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 all firm-bank deposit and lending relationships in Norway, we show that deposit relationships between firms and outside banks can 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. Consistent with hold-up theory, our findings are driven by the fact that firms' deposit account activity contains valuable information (not cross-selling), providing the first empirical 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 other (outside) banks (Diamond 1991; Rajan 1992; Sharpe 1990; Thadden 2004). This informational advantage hinders 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 firms face difficulties switching lenders, leading to hold-up problems and investment inefficiencies (e.g., 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 to show that deposit relationships between firms and outside banks can mitigate inside banks' informational monopoly, thereby increasing lender competition. 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, Berlin and Mester 1999; Drechsler, Savov, and Schnabl 2021; Fama 1985; Kashyap, Rajan, and Stein 2002; Mester, Nakamura, and Renault 2007).

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, and deposits but no loans at another bank. The former would correspond to the firm's inside bank and the latter to the (non-lender) outside bank. Second, we document that about 40% of firms that switch lenders had a deposit relationship with their new (outside) lender at least one year before switching. These patterns—which have not been documented before—suggest that deposit relationships between firms and outside banks play an important role in lender switching.

In the second part of our study, we formally analyze the role of deposit relationships in lender switching. We start by analyzing whether having a deposit relationship with

(non-lender) outside banks affects the probability that firms switch lenders, as this directly relates to lender competition. Theory predicts 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 and hence switching (Rajan 1992; Thadden 2004). 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 more likely to switch lenders in the following year, relative to firms without such a relationship. This result is economically significant, corresponding to about 50% of the unconditional likelihood of switching lenders, and consistent with our theoretical prediction.

We then investigate whether having a pre-existing deposit relationship with outside banks affects the loan conditions that firms receive upon switching, as this directly 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 (Sharpe 1990; Thadden 2004). To examine this, we employ the matching model 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 versus without a pre-existing deposit relationship. Our matching model accounts for differences across lenders, borrowers, loan contract characteristics, relationship characteristics, and macroeconomic conditions. Importantly, our matching model also accounts for the (proprietary) credit rating assigned by banks to firms, ensuring that we compare the loan conditions offered to switchers with versus without a prior deposit relationship that have exactly the same estimated credit risk according to their new (outside) lender.[1]

Our findings are threefold. First, consistent with existing evidence on hold-up problems in the loan market, we find that interest rates on new loans granted by outside banks to switching firms are on average 80 basis points (bps) lower than rates on comparable non-switching loans granted to existing borrowers. This result is economically relevant, as it compares to

[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.

an average loan rate of 520 bps, and quantitatively aligns with the 90 bps 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 equal to 170 bps compared to 50 bps for switching firms without a prior deposit relationship. Thus, consistent with our theoretical prediction, outside banks seem to bid more aggressively on loans to switching 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 outside bank 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 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 not only increases firms' probability of switching lenders, but also improves the loan terms that firms obtain upon switching 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 (Rajan 1992; Sharpe 1990; Thadden 2004). 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 (Black 1975; Fama 1985; Mester, Nakamura, and Renault 2007; Norden and Weber 2010).[2] Hence, we conjecture that information obtained from

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

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 increasing in the length, depth, and scope of the deposit relationships, and more pronounced for deposit relationships comprising a transaction account (which typically contains 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 our results are driven by the fact that deposit relationships reduce information asymmetries between firms and outside banks.

Second, theory suggests that outside banks would be less willing to bid on loans to borrowers 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 or adverse selection 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. 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 find that the initial credit rating assigned by outside banks to switching firms predicts future loan performance better for switching firms with a prior deposit relationship, compared to those without a prior deposit relationship. Given that the credit rating assigned at the time of the switch only captures information used in banks' screening process (not the monitoring process), this

creditworthiness (e.g., McKinsey 2019).

[3]We measure deposit relationship length as the number of years during which the switching firms and outside banks maintained a deposit relationship, deposit relationship depth as the share of deposits that switching firms held at the outside banks 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., interest rates below 0.25%).

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 (De Roux and Limodio 2023; Iyer, Puri, and Ryan 2016). Using this threshold-based variation, we then 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 could be that our results are not due to the role of deposit relationships in reducing outside banks' informational disadvantage, but due to 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 firms' potential deposit 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 bps 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 could be 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 (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 facilitating lender switching and attenuating hold-up. To the best of our knowledge, our findings provide 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), and offer the first empirical 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 hold-up problems in the loan market (Agarwal and Hauswald 2010; Hale and Santos 2009; Hauswald and Marquez 2006; Houston and James 1996; Ioannidou and Ongena 2010; Rajan 1992; Santos and Winton 2008; Sharpe 1990; Thadden 1995, 2004). In the theoretical model of Sharpe (1990), 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 would try to switch to an (uninformed) 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, Thadden (2004) however shows that outside banks can offer competitively lower rates using "optimal randomization" to borrowers that are—at least to them—observationally identical meaning that, in equilibrium, occasional switching occurs.

In general, prior research has highlighted that information disclosure can mitigate hold-up, either by disclosing private information (Bird, Karolyi, and Ruchti 2019; Cahn, Girotti, and Salvadè 2023), being publicly listed (Saunders and Steffen 2011; Schenone 2010), or issuing public debt (Diamond 1991; Rajan 1992). Our paper contributes to these studies by showing that deposit relationships between firms and outside banks can reduce inside banks' informational monopoly, providing a novel perspective on the two-sidedness of the banking sector. For one, our findings imply that deposit market reforms aimed at facilitating deposit switching could reduce hold-up problems in the loan market.[4] Furthermore, our paper contributes to previous papers that analyze how switching lenders affect firms' loan conditions (e.g., Ioannidou and Ongena 2010), by uncovering significant heterogeneity related to switching firms' prior deposit relationship with their new (outside) lender.[5] Assuming that the loan rate discount obtained by switchers with a prior deposit relationship is closest to the potential loan rate discount obtained in a frictionless market with perfect information, our findings imply that hold-up problems may be larger than previously thought.

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. 2021; 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 relationships, and those that have almost exclusively focus on how banks can use information from firms' deposit

[4]A recent example is the implementation of the Payment Services Directive (PSD2) in Belgium in 2018, which facilitates deposit switching for consumer and firms by shifting the administrative burden related to deposit switching from firms and consumers to banks (National Bank of Belgium 2018). For instance, since 2018, if a firm decides to transfer its deposit accounts from one bank to another, the new bank is responsible for arranging the transfer of the firm's payment and settlement orders from the firm's former current account with the former bank.

[5]Consistent with the theoretical predictions from Sharpe (1990), Ioannidou and Ongena (2010) find that switching to an outside lender leads to a 89 bps drop in borrowers' loan rate, indicating that the borrowers were being held up by their inside lenders. Other papers have reported similar estimates using data from different countries (e.g., Bonfim, Nogueira, and Ongena 2021; Liaudinskas 2023).

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).[6,7] Our contribution to this literature is twofold. Firstly, we provide new stylized facts about the structure of firm-bank deposit and lending relationships. Secondly, we show that deposit relationships can impact lender competition by mitigating outside banks' informational disadvantage vis-à-vis inside banks.

Finally, our paper relates to the relevance of information sharing between financial intermediaries (Bird, Karolyi, and Ruchti 2019; Pagano and Jappelli 1993), particularly the debate on open banking (Alok et al. 2024; Babina et al. 2024; Ghosh, Vallee, and Zeng 2024; He, Huang, and Zhou 2023; Parlour, Rajan, and Zhu 2022). In general, a common way to overcome information asymmetries in the loan market is private information sharing between banks, for instance through a credit register (Liberti, Sturgess, and Sutherland 2022; Pagano and Jappelli 1993). While private information on firms' deposit account activities (including payment data) is generally not shared through credit registers, our results highlight that such information could improve lender competition and alleviate hold-up problems, in line with the premise of open banking (He, Huang, and Zhou 2023; Marquez 2002).

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*) as a basis for corporate taxation and, hence, essentially measurement error-free. 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.[8] We aggregate this firm-bank-account-year level data to the firm-bank-year level in order to track all bank-firm lending and deposit

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

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

[8]The data do not report the type of account, but we can derive whether an account is a transaction account based on whether it earns near-zero interest rate (as explained in Section 4.2.1).

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). In doing so, we also account for bank mergers and acquisitions that took place during our sample period.[9] The final dataset comprises 180 banks and 241,466 firms for a total of 511,879 unique bank-firm 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 relationships, (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%) consist of both a deposit and a lending relationship. More interestingly, we observe that approximately 5% of firm-bank relationships consist exclusively of a lending relationship and around 15-20% of firm-bank relationships consist exclusively of a deposit relationship. The latter observation indicates that it is common for firms to have deposit relationships with banks from which they do not necessarily borrow.[10]

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 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,

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

[10] Although the objective of our paper is not to analyze why firms have deposit relationships with banks from which they do not borrow, Table O.B1 in the Online Appendix aims to offer some insights into this matter. Consistent with prior research, we find that firm-specific, bank-specific, and institutional factors play a role (e.g., d'Avernas et al. 2023; De Roux and Limodio 2023; Drechsler, Savov, and Schnabl 2017; Iyer et al. 2019; Lu, Song, and Zeng 2024). 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 (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; Lu, Song, and Zeng 2024), among others. As explained below, we control for the above-mentioned factors in our analysis to mitigate potential concerns about omitted variable bias.

in line with Figure 1, we observe that around 20% of firms has more deposit than lending relationships.[11] 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 that switch lenders to have a deposit relationship with their new lender at least one year prior to switching. Specifically, 40% of switching firms had a deposit relationship with their new (outside) lender at least one year before switching. Focusing on the switching firms that had a prior deposit relationship with the outside banks, 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. For one, 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 strong deposit relationships with their new (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 have deposit relationships with banks from which they do not borrow *yet*.

Our paper is the first to document these patterns for the corporate banking sector.[12] In general, these patterns indicate 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 upon switching lenders, and the potential mechanism underlying these effects.

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

[12] 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 have a bank relationship that only involves non-lending related activities.

3. Methodology

3.1. Definitions

Our research objective is to study the role of deposit relationships in lender switching, which requires an operational definition of lender switching. To this end, we follow Ioannidou and Ongena (2010) and impose 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 is based on the assumption 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.[13]

3.2. Method

3.2.1. Deposit relationships and the probability of switching lenders

The stylized facts documented in Section 2 show that it is common for firms that switch lenders to have a prior deposit relationship with their new (outside) lender. In the first part of our analysis, we therefore formally analyze whether having a prior deposit relationship with outside banks affects the probability that firms switch lenders. In general, theory predicts 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 and hence switching lenders (Rajan 1992; Thadden 2004). Building on the empirical framework of Bird, Karolyi, and Ruchti (2019), we test this prediction based on

[13] 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.

the following linear probability model that we estimate using Ordinary Least Squares (OLS):

$$Switch_{f,t} = \alpha + \beta Outside\ deposit\ relationship_{f,t-1} + \delta C_{f,b,t} + \lambda_f + \lambda_{b,t} + \epsilon_{f,b,t} \quad (1)$$

where $Switch_{f,t}$ is a dummy variable equal to one if a firm f switched to a new lender in year t, and $Outside\ deposit\ relationship_{f,t-1}$ is a dummy variable equal to one if firm f had a deposit relationship with at least one (non-lender) outside bank in year $t-1$. $C_{f,b,t}$ is a vector of control variables, which includes both firm and loan variables. Firm controls include firms' size, leverage ratio, EBIT to total assets, fixed assets to total assets, and organizational form (i.e., a dummy equal to one for publicly listed firms). Loan controls include the loan interest, loan amount, proportion of loan collateralized, a dummy variable equal to one for credit lines, and a (proprietary) credit rating assigned by the bank to the borrower, which capture banks' private information about the borrower. More precisely, controlling for loan terms (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 λ_f and $\lambda_{b,t}$, 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, $\epsilon_{f,b,t}$, 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.

3.2.2. Deposit relationships and the effects of switching lenders

In the second part of our empirical analysis, we study whether having a prior deposit relationship with new (outside) lenders affects the loan conditions that switching firms obtain 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; Thadden 2004).

To study this, 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. Unfortunately, we do not have data on (unsuccessful) loan applications, which is why we follow prior literature and use a strict matching model to derive the (counterfactual) loan terms offered to firms for a non-switching loan (Ioannidou and Ongena 2010). Based on the counterfactuals obtained from the matching model, we then analyze the effect of switching on firms' loan conditions, and whether this differs for switching firms with versus without a prior deposit relationship.

Our matching model 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 visual representation 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 other 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 the switching loans (as in Sharpe 1990), but in additional analyses below we also examine 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 loans are comparable in terms of key loan terms; and matching on credit rating ensures that the loans 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 to establish the matching model.

Following 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.[14] In matching the switching and non-switching loans, we allow for replacement (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:

$$R_{switch} - R_{non-switch} = \alpha + \beta Prior\ deposit\ relationship + \epsilon \tag{2}$$

where R_{switch} and $R_{non-switch}$ represent the loan rates on the switching loans and matched loans, respectively. 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 a prior deposit relationship.[15]

[14] 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 4, and shows that the standardized mean differences of the different variables are generally between -0.20 and 0.20, indicating that the variables are well-balanced.

[15] An alternative method is to split the matched sample into two sub-samples: one sample of switching loans of switchers with

A potential concern with the empirical strategy explained above is that we match switchers with non-switchers, and then explore differences in the loan conditions obtained by switchers with versus without a prior deposit relationship. This could lead to biased results in case switchers with and without a prior deposit relationship differ along certain dimensions (e.g., if outside banks assess switchers with a prior deposit relationship to be less risky on average than switchers without a prior deposit relationship). To address this concern, we apply an alternative empirical 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:

$$R_{switch}^{with\ prior\ deposit\ relationship} - R_{switch}^{without\ prior\ deposit\ relationship} = \alpha + \epsilon \tag{3}$$

where the loan rates on switching loans granted to switchers with and without a prior deposit relationship are represented by $R_{switch}^{with\ prior\ deposit\ relationship}$ and $R_{switch}^{without\ prior\ deposit\ relationship}$, respectively. 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.

3.3. Data and summary statistics

To conduct our empirical analysis, we need detailed data on firm-bank relationships and loan contracts. We obtain the former from the Norwegian Tax Administration, which tracks the deposit and lending relationships of all firm-bank pairs in Norway, 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

a prior deposit relationship and the matched non-switching loans, and another sample of switching loans of 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 results of this alternative method, which are reported in Table O.D1 in the Online Appendix, are quantitatively similar.

for the period 2014-2019, allow us to retrieve loan exposures for every firm–bank pair, including detailed information on the loan contract, such as the contractual loan amount, interest rate, proportion of the loan that is collateralized, loan type (i.e., whether the loan is a credit line or not), and loan status (i.e., the proportion of the loan that is written off). In addition, these data contain a firm-bank-specific credit rating 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, Brønnøysund Register Centre (*Brønnøysundregistrene*). Firms operating in Norway are required to register their financial statements at the Centre 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.

Our final dataset comprises 115 banks and 72,224 firms for a total of 98,655 unique bank-firm relationships over the period 2014-2019. Given our definition of switching, the dataset yields 28,741 switching loans granted to 17,881 firms. This implies that approximately 8% of the loan originations are switching loans, and that 24% of the 72,244 firms in our sample switch banks at some point during our sample period. The percentage of switching loans is relatively constant over time and comparable to the percentage found in previous papers. For instance, Ioannidou and Ongena (2010) find that 4.5% of loan originations are switching loans using Bolivian data and Degryse, Ioannidou, and Schedvin (2016) find that 5.5% of loan originations are switching loans using Swedish data.

Table 1 provides descriptive statistics for firms with and without an outside deposit relationship, and Table 2 provides descriptive statistics for switching and non-switching firms. The tables also indicate whether the differences in mean, median, and standard deviation between the two types of firms are statistically significant. Table 1 shows that the likelihood of lender switching is larger for firms with outside deposit relationship (20%) compared to

firms without outside deposit relationship (15%). Turning to Table 2, we observe that the average interest rate for switching loans with a prior deposit relationship is approximately 4%, which is 120 bps lower than for non-switching loans and 149 bps lower than switching loans for switchers without a prior deposit relationship. Further, switchers with prior deposit relationship tend to obtain loans that are larger, with a higher collateralization rate, and more likely to be credit lines, compared to switchers without a prior deposit relationship. Switchers with and without a prior deposit relationship are relatively similar in terms of size, leverage (Debt/TA), profitability (EBIT/TA), and credit rating. In addition, Table O.A1 in the Online Appendix shows that the distribution of switchers with and without a prior deposit relationship across industries is similar. 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. Table 2 shows that, for switching firms with a prior deposit relationship, the average length of the prior deposit relationship equals about seven years.

4. Results

The results section is structured as follows. First, we examine whether having deposit relationships with outside banks increases firms' probability of switching lenders. Second, we examine whether having a prior deposit relationship with outside banks influences the loan conditions that outside banks offer to switching firms. Third, we explore the mechanism underlying these effects. Finally, we present a number of extensions and robustness tests.

4.1. Main results

We first assess whether having a deposit relationship with outside banks influences firms' propensity to switch lenders using the linear probability model outlined in Equation (1). Table 3 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 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 percentage points 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 even increases to around 8 percentage points 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 4.2). Overall, the results in Table 3 are consistent with our theoretical prediction that having an outside deposit relationship increases firms' outside options and hence firms' probability of switching lenders.[16] Moreover, as explained in Section 4.3.2 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.

We next examine whether having a pre-existing deposit relationship with outside banks affects the loan conditions that firms receive upon switching. To do so, we use the matching model outlined in Equation (2). The results are presented in Table 4, which depicts the list of matching 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 variables. This corresponds to the matching strategy depicted in Figure A1a. Matching on the ten variables listed in Column I of Table 4, we are left with 1,868 switching loans that are in 4,688 matched pairs with 3,194 non-switching loans (meaning that each switching loan is matched with approximately 2.5 comparable non-switching loans). From the 1,868 switching

[16] 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 observations. 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 fact that there are few observations for 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.

loans, 30% of switching firms had a prior deposit relationship with the new (outside) bank.

In Column I, the coefficient estimate of α suggests that, on average, switchers receive a loan rate discount of nearly 80 bps, while the coefficient estimate of β indicates that switchers with a prior deposit relationships obtain an additional loan rate discount of 79 bps. In other words, on average, switchers without a prior deposit relationship receive a loan rate discount of 80 bps while switchers with a prior deposit relationship receive a loan rate discount of 159 bps. 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 bps. 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.[17]

In Column II, 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 an important advantage over the matching model in Column I. Since the comparison is now within the same bank during the same year, 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 this matching strategy as our baseline matching model. Based on this matching strategy, we find that switchers receive a loan rate discount of 48 bps, with an additional loan rate discount of 120 bps for switchers with a prior deposit relationship, consistent with our earlier results.

In Columns III to V, we subject our matching model to additional robustness tests. In Column III, we also match on a deposit relationship dummy. A potential advantage of this approach is that it ensures we compare loan rates offered by an outside bank to switching

[17] Ioannidou and Ongena (2010) and Bonfim, Nogueira, and Ongena (2021) estimate a loan rate discount of approximately 90 bps for switching firms in Bolivia and Portugal, respectively. Relative to the baseline loan rate, our estimated loan rate discount of 80 bps is slightly larger than theirs, which could be due to the fact that hold-up problems may be more pronounced 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).

firms with (without) a deposit relationship to loan rates offered by the outside bank to comparable existing borrowers with (without) deposit relationship. In Column VI, we replace the credit rating that the switching firms obtain from their new bank with the firms' most recent rating obtained 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, in Column V we replace the inside banks' most recent credit rating with the inside banks' most recent loan rate. Compared to Column IV, a potential 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).[18] 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 technical 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 160 bps to switchers with a prior deposit relationship.

A potential limitation of the regression model in Equation (2) is that we match switchers with non-switchers, and then compare the loan rate discount of switchers with and without a prior deposit relationship. This could lead to biased results in case switchers with and without a prior deposit relationship differ along certain dimensions (for instance, if banks assess switchers with a prior deposit relationship to be less risky on average than switchers without a prior deposit relationship). To address this concern, we apply an alternative matching approach. Recall that we are interested in the difference in loan rates between switchers with and without a prior deposit relationship. This means that we can directly match switchers with a prior deposit relationship to other (comparable) switchers without a prior deposit relationship, and then estimate Equation (3).

The results of this alternative matching strategy are presented in Column I of Table 5. This matching strategy significantly reduces our estimation sample, but consistent with the

[18] Research has show that banks that are concerned about their capital position could manipulate credit ratings to lower their risk-weighted assets (e.g., Plosser and Santos 2018), which would reduce the informativeness of credit ratings.

results from Table 4, we find that outside banks offer a 58 bps larger loan rate discount to switchers with versus without a prior deposit relationship. This result is statistically and economically significant. In addition, it should be stressed that these results are based on comparing switchers (with and without a prior deposit relationship) which are similar on all the variables of our benchmark matching model, including the credit rating that the outside bank assigned to the switchers. This suggests that, 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.

In Column II of Table 5, 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 to 40 observations. Nevertheless, we find that switchers with a prior deposit relationship obtain a loan rate that is 62 bps lower than the loan rate of switchers without a prior deposit relationship. In other words, having a *prior* deposit relationship matters.

In sum, 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.

4.2. 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; Thadden 2004). On the other hand, there is ample empirical evidence that banks can use information obtained 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 is the most important source of information for banks to evaluate (potential) borrowers' creditworthiness (McKinsey 2019).[19] We therefore conjecture that deposit relationships between firms and outside banks can mitigate outside banks' informational disadvantage, thereby increasing lender competition and mitigating hold-up in the loan market. Below, we provide several pieces of evidence that support this conjecture.

4.2.1. The information flow of deposit relationships

If deposit relationships allow to 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 relationship variables that allow to 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%).[20] 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

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

[20] 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.

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 results are presented in Table 6. All regressions include firm controls, loan controls, firm fixed effects, and bank-by-time fixed effects. In line with our conjecture, we find that the probability of switching lenders is increasing in the length, depth, and scope of the underlying deposit relationship, and that our results are stronger for deposit relationships that comprise a transaction account. For instance, Column I indicates that each one-year increase in the length of the outside deposit relationship increases firms' probability of switching lenders by 1 percentage point (although the squared deposit relationship length variable indicates that the effect is non-linear), and Column IV indicates that deposit relationships comprising a transaction account increase firms' probability of switching by 3 percentage points.

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 to compare the loan rate discount of switching firms with a long versus short prior deposit relationship, for instance. The results are presented in Table 7. Across the different columns, the coefficient estimate of the constant indicate that switchers receive a loan rate discount of approximately 50 bps, which accords with our estimates from Table 4. 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 switchers 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 bps larger loan rate discount, while transaction accounts are associated with a 67 bps larger loan rate discount.[21]

[21]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 must 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

Overall, Tables 6 and 7 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.

4.2.2. Deposit relationships and outside banks' informational disadvantage

Theory suggests that outside banks would be less willing to bid on loans to borrowers 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 borrowers for which the inside bank has a greater informational monopoly or, more generally, borrowers with greater information asymmetries or adverse selection problems.

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 (e.g., Beck et al. 2018). 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.[22] 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

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.

[22]We measure local bank competition using a loan-based Herfindahl-Hirschman Index, which is calculated in two steps. In the first step, we compute the squared values of each bank's market share relative to the total market. In the second step, we sum the values calculated in the first step. Higher Herfindahl-Hirschman Index values represent a more concentrated (i.e., less competitive) lending market.

deposit relationship variable and each of the four dummy variables explained above. These 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 9. All regressions include firm controls, loan 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 percentage points more likely to switch lenders the next year, and this effect increases to nearly 11 percentage points 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 9. In line with our baseline results, the coefficient estimate of the constant is significantly negative, indicating that switching firms with prior deposit relationships 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 or adverse selection problems. For instance, Columns I and II shows 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 bps, respectively (although the single-bank borrower interaction is statistically insignificant). Columns III and IV show similar results for young (informationally opaque) firms and firms that operate in areas with high bank competition.

Taken together, the results presented in Tables 8 and 9 show that our baseline results are

stronger if outside banks' informational disadvantage is more pronounced. This is in line with our theoretical prediction that deposit relationships can mitigate the winner's curse that outside banks face in competing with inside banks.

4.2.3. Deposit relationships and outside banks' screening capability

In case deposit relationships provide relevant information about firms' creditworthiness, we would expect that having a prior deposit relationship improves outside banks' screening capability. 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, but instead we use all switching loan observations and estimate the following linear probability model:

$$\begin{aligned} Loan\ default_{f,b,t+3} =& \alpha + \delta_1 Prior\ deposit\ relationship_{f,b,t} + \delta_2 Credit\ rating_{f,b,t} + \\ & \delta_3 (Prior\ deposit\ relationship \times Credit\ rating)_{f,b,t} + \gamma C_{f,b,t} + \epsilon_{f,b,t} \end{aligned} \tag{4}$$

where the outcome variable is a dummy equal to one if the new (outside) lender writes off the switching loan within the first three years after the switch. $Prior\ deposit\ relationship_{f,b,t}$ is a dummy variable equal to one if the switcher had a prior deposit relationship with the new (outside) lender, and zero otherwise. $Credit\ rating_{f,b,t}$ 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. $C_{f,b,t}$ is a vector of control variables, which consists of the variables used in our benchmark matching model (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, $\epsilon_{f,b,t}$, is clustered at the firm level. In

this regression model, δ_1 captures the potential difference in loan defaults between switchers with and 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 and without a prior deposit relationship.

The results are presented in Table 10. In this table, Columns I and II report the regression results of estimating Equation (4) before and after including control variables, respectively. First, focusing on the coefficient estimate of δ_1, we find that switchers with a prior deposit relationship have a slightly lower probability of default, which is in line with previous papers showing that banks can use information from borrowers' deposit relationships to improve loan performance (e.g., Mester, Nakamura, and Renault 2007; Norden and Weber 2010). Second, the coefficient estimate of δ_2 is positive and large, indicating that the credit rating assigned at the time of the switch is a good predictor of a switcher's future loan performance. For instance, a one standard deviation deterioration in *Credit rating* is associated with a 2 percentage points increase in a switcher's probability of default, which corresponds to about 25% of the standard deviation of switchers' average probability of default. Finally, the coefficient estimate of δ_3 is positive and statistically significant, which indicates that the predictive ability of *Credit rating* is larger for switchers with a prior deposit relationship.[23] Thus, in line with our conjecture, the results from Table 10 confirm that prior deposit relationships improve outside banks' screening capability.

4.3. Extensions

4.3.1. Other loan terms

Our baseline analysis focuses on how prior deposit relationships affect the loan rates of switching loans. In Table A3 in the Appendix, we show that prior deposit relationships also affect non-pricing terms of switching loans. We estimate the effect on the loan amount, the probability that the loan is 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

[23] Another way to assess whether prior deposit relationships improve outside banks' screening capability is by regressing the credit rating variable on the loan default variable for the sub-sample for switchers with and without a prior deposit relationship, separately, and the comparing the Adjusted R-squared of the two regressions. Doing so, we find that the Adjusted R-squared for the regression based on the sub-sample of switchers with prior deposit relationships is nearly four times larger than the Adjusted R-squared for the sub-sample of switchers without a prior deposit relationship (0.22 versus 0.06).

baseline matching model. 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 α across the three columns of Table A3. These estimates indicate that, on average, switching loans have smaller loan amounts, a lower probability of being a credit line, and a lower collateralization rate, which is consistent with findings from Bonfim, Nogueira, and Ongena (2021) for example. Turning to the coefficient estimates of β, 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, we find that outside banks offer better pricing and non-pricing loan terms to switchers with a prior deposit relationship.

4.3.2. RDD estimation

Ideally, to assess how outside deposit relationship affects 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 2,000,000 NOK per account holder, per bank (which is around 180,000 USD) 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 split deposits across banks to ensure that the amount deposited at each bank is fully insured (e.g., also see 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 disoncontinuity at the 2,000,000 NOK 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 155,000 NOK below and above the deposit insurance threshold.[24] 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:

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

Second stage:

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

where f and t correspond to firm and year, respectively.[25] 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. $1\{\textit{Deposits} > 2,000,000 \text{ NOK}\}_{f,t}$ is an indicator that equals one if firm f has total deposits exceeding 2,000,000 NOK in year t and zero otherwise, and $\textit{Outside deposit relationship}_{f,t}$ is an

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

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

indicator variable that equals one if a firm f has an outside deposit relationship in year t (as defined in Section 3.2.2). The function $f(Deposits_{f,t})$ represents local polynomial control functions of the running variable, which is the deposit balance near the 2,000,000 NOK 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 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 $g(Deposits_{f,t})$ 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 2,000,000 NOK deposit insurance threshold. β_1 thus captures the local average treatment effect of having an outside deposit relationship on firms' probability of switching lenders.[26] In robustness test reported in the Online Appendix, we include covariates, $X_{f,t}$, to control for a variety of firm characteristics.[27] The standard errors, $\epsilon_{f,t}$, 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 hold using linear and quadratic polynomial control functions with a uniform or epanechnikov kernel.

Columns I and III report the first stage results using linear and quadratic polynomial control functions, respectively. These estimates indicate that exceeding the 2,000,000 NOK deposit insurance threshold is associated with a discontinuity in the probability of having

[26] 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 2,000,000 NOK deposit insurance threshold (Hahn, Todd, and Van der Klaauw 2001).

[27] 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.

an outside deposit relationship of approximately 3.6 to 3.7 percentage points. 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 imply that having an outside deposit relationship increases firms' propensity to switch lenders by approximately 28%, which is statistically and economically significant.[28]

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.

4.3.3. Alternative channels

A potential concern is that our results may be driven by alternative channels. Prior research has for instance highlighted 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; Diamond and Dybvig 1983; Kashyap, Rajan, and Stein 2002). First, to test 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 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

[28]The economic magnitude of the RDD estimate needs to be interpreted with caution, however, as it captures a local average treatment effect.

[29]The standard deviation of the depositor size variable equals 0.02, meaning that a one standard deviation in depositor size of

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 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) or in the year they initially started their deposit relationship with the outside bank (i.e., before switching), which is inconsistent with cross-selling strategies.

4.3.4. 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 the likelihood of receiving outside bids and hence increase lender competition (Hauswald and Marquez 2006; Sharpe 1990; Thadden 2004). This implies that starting a deposit relationship with outside banks could induce inside banks to offer better loan terms. On the other hand, research has shown that obtaining credit from an

firms with an outside deposit relationship is associated with a 0.4 percentage points increase in their probability of switching lenders.

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 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. 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:

$$\Delta Y_{\textit{with outside deposit relationship}} - \Delta Y_{\textit{without outside deposit relationship}} = \alpha + \epsilon \tag{7}$$

where $\Delta Y_{\textit{with outside deposit relationship}}$ 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 $\Delta Y_{\textit{without outside deposit relationship}}$ is the change in interest rate or loan amount of matched loans. α and ϵ 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 bps (compared to similar borrowers that did not start an outside deposit relationship). Turning to 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 are offered lower loan rates by 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, these results provide further evidence that having a deposit relationship with

outside banks is in fact beneficial for borrowers as it mitigates hold-up problems.

4.3.5. 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 investigate switchers' loan rate cycle at the new lender. In particular, we trace the 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 the 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 benchmark 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.D2 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 very similar. For both samples, we find that the new lender gradually increases the loan rate over the course of the lending relationship (as in). For instance, four years after the

[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.

switch, the loan rate of switchers without a prior deposit relationship is 17 bps higher than at the time of the switch, compared to 16 bps 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.

4.3.6. Within-firm matching strategy

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.D3 in the Online Appendix. The matching variables used in the within-firm matching model correspond to the ones used in our baseline matching strategy (see Section 4). The results from the within-firm matching model indicate that, on average, outside banks offer a loan rate discount of approximately 50 bps on switching loans. This loan rate discount increases to 150 bps for switchers with prior deposit relationship, which is quantitatively similar to our baseline results.

4.3.7. Alternative definition of lender switching

Our baseline analysis is based on 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). 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.D4 and O.D5 in the Online Appendix and are very comparable to our baseline results from Tables 3 and 4, respectively. The coefficient estimates in Table O.D4 are smaller than the ones from Table 3, 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, Tables O.D4 and O.D5 confirm that 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 other (outside) banks (Rajan 1992; Sharpe 1990; 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 can mitigate inside banks' informational monopoly, thereby attenuating hold-up problems in the loan market. To show this, our paper consists of 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 outside banks 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.

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

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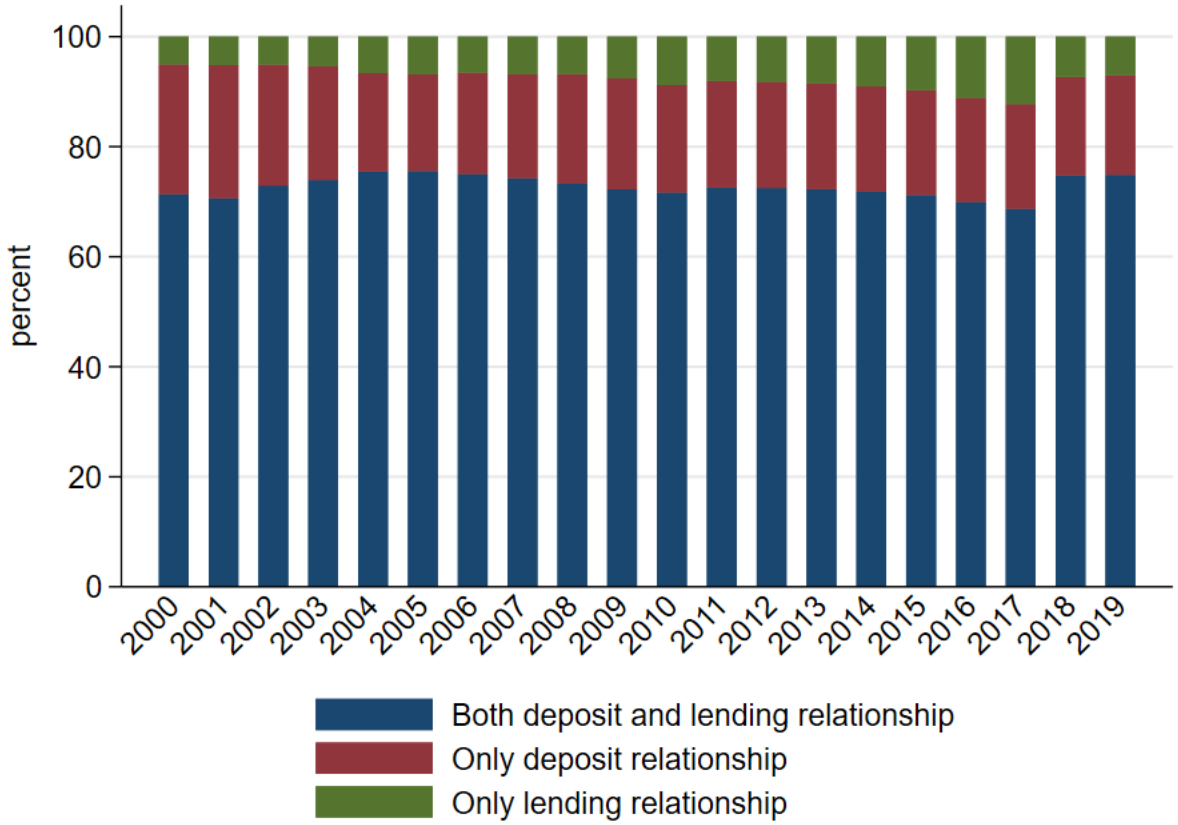
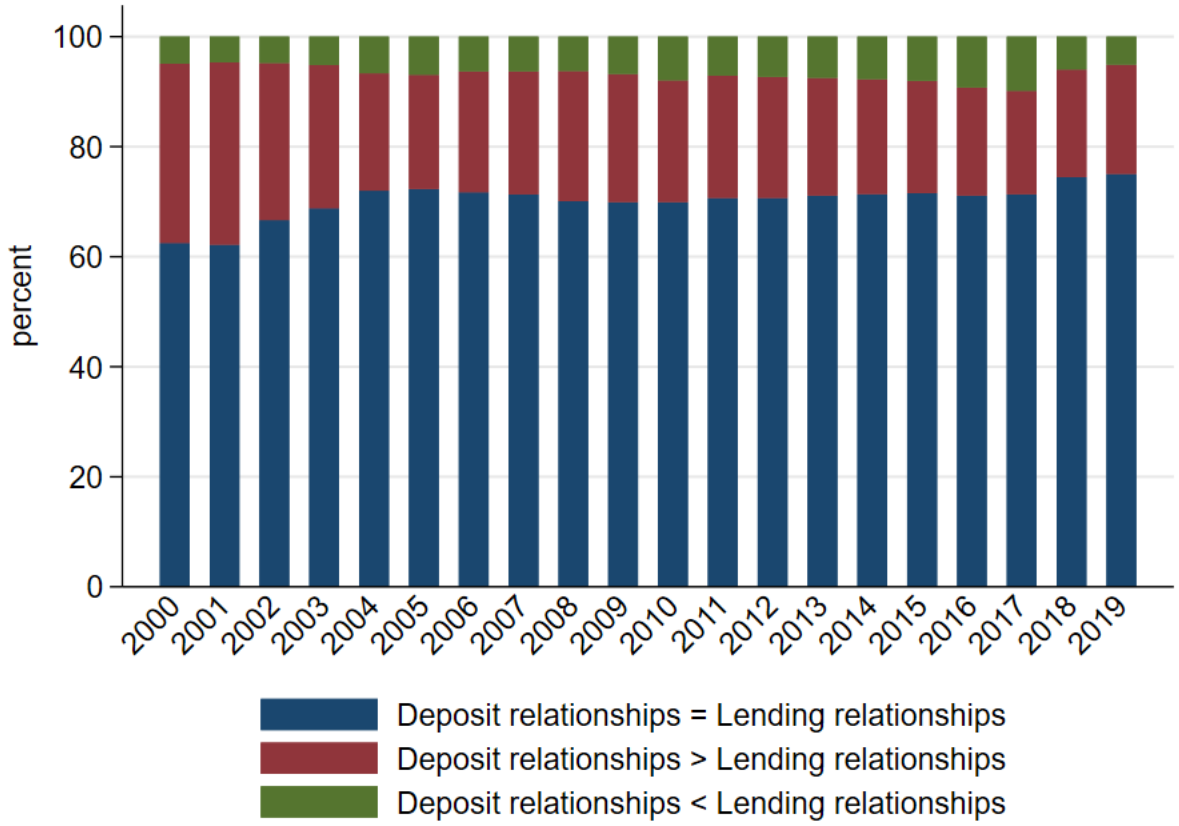
Figure 1: The structure of firm-bank relationships, for firms with at least one lending relationship



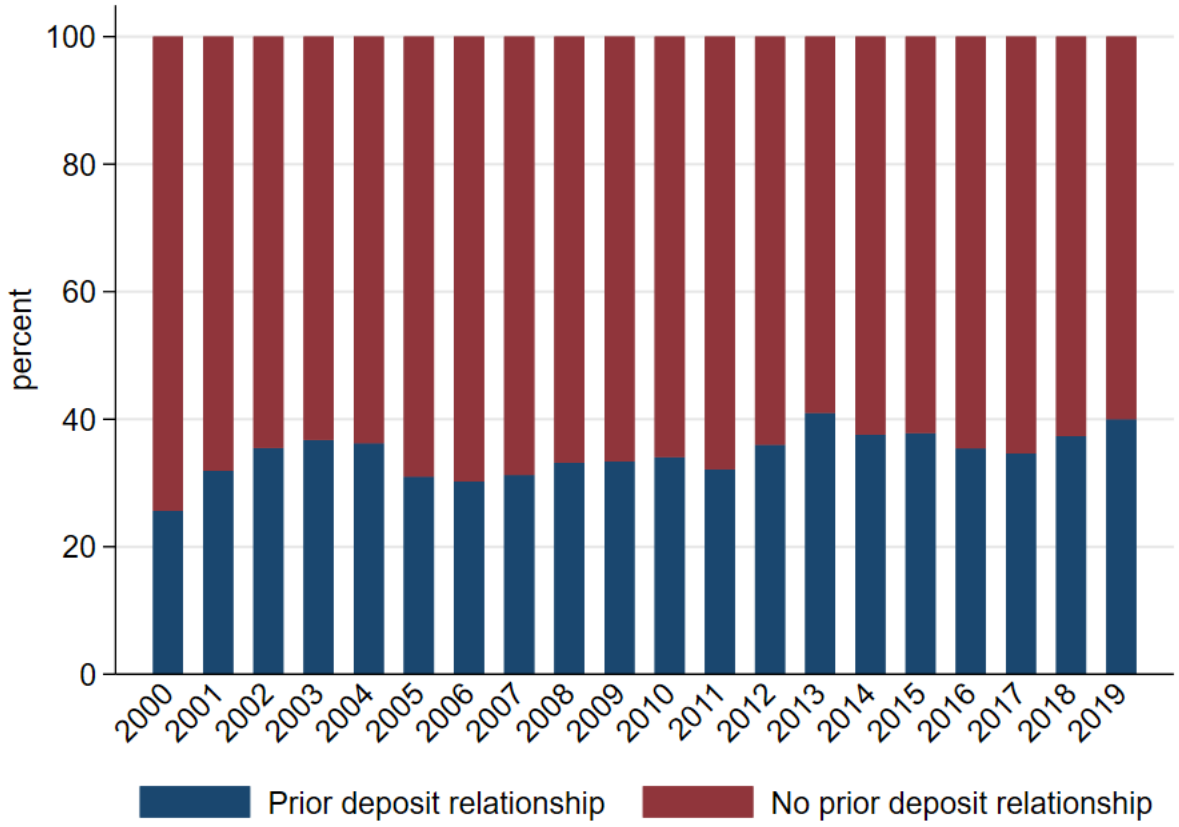
Note: This figure shows the proportion of firm-bank relationships that consists of both a deposit and a lending relationship in blue, the proportion of firm-bank relationships that consists of only a deposit relationship in red, and the proportion of firm-bank relationships that consists of only a lending relationship in green. Our 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, for firms with at least one lending relationship



Note: This figure shows the proportion of firms that maintain as many deposit relationships as lending relationship in blue, the proportion of firms that maintain more deposit relationships than lending relationships in red, and the proportion of firms that maintains fewer deposit relationships than lending relationships in green. Our 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 3: The proportion of switching firms that has a pre-existing deposit relationship with their new lender



Note: This figure shows the proportion of switching firms that had a deposit relationship with the new (outside) lender prior to switching in blue, and the proportion of switching firms that did not have a deposit relationship with new (outside) banks 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: (i) the loan should be obtained from a bank with which the firm did not have a lending relationship during the previous twelve months, and (ii) the firm must have had at least one lending relationship in the previous twelve months with at least one other bank. 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. Our sample comprises all switching loan observations of switching firms with prior deposit relationship in Norway between 2000 and 2019.

Table 1: Summary statistics for firms with and without an outside deposit relationship

	Firms with outside deposit relationship (N=65,331)			Firms without outside deposit relationship (N=268,048)		
	Mean	Median	SD	Mean	Median	SD
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
Switch	0.195***	0.000	0.396***	0.145	0.000	0.352

Note: This table reports the mean, median, and standard deviation of loan and firm characteristics for firms with and without an outside deposit relationship. The differences in means are assessed using the Student's t-test. The differences in medians are assessed using the Wilcoxon–Mann–Whitney test for continuous variables and Pearson's chi-square test for categorical variables. The differences in standard deviations are assessed using Levene's test. The table indicates whether the differences between the corresponding mean, median, and standard deviation are significant at the 10%, 5%, and 1% levels using *, **, and ***, respectively. The comparison group is the group of firms without an outside deposit relationship.

Table 2: Summary statistics for switching and non-switching firms

	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
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
Prior deposit relationship length	7.181***	6.000***	5.761***	0.000***	0.000***	0.000***	4.803	2.000	5.729

Note: This table reports the mean, median, and standard deviation of loan and firm characteristics for switching firms with a prior deposit relationship, switching firms without a prior deposit relationship , and non-switching firms. The differences in means are assessed using the Student's t-test. The differences in medians are assessed using the Wilcoxon–Mann–Whitney test for continuous variables and Pearson's chi-square test for categorical variables. The differences in standard deviations are assessed using Levene's test. The table indicates whether the differences between the corresponding mean, median, and standard deviation are significant at the 10%, 5%, and 1% levels using *, **, and ***, respectively. The comparison group is the group of non-switchers.

Table 3: Deposit relationships and the likelihood of switching lenders

	I Switch	II Switch	III Switch	IV Switch	V 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
Firm controls	Yes	Yes	Yes	Yes	Yes
Loan 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

Note: This table reports how having a prior deposit relationship with outside banks affects firms' probability of switching lenders. The outcome variable is a dummy variable equal to one if firm f switches to an outside bank at time t. The independent variable of interest is a dummy variable (*Outside deposit relationship*) equal to one if firm f had a deposit relationship with at least one outside bank at time $t-1$. The vector of firm controls includes firms' size, leverage ratio, EBIT to total assets, and fixed assets to total assets, and a dummy variable equal to one for public companies. The vector of loan controls includes the loan rate, loan amount, the proportion of loan collateralized, the probability of loan default, and a dummy variable equal to one for credit lines. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Table 4: Deposit relationships and outside banks' loan offers

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
Credit rating	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	1,868	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	4,688	5,330	4,773	4,701	1,317
Proportion of switching loans with a prior deposit relationship	30%	30%	30%	32%	30%
Constant	-0.796*** (0.087)	-0.483*** (0.064)	-0.410*** (0.067)	-0.469*** (0.070)	-0.577*** (0.096)
Prior deposit relationship	-0.791*** (0.188)	-1.210*** (0.163)	-1.438*** (0.176)	-1.203*** (0.170)	-1.159*** (0.241)

Note: This table reports the estimated loan rate discount offered by outside banks to switching firms. We distinguish between switching firms with and without a prior deposit relationship. 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 (*Prior deposit relationship*) equal to one if the switcher and the outside bank had a prior deposit relationship. We report the coefficient of the constant and the dummy variable. We weigh each observation by one over the total number of comparable non-switching loans per switching loan. Across the different columns, we report the variables used in the matching procedure. All variables are defined in Table O.C1 in the Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Table 5: Deposit relationships and outside banks' loan offers: Comparing switchers to switchers

	I	II
	Loan rate	Loan rate
Year	Yes	Yes
Outside bank	Yes	Yes
Baseline matching variables	Yes	Yes
Comparison group	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)

Note: This table reports the estimated loan rate discount offered by outside banks to switching firms. We distinguish between switching firms with and without a prior deposit relationship. Our empirical strategy proceeds in three steps. 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' outside banks at the time of the switch. Second, we calculate the spreads between the rates on the switching (matched) loans. Third, we regress these spreads on a constant. We weigh each observation by one over the total number of comparable switching loans without a prior deposit relationship per switching loan with prior deposit relationship. The set of baseline matching variables is explained in Section 4.1. All variables are defined in Table O.C1 in the Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Table 6: Deposit relationships and the likelihood of switching lenders: Heterogeneity in the information flow of deposit relationships

	I	II	III	IV
	Switch	Switch	Switch	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
Firm controls	Yes	Yes	Yes	Yes
Loan controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Bank × Time FE	Yes	Yes	Yes	Yes

Note: This table reports how having a prior deposit relationship with outside banks affects firms' probability of switching lenders. The outcome variable is a dummy variable equal to one if firm f switches to an outside bank at time t. The independent variables of interest are a dummy variable (*Outside deposit relationship*) equal to one if firm f had a deposit relationship with at least one outside bank at time $t-1$, and its interaction with variables that capture the information flow of the deposit relationship. The variables used to capture the information flow of deposit relationship are the length, depth, and scope of the deposit relationship, and an indicator variable equal to one if the deposit relationship comprises a transaction account (as explained in Section 4.2.1). The vector of firm controls includes firms' size, leverage ratio, EBIT to total assets, and fixed assets to total assets, and a dummy variable equal to one for public companies. The vector of loan controls includes the loan rate, loan amount, the proportion of loan collateralized, the probability of loan default, and a dummy variable equal to one for credit lines. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Table 7: Deposit relationships and outside banks' loan offers: Heterogeneity in the information flow of deposit relationships

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	-0.483*** (0.064)	-0.483*** (0.064)	-0.483*** (0.064)	-0.483*** (0.065)
Prior deposit relationship	-0.936*** (0.322)	-0.659** (0.318)	-0.253 (0.246)	-0.636* (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)

Note: This table reports the estimated loan rate discount offered by outside banks to switching firms. We distinguish between switching firms with and without a prior deposit relationship. 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, a dummy variable (*Prior deposit relationship*) equal to one if the switcher and the outside bank had a prior deposit relationship, and interactions with variables that capture the information flow of the deposit relationship. The variables used to capture the information flow of deposit relationship are the length, depth, and scope of the deposit relationship, and an indicator variable equal to one if the deposit relationship comprises a transaction account (as explained in Section 4.2.1). We report the coefficient of the constant, the dummy variable, and its interactions. We weigh each observation by one over the total number of comparable non-switching loans per switching loan. Across the different columns, we report the variables used in the matching procedure. The set of baseline matching variables is explained in Section 4.1. All variables are defined in Table O.C1 in the Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Table 8: Deposit relationships and the likelihood of switching lenders: Heterogeneity in outside banks' informational disadvantage

	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
Firm controls	Yes	Yes	Yes	Yes
Loan controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Bank × Time FE	Yes	Yes	Yes	Yes

Note: This table reports how having a prior deposit relationship with outside banks affects firms' probability of switching lenders. The outcome variable is a dummy variable equal to one if firm f switches to an outside bank at time t. The independent variables of interest are a dummy variable (*Outside deposit relationship*) equal to one if firm f had a deposit relationship with at least one outside bank at time $t-1$, and its interaction with variables that capture the outside banks' informational disadvantage. The variables used to capture outside banks' informational disadvantage are dummy variables equal to one for single-bank borrowers, borrowers with long inside bank relationships, young firms, and firms operating in regions with high bank competition (as explained in Section 4.2.2). The vector of firm controls includes firms' size, leverage ratio, EBIT to total assets, and fixed assets to total assets, and a dummy variable equal to one for public companies. The vector of loan controls includes the loan rate, loan amount, the proportion of loan collateralized, the probability of loan default, and a dummy variable equal to one for credit lines. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Table 9: Deposit relationships and outside banks' loan offers: Heterogeneity in outside banks' informational disadvantage

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*** (0.143)	-0.470*** (0.093)	-0.472*** (0.073)	-0.756*** (0.156)
Prior deposit relationship	-1.029*** (0.237)	-1.075*** (0.163)	-1.011*** (0.251)	-0.742*** (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)

Note: This table reports the estimated loan rate discount offered by outside banks to switching firms. We distinguish between switching firms with and without a prior deposit relationship. 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, a dummy variable (*Prior deposit relationship*) equal to one if the switcher and the outside bank had a prior deposit relationship, and interactions with variables that capture outside banks' informational disadvantage. The variables used to capture outside banks' informational disadvantage are dummy variables equal to one for single-bank borrowers, borrowers with long inside bank relationships, young firms, and firms operating in regions with high bank competition (as explained in Section 4.2.2). We report the coefficient of the constant, the dummy variable, and its interactions. We weigh each observation by one over the total number of comparable non-switching loans per switching loan. Across the different columns, we report the variables used in the matching procedure. The set of baseline matching variables is explained in Section 4.1. All variables are defined in Table O.C1 in the Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

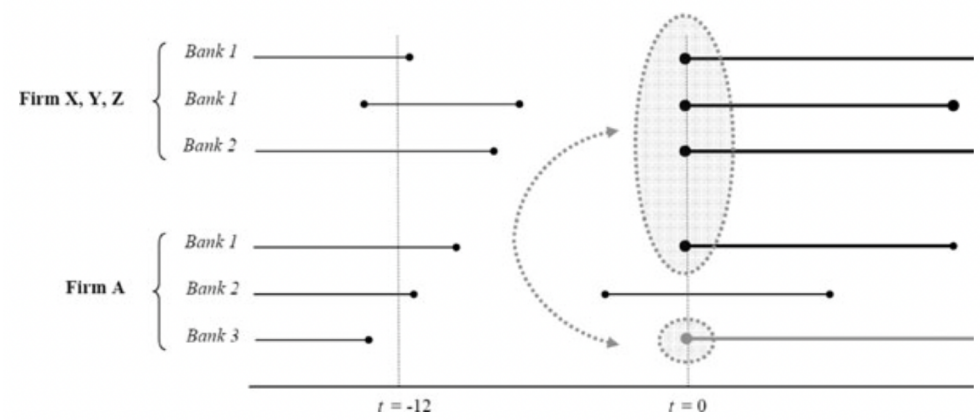
Table 10: Deposit relationships and outside bank' screening capability

	I	II
	Loan default	Loan default
Prior deposit relationship	-0.004***	-0.007***
	(0.001)	(0.002)
Credit rating	0.196***	0.197***
	(0.037)	(0.037)
Prior deposit relationship × Credit rating	0.268***	0.272***
	(0.076)	(0.076)
Controls	No	Yes
Number of observations	28,741	28,740
Adjusted R-squared	0.110	0.118

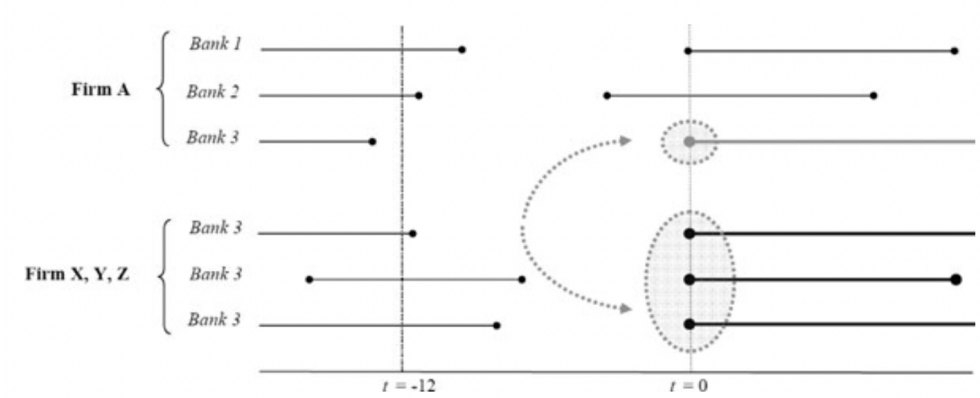
Note: This table reports the degree to which the credit rating assigned by new (outside) lender to switchers can predict switchers' future loan performance, and how this depends on whether the switchers had a prior deposit relationship with the new (outside) lender. The outcome variable is a dummy equal 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 had a prior deposit relationship with the new (outside) lender, and zero otherwise. *Credit rating* 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). The controls 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. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Appendix

Figure A1: Matching strategy



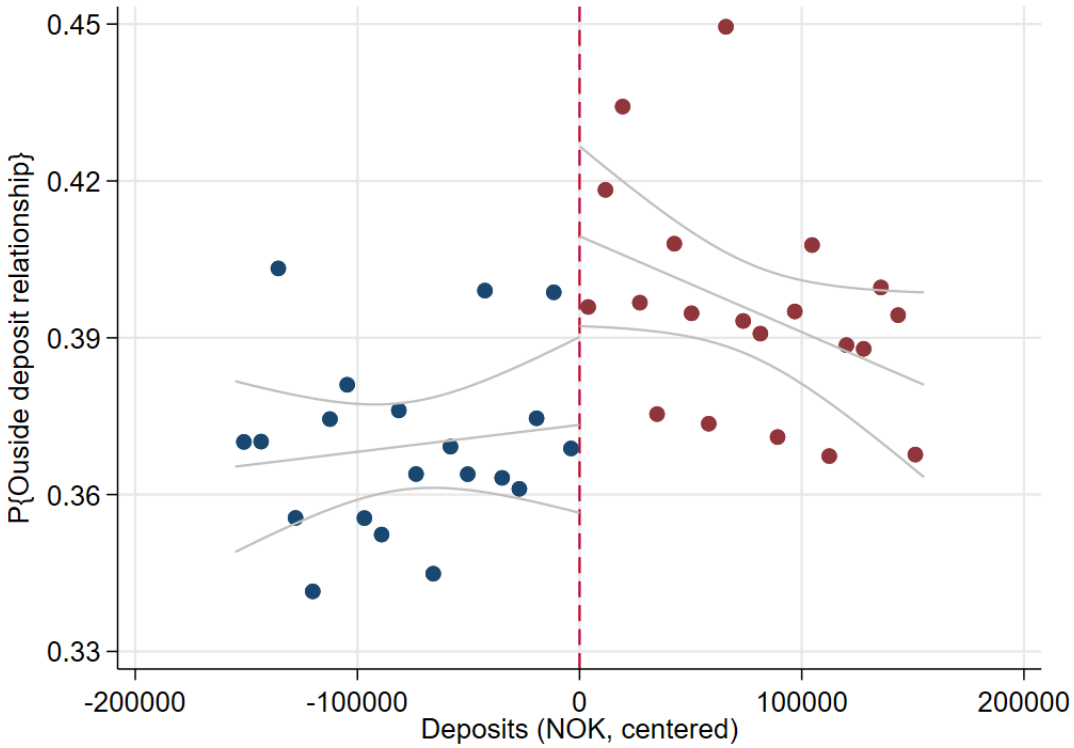
(a) Switching versus non-switching loans at the switcher's inside bank



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

Note: The top figure displays the matching strategy that compares the loan rate of the switching loans to the loan rate of comparable 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 the switching loans to the loan rate of comparable non-switching loans that the switcher's outside bank originates at the time of the switch. 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).

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



Note: This figure presents a bin scatter of the probability of having an outside deposit relationship for firms with deposits 155,000 NOK above and below the 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 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 is 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 firm.
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: (i) the loan should be obtained from a bank with which the firm did not have a lending relationship during the previous twelve months, and (ii) 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

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
Credit rating	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	1,868	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	4,688	5,330	4,773	4,701	1,317
Proportion of switching loans with a prior deposit relationship	30%	30%	30%	32%	30%
Constant	-1.046*** (0.079)	-0.807*** (0.063)	-0.795*** (0.067)	-0.813*** (0.068)	-0.904*** (0.095)

Note: This table reports the estimated loan rate discount offered by outside banks to switching firms. 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. We weigh each observation by one over the total number of comparable non-switching loans per switching loan. Across the different columns, we report the variables used in the matching procedure. All variables are defined in Table O.C1 in the Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

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

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***	-0.084***	-25.928***
	(0.115)	(0.007)	(3.334)
Prior deposit relationship	0.995***	0.112***	9.961
	(0.156)	(0.014)	(10.743)

Note: This table reports the estimated difference between the loan terms offered by outside banks to switching firms. We distinguish between switching firms with and without a prior deposit relationship. 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 difference between the loan terms on the switching loans and each matched loan. Third, we regress these differences on a constant and a dummy variable (*Prior deposit relationship*) equal to one if the switcher and the outside bank had a prior deposit relationship. We report the coefficient of the constant and the dummy variable. We weigh each observation by one over the total number of comparable non-switching loans per switching loan. Across the different columns, we report the variables used in the matching procedure. All variables are defined in Table O.C1 in the Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

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

	I Outside deposit relationship	II Switch	III Outside deposit relationship	IV Switch
I(Deposits > 2,000,000 NOK)	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

Note: This table reports how having a prior deposit relationship with outside banks affects firms' probability of switching lenders, using a discontinuity in the probability of having a deposit relationship with outside banks around the deposit insurance threshold. Columns I and II report the first- and second-stage results using local first-order polynomials, while Columns III and IV report the first- and second-stage results using local second-order polynomials. The outcome variable of the first-stage regressions is a dummy variable (*Outside deposit relationship*) equal to one if firm f had a deposit relationship with at least one outside bank at time $t-1$. The outcome variable of the second-stage regressions is a dummy variable ($Switch$) equal to one if firm f switches to an outside bank at time t. **I**(Deposits > 2,000,000 NOK) is a dummy variable equal to one if a firm had deposits exceeding the deposit insurance threshold at time $t-1$. All columns are based on a triangular kernel and CER-optimal bandwidths. All variables are defined in Table O.C1 in the Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

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

	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
Firm controls	Yes	Yes	Yes
Loan controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Bank × Time FE	Yes	Yes	Yes

Note: This table reports how having a prior deposit relationship with outside banks affects firms' probability of switching lenders. The outcome variable is a dummy variable equal to one if firm f switches to an outside bank at time t. The independent variables of interest are a dummy variable (*Outside deposit relationship*) equal to one if firm f had a deposit relationship with at least one outside bank at time $t-1$, and its interaction with variables that capture the role of deposits as a means of cross-selling, collateral, and bank funding. The variables used to capture the role of deposits as a means of cross-selling, collateral, and bank funding are the deposit rate that switching firms earn at the outside bank, the switching firms' deposit-to-loan ratio, and 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 4.3.3). The vector of firm controls includes firms' size, leverage ratio, EBIT to total assets, and fixed assets to total assets, and a dummy variable equal to one for public companies. The vector of loan controls includes the loan rate, loan amount, the proportion of loan collateralized, the probability of loan default, and a dummy variable equal to one for credit lines. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

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

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)

Note: This table reports the estimated loan rate discount offered by outside banks to switching firms. We distinguish between switching firms with and without a prior deposit relationship. 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, a dummy variable (*Prior deposit relationship*) equal to one if the switcher and the outside bank had a prior deposit relationship, and interactions with variables that capture the role of deposits as a means of cross-selling, collateral, and bank funding. The variables used to capture the role of deposits as a means of cross-selling, collateral, and bank funding are the deposit rate that switching firms earn at the outside bank, the switching firms' deposit-to-loan ratio, and 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 4.3.3). We report the coefficient of the constant, the dummy variable, and its interactions. We weigh each observation by one over the total number of comparable non-switching loans per switching loan. Across the different columns, we report the variables used in the matching procedure. The set of baseline matching variables is explained in Section 4.1. All variables are defined in Table O.C1 in the Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Table A7: Deposit relationships and outside banks' deposit offers

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	0.001	0.007	0.003	-0.021
	(0.015)	(0.015)	(0.016)	(0.015)	(0.022)
Panel B	Year of deposit switch				
Number of observations	426	610	284	598	200
Constant	0.003	0.006	0.025	0.006	-0.010
	(0.033)	(0.022)	(0.027)	(0.022)	(0.037)

Note: This table reports the estimated difference between the deposit rate offered by outside banks to (future) switching firms that have a prior deposit relationship and the deposit rate offered by outside banks to observably similar firms. Our empirical strategy proceeds in three steps. 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 regress these spreads on a constant. We report the coefficient of the constant. We weigh each observation by one over the total number of comparable non-switching firms per switching firm. Across the different columns, we report the variables used in the matching procedure. All variables are defined in Table O.C1 in the Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

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

	ΔLoan rate$_{[t,t+1]}$	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)

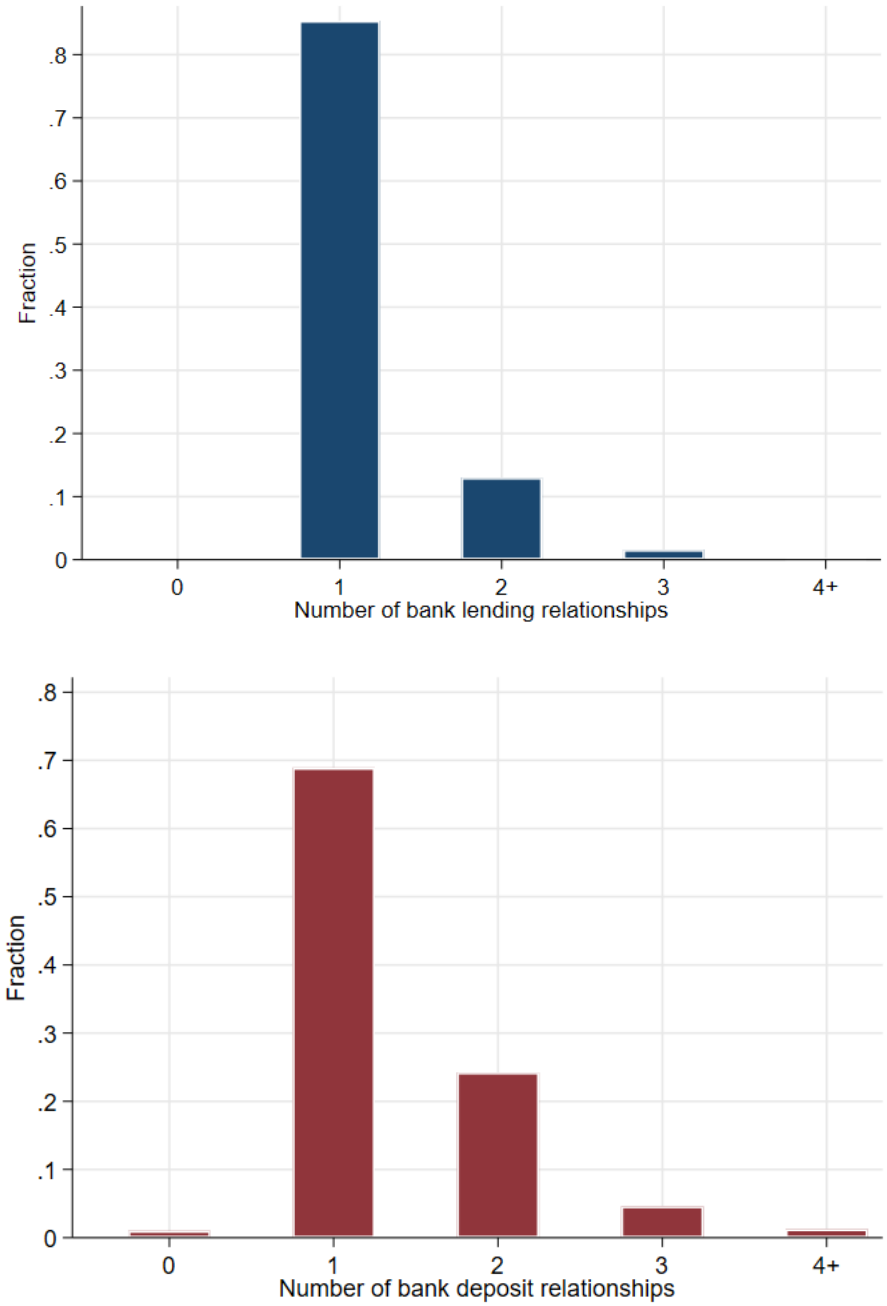
Note: This table presents the change in loan terms that firms receive from their incumbent banks after opening a deposit account with another (non-lender) outside bank. The outcome variables are the change in loan rates and credit between year t and $t+1$ in Columns I and II, respectively. Our empirical strategy proceeds 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. 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. We report the coefficient of the constant. In addition to matching on inside bank and borrower identity, we also match on the baseline matching variables used in our benchmark model, as explained in Section 4.1. All variables are defined in Table O.C1 in the Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

ONLINE APPENDIX

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

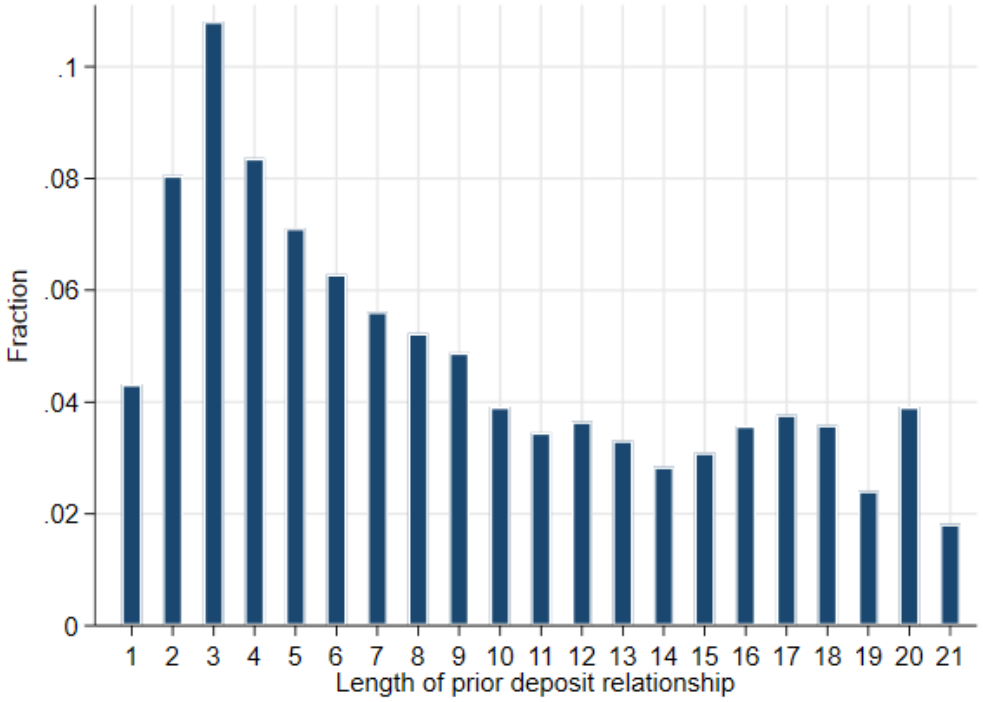
Jin Cao, Emilia Garcia-Appendini, and Cédric Huylebroek

Figure O.A1: The distribution of the number of lending and deposit relationships per firm, for firms with at least one lending relationship



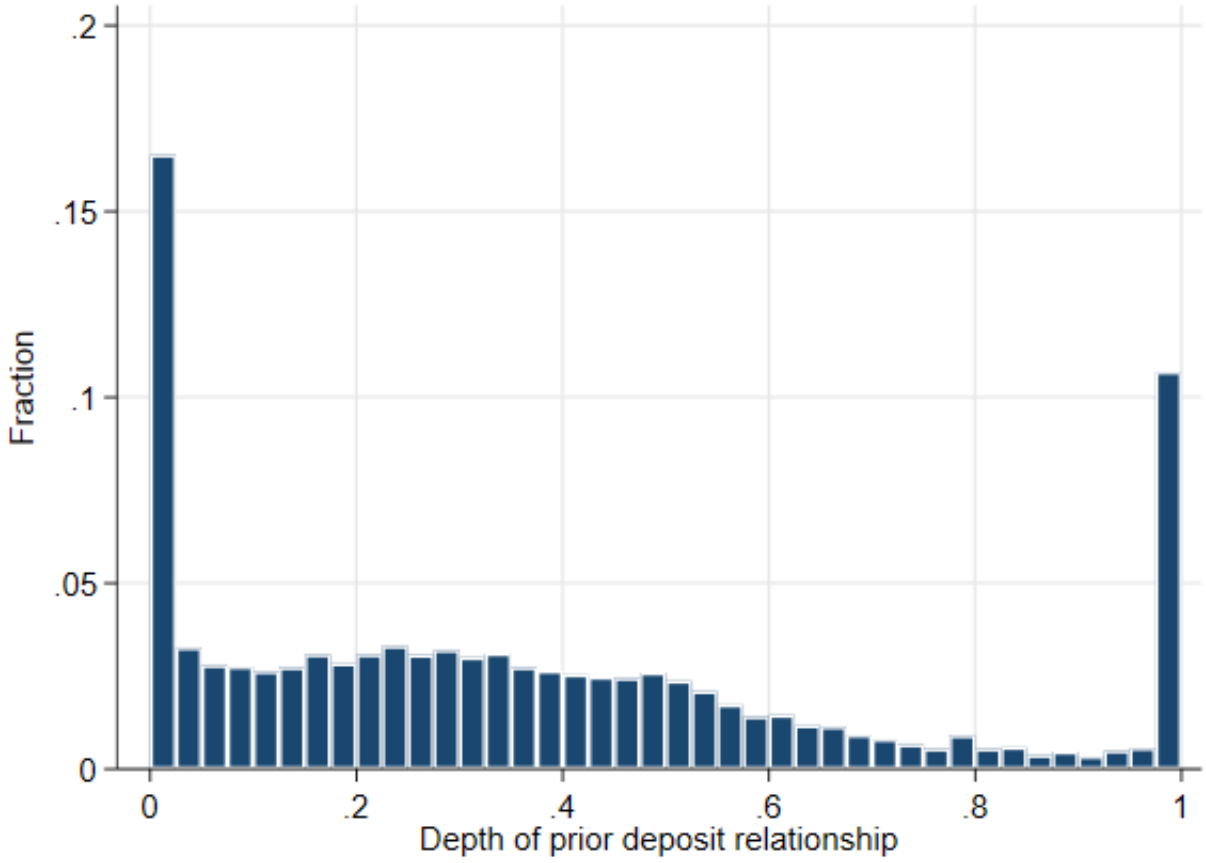
Note: This figure shows the distribution of the number of deposit and lending relationships that firms maintain over our sample period. The distribution of the number of lending relationships is depicted in the top figure (in blue), the distribution of the number of deposit relationships is depicted in the bottom figure (in red). Our 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 O.A2: The distribution of prior deposit relationship length between switching firms and outside banks



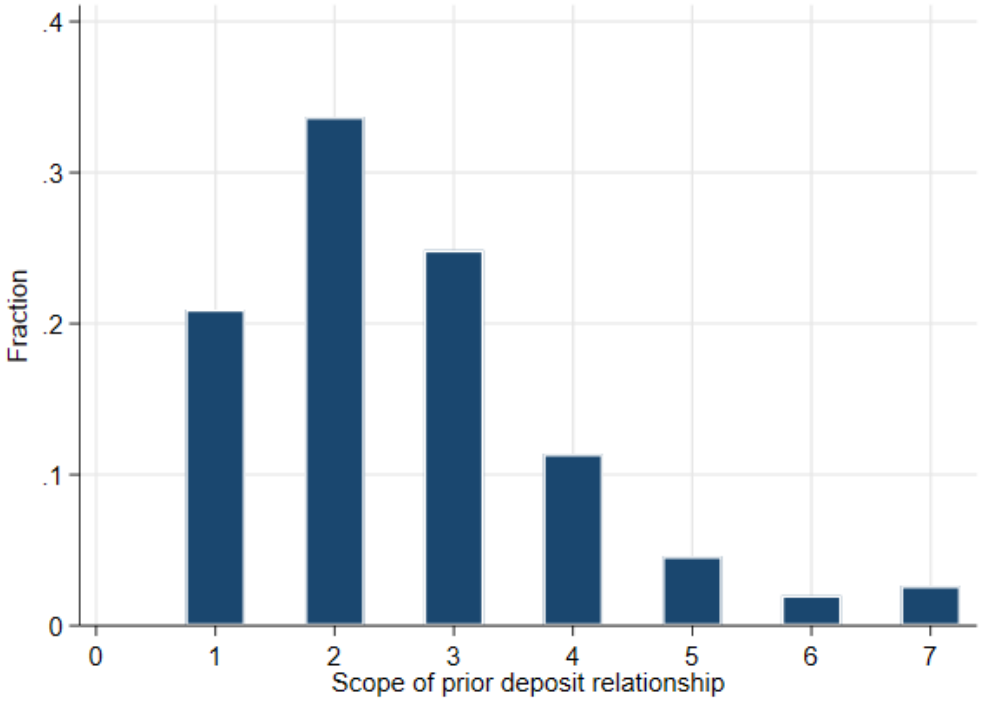
Note: This figure shows the distribution of deposit relationship length of switchers that had a deposit relationship with their new (outside) banks prior to switching. Deposit relationship length is measured as the number of years during which a firm and bank maintained a deposit relationship. Following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

Figure O.A3: The distribution of prior deposit relationship depth between switching firms and outside banks



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

Figure O.A4: The distribution of prior deposit relationship scope between switching firms and outside banks



Note: This figure shows the distribution of deposit relationship scope of switchers that had a deposit relationship with their new (outside) banks prior to switching. Deposit relationship scope 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: (i) the loan should be obtained from a bank with which the firm did not have a lending relationship during the previous twelve months, and (ii) the firm must have had at least one lending relationship in the previous twelve months with at least one other bank. The depth of the prior deposit relationship is measured as the number of products (or accounts) underlying the deposit relationship. Our sample comprises all switching loan observations of switching firms with prior deposit relationship in Norway between 2000 and 2019.

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

	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

Note: This table reports the percentage of switching and non-switching loan observations 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: (i) the loan should be obtained from a bank with which the firm did not have a lending relationship during the previous twelve months, and (ii) the firm must have had at least one lending relationship in the previous twelve months with at least one other bank. Our sample comprises all switching and non-switching loan observations of firms in Norway between 2014 and 2019.

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 obtain credit. Although the objective of our paper is not to analyze 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. There could be several potential explanations 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 (De Roux and Limodio 2023; Iyer et al. 2019), which covers up to 2,000,000 NOK 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 may proxy 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. 2023).[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

	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)
I(Deposits > 2,000,000 NOK)		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

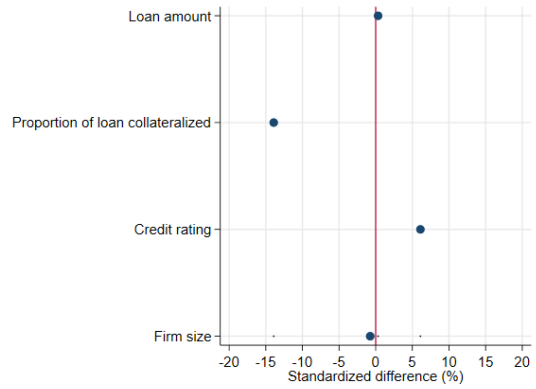
Note: This table reports the factors that influence firms' propensity to have deposit relationships with outside banks. The outcome variable is a dummy variable (*Outside deposit relationship*) equal to one if firm f had a deposit relationship with at least one outside bank at time t. All variables are defined in Table O.C1 in Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Table O.C1: Matching variables

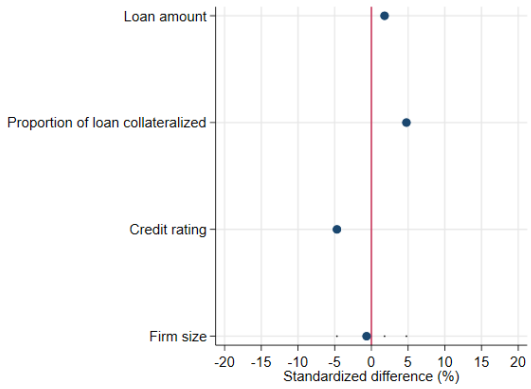
Category	Variable	Categories	Possible values
Macro	Year	6	2014, 2015, 2016, 2017, 2018, 2019
Bank	Inside bank	2	=1 if the firm had a lending relationship with the bank in the last 12 months, 0 otherwise
Bank	Outside bank	2	=1 if the firm did not have a lending relationship with the bank in the last 12 months, 0 otherwise
Firm	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 (based on 2-digit SIC code)
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	Collateral	2	=1 if the matched loans have similar ratios of collateral value to loan value, 0 otherwise
Firm-Bank	Credit rating	2	=1 if the matched firms have a similar credit rating, 0 otherwise

Firm-Bank	Deposit relationship	2	=1 if the matched firms has a deposit relationship with its bank, 0 otherwise
Firm-Bank	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
Firm-Bank	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

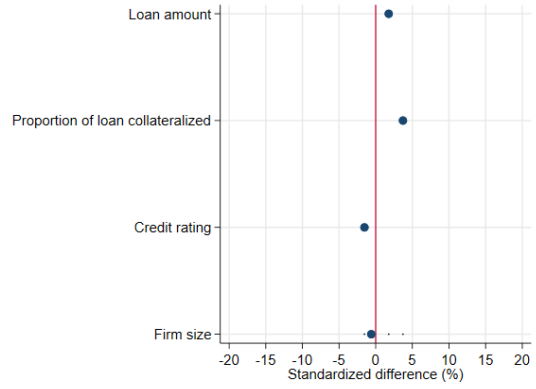
Figure O.B1: Balance test for continuous variables used in our matching model



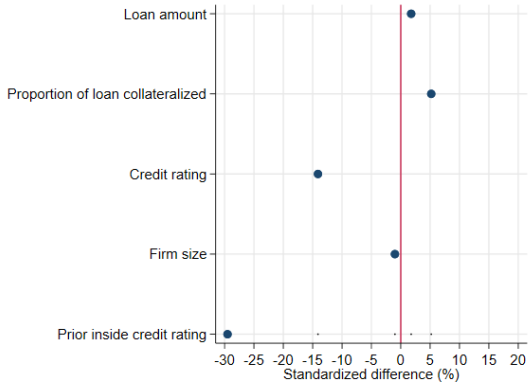
I



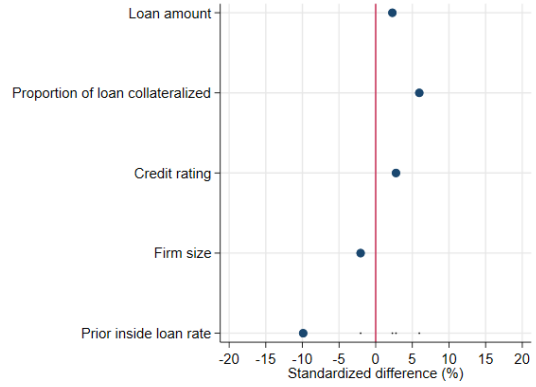
II



III



IV



V

Note: This figure presents the balance test statistics for the continuous variables used in our baseline matching model, as explained in Section 4 of the paper.

Online Appendix O.D

In Section 4.3.2 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 2,000,000 NOK 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 (Imbens and Lemieux 2008). 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. 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.C1 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 (McCrary 2008). 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

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

of the threshold. 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. In practice, however, firms' deposit balances are subject to unforeseen shocks (such as cash windfalls, 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.C1 plots the distribution of firms' deposits in an interval of 40,000 NOK below and above the deposit insurance threshold, and does not point towards any significant type of sorting just above or below the threshold. More formally, using the methods proposed by McCrary (2008) and Cattaneo, Jansson, and Ma (2020), Figure O.C2 confirms that there is no statistical evidence of bunching.[c]

Overall, the lack of evidence for manipulation around the 2,000,000 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), but Table O.C2 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,

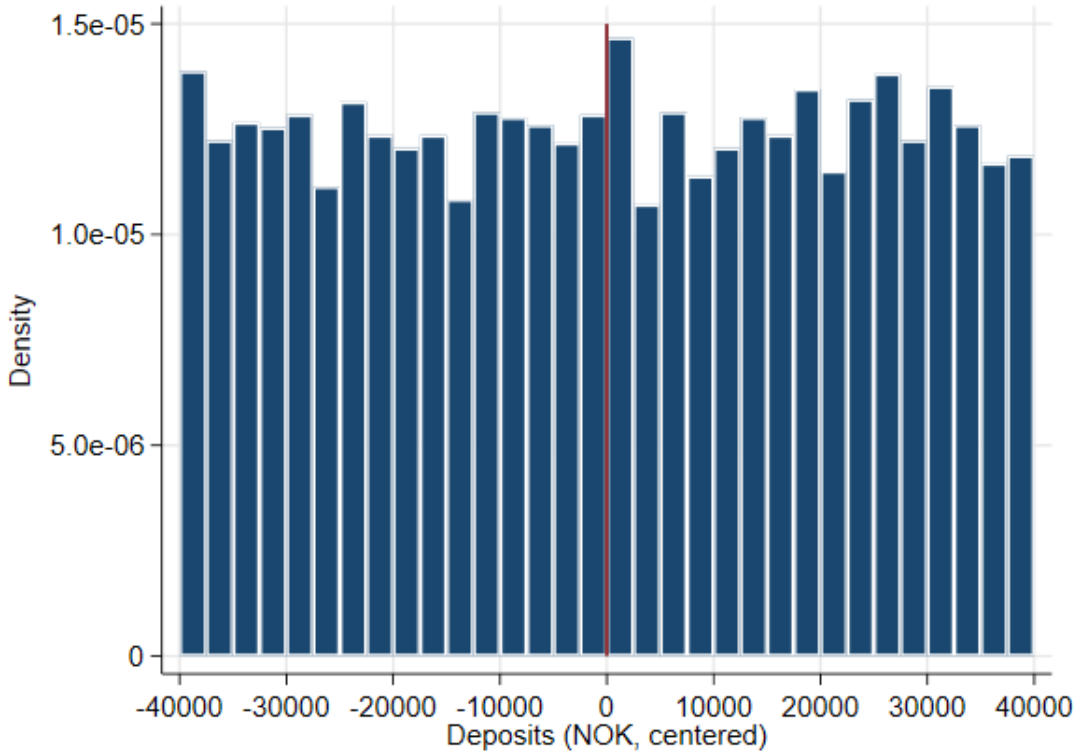
[c]Figure O.C2 is constructed using a local linear polynomial control function and a triangular kernel. Unreported tests show that the result is the same using different polynomial control functions or kernels.

to mitigate any concern that our results could be influenced by observable characteristics of firms that are close to the threshold, Table O.C4 confirms that our estimated effects remain stable if we control for firm size, leverage, profitability, and tangible assets.

Placebo test

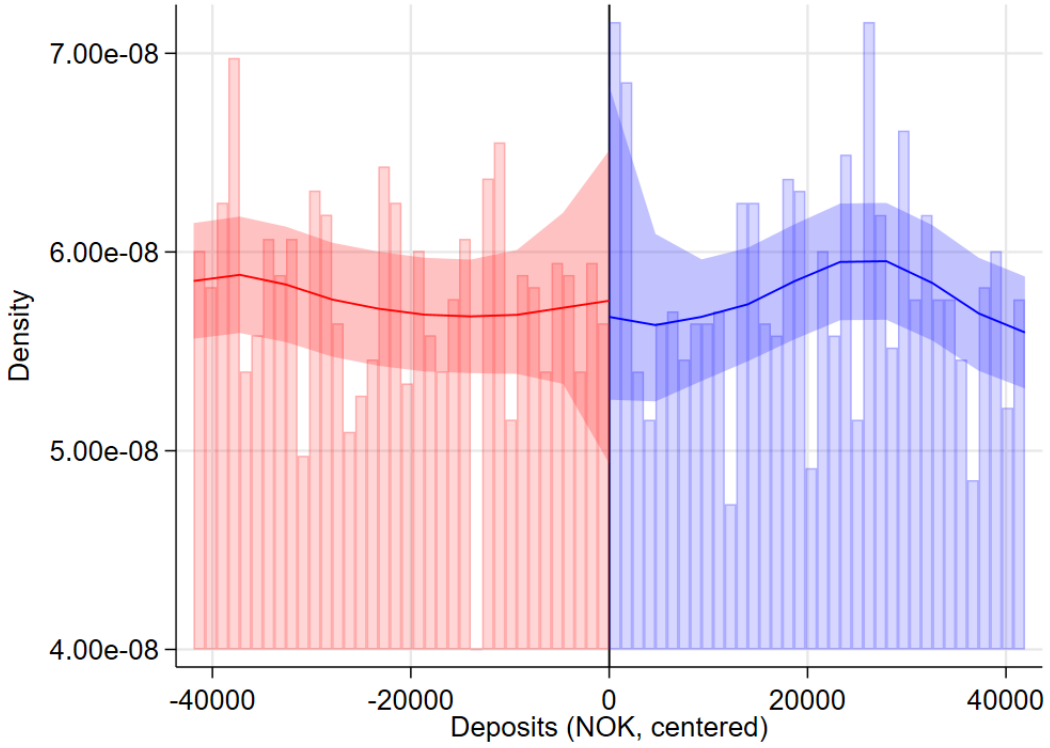
Our baseline analysis shows that there is a significant discontinuity (jump) in the probability of outside deposit relationships once a firm's total deposits crosses the deposit insurance threshold of 2,000,000 NOK. As a placebo test, we evaluate whether there is no discontinuity around other (irrelevant) cutoffs. Table O.C4 reports results based on placebo cutoffs of 1,500,000 and 2,500,000 NOK, 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.C1: RDD robustness: Density plot



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

Figure O.C2: RDD robustness: Density break test



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

Table O.C1: RDD robustness: Discontinuity for potential confounders

	I Size	II Debt/TA	III EBIT/TA	IV Fixed assets/TA	V ln(Credit)
I(Deposits > 2,000,000 NOK)	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

Note: This table reports how firm characteristics change around the deposit insurance threshold. Across the different column, the outcome variables are firm size, debt/TA, EBIT/TA, fixed assets/TA, and total credit outstanding. **I**(Deposits > 2,000,000 NOK) is a dummy variable equal to one if a firm had deposits exceeding the deposit insurance threshold at time $t-1$. All columns are based on a triangular kernel, local first-order polynomials, and CER-optimal bandwidths. All variables are defined in Table O.C1 in Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Table O.C2: RDD robustness: Alternative kernels

	I	II	III	IV
Panel A	Outside deposit relationship	Outside deposit relationship	Outside deposit relationship	Outside deposit relationship
I(Deposits > 2,000,000 NOK)	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

Note: This table reports how having a prior deposit relationship with outside banks affects firms' probability of switching lenders, using a discontinuity in the probability of having a deposit relationship with outside banks around the deposit insurance threshold. Panel A reports the first-stage results using the kernels and local polynomials reported at the bottom of the table, and Panel B reports the corresponding second-stage results. The outcome variable of the first-stage regressions is a dummy variable (*Outside deposit relationship*) equal to one if firm f had a deposit relationship with at least one outside bank at time $t-1$. The outcome variable of the second-stage regressions is a dummy variable ($Switch$) equal to one if firm f switches to an outside bank at time t. **I**(Deposits > 2,000,000 NOK) is a dummy variable equal to one if a firm had deposits exceeding the deposit insurance threshold at time $t-1$. All columns are based on a triangular kernel and CER-optimal bandwidths. All variables are defined in Table O.C1 in Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Table O.C3: RDD robustness: Controlling for additional firm characteristics

	I Outside deposit relationship	II Switch	III Outside deposit relationship	IV Switch
I(Deposits > 2,000,000 NOK)	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
Firm controls	Yes	Yes	Yes	Yes

Note: This table reports how having a prior deposit relationship with outside banks affects firms' probability of switching lenders, using a discontinuity in the probability of having a deposit relationship with outside banks around the deposit insurance threshold. Columns I and II report the first- and second-stage results using local first-order polynomials, while the specifications in columns III and IV report the first- and second-stage results using local second-order polynomials. The outcome variable of the first-stage regressions is a dummy variable (*Outside deposit relationship*) equal to one if firm f had a deposit relationship with at least one outside bank at time $t-1$. The outcome variable of the second-stage regressions is a dummy variable (*Switch*) equal to one if firm f switches to an outside bank at time t. **I**(Deposits > 2,000,000 NOK) is a dummy variable equal to one if a firm had deposits exceeding the deposit insurance threshold at time $t-1$. All columns are based on a triangular kernel and CER-optimal bandwidths. All variables are defined in Table O.C1 in Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Table O.C4: RDD robustness: Placebo thresholds

	I Outside deposit relationship	II Switch	III Outside deposit relationship	IV Switch
I(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

Note: This table reports how having a prior deposit relationship with outside banks affects firms' probability of switching lenders, using a discontinuity in the probability of having a deposit relationship with outside banks around the deposit insurance threshold. Columns I and II report the first- and second-stage results using a placebo threshold of 1,500,000 NOK, while Columns III and IV report the first- and second-stage results using a placebo threshold of 2,500,000 NOK. The outcome variable of the first-stage regressions is a dummy variable (*Outside deposit relationship*) equal to one if firm f had a deposit relationship with at least one outside bank at time $t-1$. The outcome variable of the second-stage regressions is a dummy variable (*Switch*) equal to one if firm f switches to an outside bank at time t. **I**(Deposits > 2,000,000 NOK) is a dummy variable equal to one if a firm had deposits exceeding the deposit insurance threshold at time $t-1$. All columns are based on a triangular kernel, local first-order polynomials, and CER-optimal bandwidths. All variables are defined in Table O.C1 in Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Online Appendix O.E

Table O.D1: Deposit relationships and outside banks' loan offers: Estimation using sub-samples

	I Loan rate	II Loan rate	III Loan rate	IV Loan rate	V Loan rate
Year	Yes	Yes	Yes	Yes	Yes
Outside bank	Yes	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 observations	4,688	5,330	4,773	4,701	1,317
Switching loans without prior deposit relationship	-0.798*** (0.087)	-0.483*** (0.064)	-0.410*** (0.067)	-0.469*** (0.070)	-0.577*** (0.096)
Switching loans with prior deposit relationship	-1.619*** (0.166)	-1.692*** (0.150)	-1.848*** (0.163)	-1.672*** (0.155)	-1.735*** (0.221)

Note: This table reports the estimated loan rate discount offered by outside banks to switching firms. We distinguish between switching firms with and without a prior deposit relationship. Our empirical strategy proceeds in four 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 spread 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. Fourth, for each of these sub-samples, we regress these spreads on a constant. We report the coefficient of the constant for both sub-samples. We weigh each observation by one over the total number of comparable non-switching loans per switching loan. All variables are defined in Table O.C1 in Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Table O.D2: Deposit relationships and outside banks' loan offers: The loan rate cycle after switching

	I	II	III	VI
Periods since switching lenders	1 year	2 years	3 years	4 years
Panel A	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	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)

Note: This table presents the loan rate cycle of loans obtained by switching firms from their new (outside) lender over the course of the new lending relationship. 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. In addition to matching on bank and borrower identity, we also match on the variables used in our benchmark model, as explained in Section 4.1. Second, we split the sample into firms with and without prior deposit relationship, and group the corresponding matches in four one-year periods since the switching loan. Then, for each of the two sub-samples and four groups, we regress the spreads on a constant and calendar-time dummies. We report the coefficients of the constant. The baseline matching variables include firm size, sector, region, organization type, credit rating, loan amount, loan collateralization, and loan type. All variables are defined in Table O.C1 in Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Table O.D3: Deposit relationships and outside banks' loan offers: Within-firm analysis

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)

Note: This table reports the estimated loan rate discount offered by outside banks to switching firms. We distinguish between switching firms with and without a prior deposit relationship. Our empirical strategy proceeds in three steps. 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 regress these spreads on a constant and a dummy variable (*Prior deposit relationship*) equal to one if the switcher and the outside bank had a prior deposit relationship. We report the coefficient of the constant and the dummy variable. We weigh each observation by one over the total number of comparable non-switching loans per switching loan. Across the different columns, we report the variables used in the matching procedure. The baseline matching variables include firm size, sector, region, organization type, credit rating, loan amount, loan collateralization, and loan type. All variables are defined in Table O.C1 in Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Table O.D4: Deposit relationships and the likelihood of switching lenders: Alternative definition of lender switching

	I Switch	II Switch	III Switch	IV Switch	V 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
Firm controls	Yes	Yes	Yes	Yes	Yes
Loan 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

Note: This table reports how having a prior deposit relationship with outside banks affects firms' probability of switching lenders. The outcome variable is a dummy variable equal to one if firm f switches to an outside bank at time t. The independent variable of interest is a dummy variable (*Outside deposit relationship*) equal to one if firm f had a deposit relationship with at least one outside bank at time $t-1$. The vector of firm controls includes firms' size, leverage ratio, EBIT to total assets, and fixed assets to total assets, and a dummy variable equal to one for public companies. The vector of loan controls includes the loan rate, loan amount, the proportion of loan collateralized, the probability of loan default, and a dummy variable equal to one for credit lines. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

Table O.D5: Deposit relationships and outside banks' loan offers: Alternative definition of lender switching

Matching variables	I Loan rate	II Loan rate	III Loan rate	VI Loan rate	V Loan rate
Year	Yes	Yes	Yes	Yes	Yes
Outside bank	Yes	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	723	1,960	1,786	1,679	630
Number of non-switching loans	1,309	3,338	3,058	2,986	993
Number of observations	1,585	4,807	4,429	4,146	1,199
Proportion of switching loans with a prior deposit relationship	48%	13%	12%	14%	13%
Constant	-0.589*** (0.166)	-0.436*** (0.060)	-0.392*** (0.061)	-0.414*** (0.065)	-0.548*** (0.092)
Prior deposit relationship	-0.808*** (0.255)	-0.526** (0.246)	-0.615** (0.267)	-0.596** (0.255)	-0.798** (0.323)

Note: This table reports the estimated loan rate discount offered by outside banks to switching firms. We distinguish between switching firms with and without a prior deposit relationship. 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 (*Prior deposit relationship*) equal to one if the switcher and the outside bank had a prior deposit relationship. We report the coefficient of the constant and the dummy variable. We weigh each observation by one over the total number of comparable non-switching loans per switching loan. The sample used in these regressions is restricted to switching loans of firms that never had a prior lending relationship with the outside bank. The baseline matching variables include firm size, sector, region, organization type, credit rating, loan amount, loan collateralization, and loan type. All variables are defined in Table O.C1 in Appendix. Standard errors are clustered at the firm level and reported in parentheses. *, ** and *** denote significance at 10%, 5% and 1%, respectively.

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