relationship with at least one (non-lender) outside bank in year t. $F_{i,(j,)t}$ corresponds to the total deposits of firm f in year t, the squared total deposits of firm f in year t, a dummy variable equal to one if firm f has total deposits exceeding the NOK 2,000,000 deposit insurance threshold in year t, the deposit-to-loans ratio of bank j in year t, the IT expenses-to-total assets of bank j in year t, or the bank deposit competition in the municipality of firm i in year t. $X_{i,j,t}$ is a vector of firm and bank control variables. Firm controls include firms' size, leverage ratio, EBIT to total assets, fixed assets to total assets, and a dummy variable equal to one for public companies. Bank controls include banks' size, equity ratio, and net income ratio. η_i, δ_j, and ωt are firm, bank, and time fixed effects, respectively. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

	I	II	III	IV	V	VI
Firm deposits	0.020***					0.022***
	(0.001)					(0.001)
Firm deposits^2	-0.001***					-0.001***
	(0.000)					(0.000)
1{Deposits > NOK 2,000,000}		0.017***				0.012***
		(0.002)				(0.002)
Bank deposits-to-loans ratio			0.041***			0.038***
			(0.005)			(0.005)
Bank IT investments				0.009***		0.008***
				(0.001)		(0.001)
Local deposit competition					0.036***	0.029***
					(0.006)	(0.006)
Observations	320,961	320,961	320,961	320,961	320,961	320,961
Adjusted R-squared	0.539	0.533	0.533	0.533	0.532	0.539
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Bank FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes

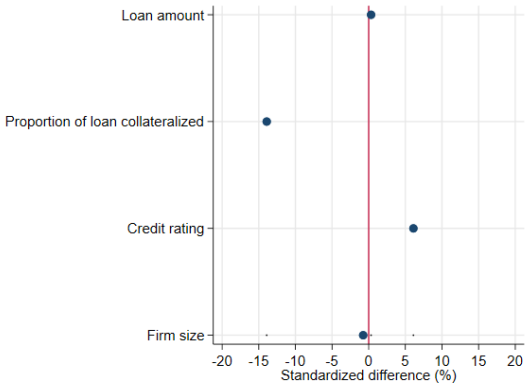
Table O.C1. Matching variables

This table lists the variables used in our matching models, as explained in Section 3.2.2. All variables are defined in Table A1 in the Appendix.

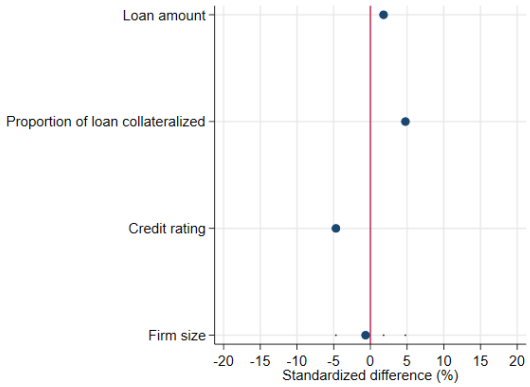
Variable	Categories	Possible values
Year	6	2014, 2015, 2016, 2017, 2018, 2019
Inside bank	2	=1 if the firm had a lending relationship with the bank in the last 12 months, 0 otherwise
Outside bank	2	=1 if the firm did not have a lending relationship with the bank in the last 12 months, 0 otherwise
Firm	74,295	=1 per firm identity, 0 otherwise
Firm locality	359	Locality where the firm is registered
Firm industry	15	Industry in which the firm operates
Firm legal structure	2	Private limited-liability company, Public limited-liability company
Firm size	2	=1 if the matched firms have similar size (based on the logarithm of total assets), 0 otherwise
Loan amount	2	=1 if the matched loans have a similar loan amount, 0 otherwise
Loan type	2	=1 if the matched loans have the same loan type (i.e., credit line or not), 0 otherwise
Loan collateralization	2	=1 if the matched loans have similar ratios of collateral value to loan value, 0 otherwise
Credit rating	2	=1 if the matched firms have a similar credit rating, 0 otherwise
Deposit relationship	2	=1 if the matched firms has a deposit relationship with its bank, 0 otherwise
Prior inside credit rating	2	=1 if the matched firms have a similar rating as the loan switchers' most recent inside rating that existed prior to the loan switch, 0 otherwise
Prior inside loan rate	2	=1 if the matched inside loans have similar loan rates as the loan switcher's most recent inside loan prior to the loan switch, 0 otherwise

Figure O.B1. Balance test for continuous variables used in our matching model

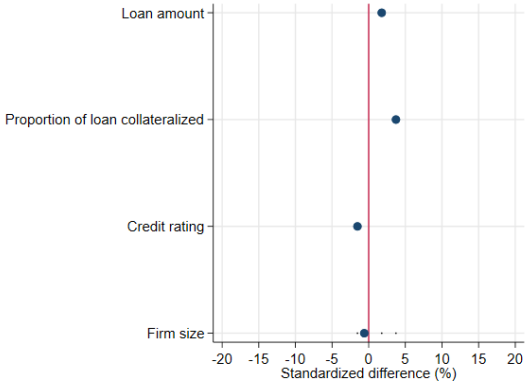
This figure presents the balance test statistics for the continuous variables used in our baseline matching model, as explained in Section 4.2.



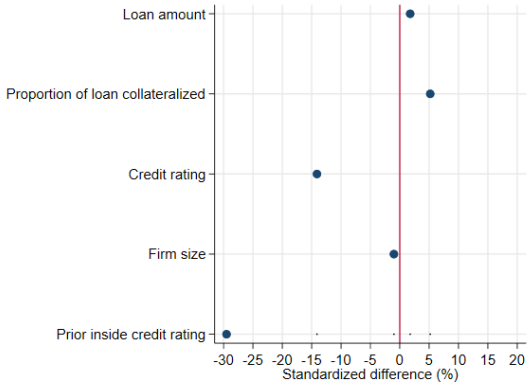
I



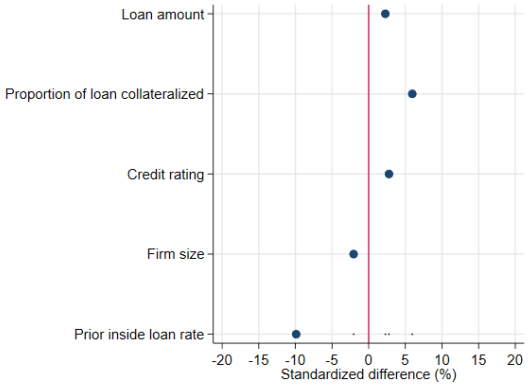
II



III



IV



V

Online Appendix O.D

In Section 4.4.2 of our paper we exploit the corporate deposit insurance threshold through a regression discontinuity design (RDD) to obtain quasi-random variation in firms' propensity to have an outside deposit relationship. Below, we provide evidence supporting the continuity assumption underlying the RDD estimator. Furthermore, we show that our estimates hold using alternative kernels, that our estimates are stable to the inclusion of additional control variables, and that our estimates become statistically insignificant at arbitrarily chosen (placebo) cutoffs.

Continuity assumption

The validity of our RDD estimates relies on the underlying continuity assumption. In our setting, this assumption requires that (1) all possible confounders are continuous at the NOK 2,000,000 deposit insurance threshold and (2) there is no manipulation of the threshold. Although the validity of the continuity assumption cannot be tested directly, we can perform tests that mitigate concerns that the assumption is violated. Accordingly, we provide two pieces of evidence that support the continuity assumption in our setting.

First, we analyze whether there is a discontinuity at the threshold for other covariates. In essence, a concern would be that, if we observe a discontinuity in any other covariates, the discontinuity in our outcome variable may be due to a discontinuity in a confounder and not the treatment effect (Imbens and Lemieux 2008). We use our fuzzy regression discontinuity design to evaluate whether firms with deposits above and below the threshold differ based on any other observable characteristics. The results are reported in Table O.D1 and confirm that the two groups of firms near the cutoff that we study are observably similar on various dimensions such as size, leverage (debt/TA), profitability (EBIT/TA), tangible assets (fixed assets/TA), and total credit outstanding.[b]

Second, we analyze whether there is evidence of manipulation of the assignment variable. A concern would be that, if firms are aware of the deposit insurance threshold and could perfectly manipulate it, they would be able to sort on their preferred side of the threshold.

[b]The latter suggests that firms just above and below the threshold do not differ in terms of credit demand.

This kind of sorting could correlate with some unobservable characteristics, implying that such unobservable covariates would vary discontinuously at the threshold, thereby invalidating the continuity assumption (McCrary 2008). In practice, however, firms' deposit balances are subject to unforeseen shocks (such as cash windfalls, see Gilje, Loutskina, and Strahan 2016) that can force them to either side of the deposit insurance threshold. To further support our case, we formally test for manipulation following McCrary (2008) and Cattaneo, Jansson, and Ma (2020). When the incentive to manipulate goes in a clear direction, we should detect a discontinuity in the density of observations around the threshold. Figure O.D1 plots the distribution of firms' deposits in an interval of NOK 40,000 below and above the deposit insurance threshold, and does not point towards any significant type of sorting just below or above the threshold. More formally, using the methods proposed by McCrary (2008) and Cattaneo, Jansson, and Ma (2020), Figure O.D2 confirms that there is no statistical evidence of bunching.[c]

Overall, the lack of evidence for manipulation around the deposit insurance threshold and observational similarity between our groups of treated and control firms near the threshold suggest that firms are either unwilling or unable to fully manage their deposit balances. This implies that our local average treatment effect estimates are unlikely to be biased by sorting.

Kernel

Our baseline results are based on a triangular kernel (with linear and quadratic polynomial control functions), and Table O.D2 shows that our results also hold using alternative kernels, such as a uniform and epanechnikov kernel (the p-value of the second stage coefficient in Column IV is 0.11).

Controlling for firm characteristics

In principle, controlling for other covariates should not change the estimated RDD parameters since other covariates should be balanced around the threshold, as shown above. Nevertheless, to mitigate any concern that our results could be influenced by observable characteristics of

[c]Figure O.D2 is constructed using a local linear polynomial control function and a triangular kernel. Unreported tests show that the result is the same using different polynomial control functions or kernels.

firms that are close to the threshold, Table O.D4 confirms that our estimated effects remain stable if we control for firm size, leverage, profitability, and tangible assets.

Placebo test

Our baseline analysis shows that there is a significant discontinuity (jump) in the probability of outside deposit relationships once a firm's total deposits amount crosses the deposit insurance threshold of NOK 2,000,000. As a placebo test, we evaluate whether there is no discontinuity around other (irrelevant) cutoffs. Table O.D4 reports results based on placebo cutoffs of NOK 1,500,000 and NOK 2,500,000, and confirms that there is no statistically significant discontinuity in firms' propensity to have outside deposit relationships at either of the placebo cutoffs.

Figure O.D1. RDD robustness: Density plot

This figure presents the distribution of firms' total deposits. We restrict the range of this variable to NOK 40,000 above and below the deposit insurance threshold for presentation purposes.

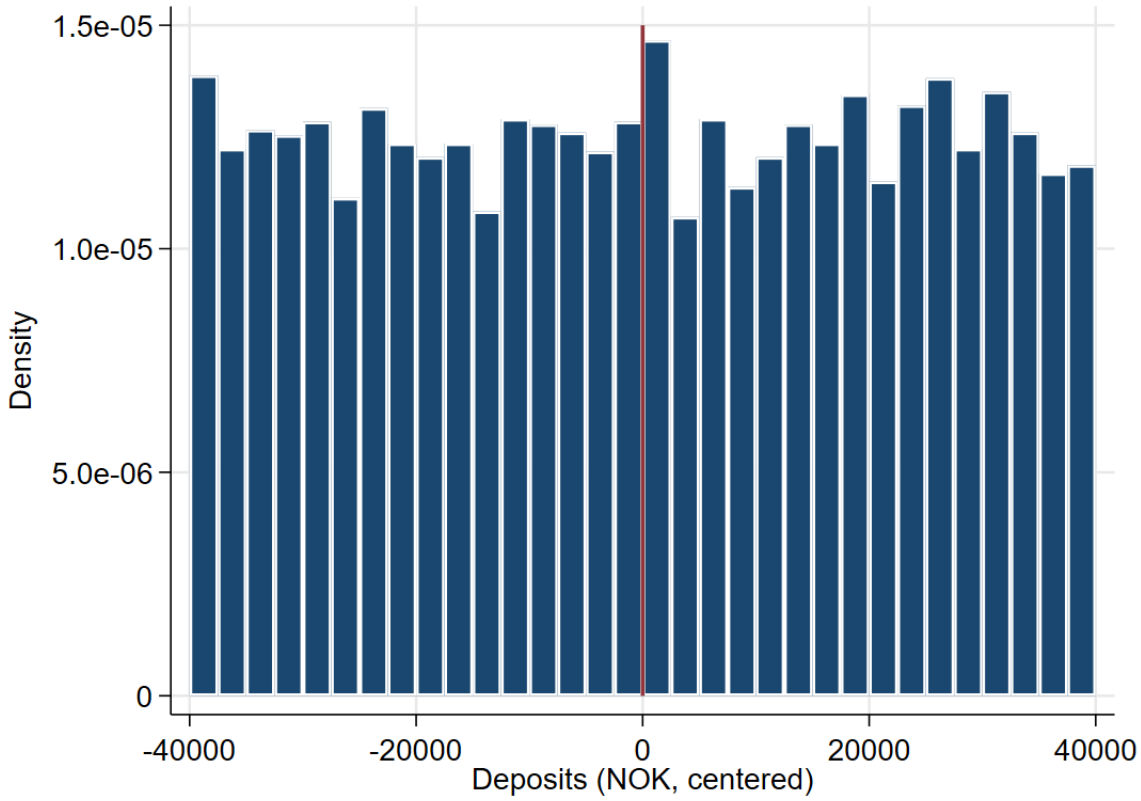


Figure O.D2. RDD robustness: Density break test

This figure presents a formal statistical test of bunching around the NOK 2,000,000 deposit insurance threshold using the method proposed by Cattaneo, Jansson, and Ma (2020).

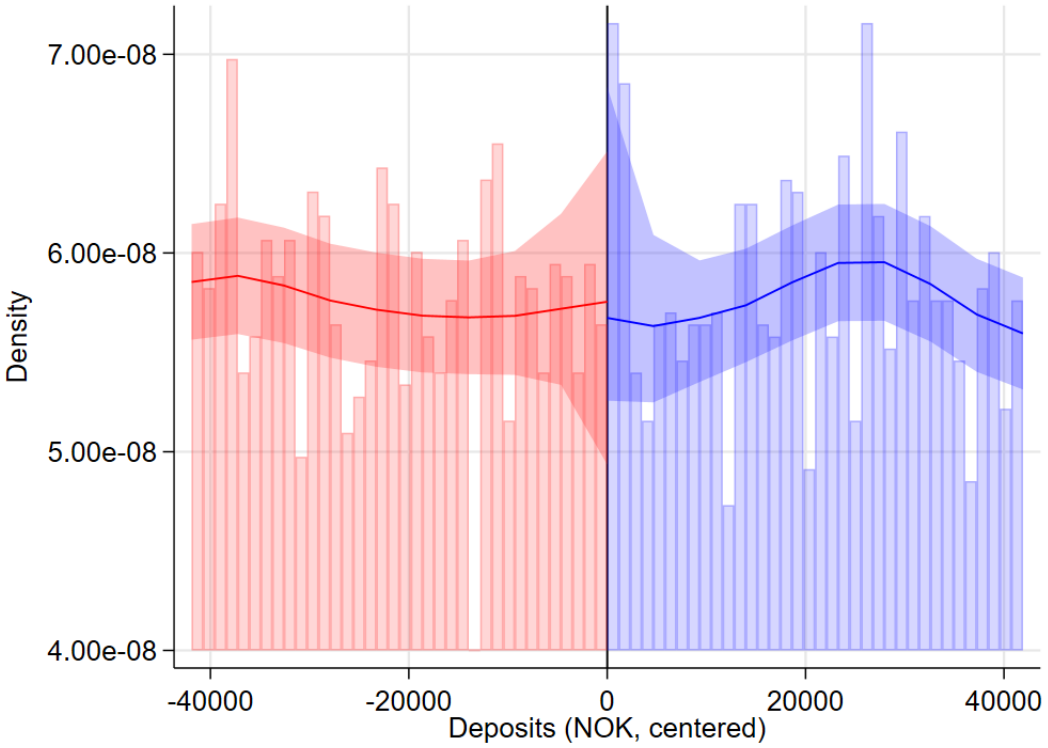


Table O.D1. RDD robustness: Discontinuity for potential confounders

This table reports how firm characteristics change around the deposit insurance threshold, using the following regression model:

$$Y_{i,t} = \alpha_0 + \alpha_1(1\{Deposits > \text{NOK } 2,000,000\}_{i,t}) + f(Deposits_{i,t}) + \epsilon_{i,t}$$

where $Y_{i,t}$ corresponds to firm size, debt/TA, EBIT/TA, fixed assets/TA, or total credit of firm i in year t. $1\{Deposits > \text{NOK } 2,000,000\}_{i,t}$ is an indicator variable that equals one if firm i has total deposits exceeding NOK 2,000,000 in year t. The function $f(Deposits_{i,t})$ represents local polynomial control functions of the running variable, which is the deposit balance near the deposit insurance threshold. $\epsilon_{i,t}$ is the error term, which is clustered at the firm level. The order of the local polynomial, kernel, bandwidth selection are indicated at the bottom of the table. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

	I	II	III	IV	V
	Size	Debt/TA	EBIT/TA	Fixed assets/TA	ln(Credit)
1{Deposits > NOK 2,000,000}	0.022	0.135	-0.210	-0.836	-0.008
	(0.032)	(0.909)	(0.558)	(0.984)	(0.221)
Observations	76,348	76,348	76,348	76,348	76,348
Observations left of cutoff	44,640	44,640	44,640	44,640	44,640
Observations right of cutoff	31,708	31,708	31,708	31,708	31,708
Kernel	Triangular	Triangular	Triangular	Triangular	Triangular
Order polynomial	1	1	1	1	1
Bandwidth selection	CER	CER	CER	CER	CER

Table O.D2. RDD robustness: Alternative kernels

This table reports how outside deposit relationships affect firms' probability of switching lenders, using a discontinuity in firms' probability of having an outside deposit relationship around the deposit insurance threshold. Panel A reports the first stage results, estimated using the following regression model:

$$Outside\ deposit\ relationship_{i,t} = \alpha_0 + \alpha_1(1\{Deposits > \text{NOK } 2,000,000\}_{i,t}) + f(Deposits_{i,t}) + \epsilon_{i,t}$$

Panel B reports the corresponding second stage results, estimated using the following regression model:

$$Switch_{i,t+1} = \beta_0 + \beta_1 \widehat{Outside\ deposit}\ relationship_{i,t} + g(Deposits_{i,t+1}) + \upsilon_{i,t+1}$$

where $Switch_{i,t+1}$ is a dummy variable equal to one if a firm i switched to a new lender in year $t+1$. $Outside\ deposit\ relationship_{i,t}$ is a dummy variable equal to one if firm i had a deposit relationship with at least one (non-lender) outside bank in year t. $1\{Deposits > \text{NOK } 2,000,000\}_{i,t}$ is an indicator variable that equals one if firm i has total deposits exceeding NOK 2,000,000 in year t. The functions $f(Deposits_{i,t})$ and $g(Deposits_{i,t+1})$ represent local polynomial control functions of the running variable, which is the deposit balance near the deposit insurance threshold. $\epsilon_{i,t}$ and $\upsilon_{i,t+1}$ are the error terms, which are clustered at the firm level. The order of the local polynomial, kernel, bandwidth selection are indicated at the bottom of the table. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

	I	II	III	IV
Panel A	Outside deposit relationship	Outside deposit relationship	Outside deposit relationship	Outside deposit relationship
1{Deposits > NOK 2,000,000}	0.036***	0.037***	0.039***	0.035**
	(0.010)	(0.013)	(0.012)	(0.016)
Panel B	Switch	Switch	Switch	Switch
RD estimate	0.279*	0.351*	0.264*	0.436
	(0.150)	(0.182)	(0.153)	(0.295)
Observations	60,507	70,998	57,501	36,516
Observations left of cutoff	34,233	41,027	32,308	19,435
Observations right of cutoff	26,274	29,971	25,193	17,081
Kernel	Epanechnikov	Epanechnikov	Uniform	Uniform
Order polynomial	1	2	1	2
Bandwidth selection	CER	CER	CER	CER

Table O.D3. RDD robustness: Controlling for additional firm characteristics

This table reports how outside deposit relationships affect firms' probability of switching lenders, using a discontinuity in firms' probability of having an outside deposit relationship around the deposit insurance threshold. Columns I and III report the first stage results, estimated using the following regression model:

$$Outside\ deposit\ relationship_{i,t} = \alpha_0 + \alpha_1(1\{Deposits > \text{NOK } 2,000,000\}_{i,t}) + f(Deposits_{i,t}) + \delta X_{i,t} + \epsilon_{i,t}$$

Columns II and IV report the corresponding second stage results, estimated using the following regression model:

$$Switch_{i,t+1} = \beta_0 + \beta_1 \widehat{Outside\ deposit}\ relationship_{i,t} + g(Deposits_{i,t+1}) + \theta X_{i,t+1} + \upsilon_{i,t+1}$$

where $Switch_{i,t+1}$ is a dummy variable equal to one if a firm i switched to a new lender in year $t+1$. $Outside\ deposit\ relationship_{i,t}$ is a dummy variable equal to one if firm i had a deposit relationship with at least one (non-lender) outside bank in year t. $1\{Deposits > \text{NOK } 2,000,000\}_{i,t}$ is an indicator variable that equals one if firm i has total deposits exceeding NOK 2,000,000 in year t. The functions $f(Deposits_{i,t})$ and $g(Deposits_{i,t+1})$ represent local polynomial control functions of the running variable, which is the deposit balance near the deposit insurance threshold. $X_{i,t+1}$ is a vector of control variables, which includes firm size, leverage, profitability, and tangible assets. $\epsilon_{i,t}$ and $\upsilon_{i,t+1}$ are the error terms, which are clustered at the firm level. The order of the local polynomial, kernel, bandwidth selection are indicated at the bottom of the table. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

	I	II	III	IV
	Outside deposit relationship	Switch	Outside deposit relationship	Switch
1{Deposits > NOK 2,000,000}	0.035***		0.035**	
	(0.011)		(0.014)	
RD estimate		0.273*		0.401*
		(0.153)		(0.234)
Observations	76,348	76,348	76,348	76,348
Observations left of cutoff	44,640	44,640	44,640	44,640
Observations right of cutoff	31,708	31,708	31,708	31,708
Kernel	Triangular	Triangular	Triangular	Triangular
Order polynomial	1	1	2	2
Bandwidth selection	CER	CER	CER	CER
Controls	Yes	Yes	Yes	Yes

Table O.D4. RDD robustness: Placebo thresholds

This table reports how outside deposit relationships affect firms' probability of switching lenders, using a discontinuity in firms' probability of having an outside deposit relationship around the deposit insurance threshold. Columns I and III report the first stage results, estimated using the following regression model:

$$Outside\ deposit\ relationship_{i,t} = \alpha_0 + \alpha_1(1\{Deposits > Placebo\ threshold_{i,t}) + f(Deposits_{i,t}) + \epsilon_{i,t}$$

Columns II and IV report the corresponding second stage results, estimated using the following regression model:

$$Switch_{i,t+1} = \beta_0 + \beta_1 \widehat{Outside\ deposit}\ relationship_{i,t} + g(Deposits_{i,t+1}) + \upsilon_{i,t+1}$$

where $Switch_{i,t+1}$ is a dummy variable equal to one if a firm i switched to a new lender in year $t+1$. $Outside\ deposit\ relationship_{i,t}$ is a dummy variable equal to one if firm i had a deposit relationship with at least one (non-lender) outside bank in year t. $1\{Deposits > Placebo\ threshold\}_{i,t}$ is an indicator variable that equals one if firm i has total deposits exceeding the placebo threshold (indicated at the bottom of he table) in year t. The functions $f(Deposits_{i,t})$ and $g(Deposits_{i,t+1})$ represent local polynomial control functions of the running variable, which is the deposit balance near the deposit insurance threshold. $\epsilon_{i,t}$ and $\upsilon_{i,t+1}$ are the error terms, which are clustered at the firm level. The order of the local polynomial, kernel, bandwidth selection are indicated at the bottom of the table. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

	I Outside deposit relationship	II Switch	III Outside deposit relationship	IV Switch
1{Deposits > placebo threshold}	0.003		0.008	
	(0.009)		(0.014)	
RD estimate		2.004		-0.355
		(16.445)		(1.074)
Observations	71,120	71,120	49,941	49,941
Observations left of cutoff	40,296	40,296	28,692	28,692
Observations right of cutoff	30,824	30,824	21,249	21,249
Kernel	Triangular	Triangular	Triangular	Triangular
Order polynomial	1	1	1	1
Bandwidth selection	CER	CER	CER	CER
Placebo threshold	1,500,000 NOK	1,500,000 NOK	2,500,000 NOK	2,500,000 NOK

Table O.E1. Deposit relationships and outside banks' loan offers: The loan rate cycle after switching

This table reports how prior deposit relationships affect the loan rate cycle of switching firms over the course of their new lending relationship with their new (outside) lender, based on the following matching approach: First, we trace switchers over time at their new (outside) lender, and compute the spread between the loan rate on the switching loan and the loan rate on future loans that the switchers obtain from the new lender after the switch. Second, we split the sample into switching firms with and without prior deposit relationship, and group the corresponding matches in four one-year periods since the switching loan. Third, for each of the two sub-samples and four groups, we use the calculated spreads to estimate the following regression model:

$$R_{i,j,\tau} - R_{m(i,j,t)} = \alpha + \gamma_\tau + \epsilon_{i,j,\tau}$$

where $R_{i,j,t+\tau}$ represents the loan rate on loans granted by bank j to firm i in year τ and $R_{m(i,j,t)}$ the loan rate on its matched switching loan granted in year t. α is the constant. γ_τ represents time fixed effects. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. Across the different columns, we report the variables used in the matching procedure. The set of baseline matching variables includes firm size, sector, region, legal structure, credit rating, loan amount, loan collateralization, and loan type, as explained in Section 4.2. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

	I	II	III	VI
Periods since switching lenders	1 year	2 years	3 years	4 years
Panel A	Switching firms without prior deposit relationship			
Number of observations	322	428	328	86
Constant	0.092***	0.034***	0.079***	0.170***
	(0.008)	(0.004)	(0.008)	(0.018)
Panel B	Switching firms with prior deposit relationship			
Number of observations	91	78	52	11
Constant	0.031**	0.027***	0.078***	0.158***
	(0.012)	(0.007)	(0.020)	(0.048)

Table O.E2. Deposit relationships and outside banks' loan offers: Within-firm matching approach

This table reports how prior deposit relationships affect the loan rate discount offered by outside banks to switching firms, based on the following matching approach: First, we match each switching loan granted by outside banks with concurrent non-switching loans granted by inside banks to the same firm. Second, we calculate the spreads between the rates on the switching loans and each matched, non-switching loan. Third, we use the calculated spreads to estimate the following regression model:

$$R_{i,j,t} - R_{m(i,j,t)} = \alpha + \beta Prior\ deposit\ relationship_{i,j,t} + \epsilon_{i,j,t}$$

where $R_{i,j,t}$ represents the loan rate on switching loans granted by bank j to firm i in year t and $R_{m(i,j,t)}$ the loan rate on its matched counterfactual. α is the constant and $Prior\ deposit\ relationship_{i,j,t}$ is a dummy variable equal to one if the switcher and the new (outside) lender had a prior deposit relationship. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. We weigh each observation by one over the total number of comparable matched loans per switching loan. Across the different columns, we report the variables used in the matching procedure. The set of baseline matching variables includes firm size, sector, region, legal structure, credit rating, loan amount, loan collateralization, and loan type, as explained in Section 4.2. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Matching variables	I
	Loan rate
Year	Yes
Firm	Yes
Baseline matching variables	Yes
Number of switching loans	797
Number of non-switching loans	806
Number of observations	1,031
Proportion of switching loans with a prior deposit relationship	27%
Constant	-0.530***
	(0.138)
Prior deposit relationship	-1.030***
	(0.371)

Table O.E3. Deposit relationships and the probability of switching lenders: Alternative definition of lender switching

This table reports how outside deposit relationships affect firms' probability of switching lenders, based on the following regression model:

$$Switch_{i,t} = \alpha + \beta Outside\ deposit\ relationship_{i,t-1} + \gamma X_{i,j,t} + \eta_i + \delta_{j,t} + \epsilon_{i,j,t}$$

where $Switch_{i,t}$ is a dummy variable equal to one if a firm i switched to a new lender in year t. $Outside\ deposit\ relationship_{i,t-1}$ is a dummy variable equal to one if firm i had a deposit relationship with at least one (non-lender) outside bank in year $t-1$. $X_{i,j,t}$ is a vector of firm and firm-bank control variables. Firm controls include firms' size, leverage ratio, EBIT to total assets, fixed assets to total assets, and a dummy variable equal to one for public companies. Firm-bank controls include the loan rate, loan amount, the proportion of loan collateralized, the probability of default, and a dummy variable equal to one for credit lines. η_i and $\delta_{j,t}$ are firm and bank-by-time fixed effects, respectively. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

	I	II	III	IV	V
	Switch	Switch	Switch	Switch	Switch
Outside deposit relationship$_{t-1}$	0.024***	0.069***	0.045***	0.045***	0.043***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)
Observations	320,484	307,300	307,300	307,300	307,297
Adjusted R-squared	0.017	0.167	0.193	0.196	0.200
Controls	Yes	Yes	Yes	Yes	Yes
Firm FE	No	Yes	Yes	Yes	Yes
Time FE	No	No	Yes	Yes	No
Bank FE	No	No	No	Yes	No
Bank × Time FE	No	No	No	No	Yes

Table O.E4. Deposit relationships and outside banks' loan offers: Alternative definition of lender switching

This table reports how prior deposit relationships affect the loan rate discount offered by outside banks to switching firms, based on the following matching approach: First, we match each switching loan with all similar non-switching loans granted to other comparable firms by the switcher's inside or outside banks at the time of the switch. Second, we calculate the spreads between the rates on the switching loans and each matched loan. Third, we use the calculated spreads to estimate the following regression model:

$$R_{i,j,t} - R_{m(i,j,t)} = \alpha + \beta Prior\ deposit\ relationship_{i,j,t} + \epsilon_{i,j,t}$$

where $R_{i,j,t}$ represents the loan rate on switching loans granted by bank j to firm i in year t and $R_{m(i,j,t)}$ the loan rate on its matched counterfactual. α is the constant and $Prior\ deposit\ relationship_{i,j,t}$ is a dummy variable equal to one if the switcher and the new (outside) lender had a prior deposit relationship. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. We weigh each observation by one over the total number of comparable matched loans per switching loan. Across the different columns, we report the variables used in the matching procedure. The set of baseline matching variables includes firm size, sector, region, legal structure, credit rating, loan amount, loan collateralization, and loan type, as explained in Section 4.2. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Matching variables	I	II	III	VI	V
	Loan rate	Loan rate	Loan rate	Loan rate	Loan rate
Year	Yes	Yes	Yes	Yes	Yes
Inside bank	Yes				
Outside bank		Yes	Yes	Yes	Yes
Baseline matching variables	Yes	Yes	Yes	Yes	Yes
Deposit relationship			Yes		
Prior credit rating from inside banks				Yes	
Loan rate on prior inside loans					Yes
Number of switching loans	712	1,960	1,786	1,679	630
Number of non-switching loans	1,290	3,338	3,058	2,986	993
Number of observations	1,563	4,807	4,429	4,146	1,199
Proportion of switching loans with a prior deposit relationship	48%	13%	12%	14%	13%
Constant	-0.559***	-0.436***	-0.392***	-0.414***	-0.548***
	(0.159)	(0.060)	(0.061)	(0.065)	(0.092)
Prior deposit relationship	-0.878***	-0.526**	-0.615**	-0.596**	-0.798**
	(0.255)	(0.246)	(0.267)	(0.255)	(0.323)

Table O.E5. Deposit relationships and outside banks' loan offers: Estimation using sub-samples

This table reports how prior deposit relationships affect the loan rate discount offered by outside banks to switching firms, based on the following matching approach: First, we match each switching loan with all similar non-switching loans granted to other comparable firms by the switcher's inside or outside banks at the time of the switch. Second, we calculate the spreads between the rates on the switching loans and each matched loan. Third, we split our sample into switching firms with and without a prior deposit relationship and, for each of these sub-samples, use the calculated spreads to estimate the following regression model:

$$R_{i,j,t} - R_{m(i,j,t)} = \alpha + \epsilon_{i,j,t}$$

where $R_{i,j,t}$ represents the loan rate on switching loans granted by bank j to firm i in year t and $R_{m(i,j,t)}$ the loan rate on its matched counterfactual. α is the constant. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. We weigh each observation by one over the total number of comparable matched loans per switching loan. Across the different columns, we report the variables used in the matching procedure. The set of baseline matching variables includes firm size, sector, region, legal structure, credit rating, loan amount, loan collateralization, and loan type, as explained in Section 4.2. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Matching variables	I	II	III	IV	V
	Loan rate	Loan rate	Loan rate	Loan rate	Loan rate
Year	Yes	Yes	Yes	Yes	Yes
Inside bank	Yes				
Outside bank		Yes	Yes	Yes	Yes
Baseline matching variables	Yes	Yes	Yes	Yes	Yes
Deposit relationship			Yes		
Prior credit rating from inside banks				Yes	
Loan rate on prior inside loans					Yes
Panel A	Switching firms without prior deposit relationship				
Number of observations	3,138	4,103	3,726	3,540	1,008
Constant	-0.798***	-0.483***	-0.410***	-0.469***	-0.577***
	(0.087)	(0.064)	(0.067)	(0.070)	(0.096)
Panel B	Switching firms with prior deposit relationship				
Number of observations	1,536	1,227	1,047	1,161	309
Constant	-1.619***	-1.692***	-1.848***	-1.672***	-1.735***
	(0.166)	(0.150)	(0.163)	(0.155)	(0.221)

Table O.E6. Deposit relationships and outside banks' loan offers: Estimation using firm-bank pairs with a single loan

This table reports how prior deposit relationships affect the loan rate discount offered by outside banks to switching firms, based on the following matching approach: First, we match each switching loan with all similar non-switching loans granted to other comparable firms by the switcher's inside or outside banks at the time of the switch. Second, we calculate the spreads between the rates on the switching loans and each matched loan. Third, we use the calculated spreads to estimate the following regression model:

$$R_{i,j,t} - R_{m(i,j,t)} = \alpha + \beta Prior\ deposit\ relationship_{i,j,t} + \epsilon_{i,j,t}$$

where $R_{i,j,t}$ represents the loan rate on switching loans granted by bank j to firm i in year t and $R_{m(i,j,t)}$ the loan rate on its matched counterfactual. α is the constant and $Prior\ deposit\ relationship_{i,j,t}$ is a dummy variable equal to one if the switcher and the new (outside) lender had a prior deposit relationship. $\epsilon_{i,j,t}$ is the error term, which is clustered at the firm level. We weigh each observation by one over the total number of comparable matched loans per switching loan. Across the different columns, we report the variables used in the matching procedure. All variables are defined in Table A1 in the Appendix. The sample comprises all firms with at least one lending relationship and at most one loan product per bank operating in Norway between 2014 and 2019. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Matching variables	I	II	III	IV	V
	Loan rate	Loan rate	Loan rate	Loan rate	Loan rate
Year	Yes	Yes	Yes	Yes	Yes
Inside bank	Yes				
Outside bank		Yes	Yes	Yes	Yes
Baseline matching variables	Yes	Yes	Yes	Yes	Yes
Deposit relationship			Yes		
Prior credit rating from inside banks				Yes	
Loan rate on prior inside loans					Yes
Number of switching loans	499	536	477	465	150
Number of non-switching loans	695	680	617	602	169
Number of observations	796	780	695	686	175
Proportion of switching loans with a prior deposit relationship	22%	56%	58%	60%	46%
Constant	-0.407**	-0.796***	-0.664***	-0.888***	-1.032***
	(0.203)	(0.178)	(0.202)	(0.183)	(0.157)
Prior deposit relationship	-2.507***	-1.598***	-1.872***	-1.527***	-1.124***
	(0.585)	(0.315)	(0.337)	(0.324)	(0.394)

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