Cross-Selling in Bank Household Relationships. Implications for Deposit Pricing, Loan Pricing, and Monetary Policy.

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Using administrative data on deposits and loans of every Norwegian with every Norwegian bank, we show that an existing deposit account makes a household more likely to hold deposits at the same bank later despite better alternatives and more likely to borrow there. Consistent with this, banks accept lower deposit spreads from potential future borrowers. Banks charge existing depositors a premium on loans compared to other households, suggesting that cross-selling is driven by demand rather than supply complementarities. Finally, discounting future cross-selling profits motivates lower deposit spreads in times of lower policy rates and contributes to monetary policy transmission.

Keywords: switching costs, customer lifetime value (clv), cross-selling, relationship banking, supply complementarities, demand complementarities, deposit pricing, deposit channel of monetary policy

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1 Introduction

Deposit funding provides numerous benefits to banks. Drechsler, Savov, and Schnabl (2017) (henceforth DSS 2017), for instance, emphasize that deposits are a cheap and stable financing source for lending. Berlin and Mester (1999) and Drechsler, Savov, and Schnabl (2021) stress that deposit interest rates have a low sensitivity to market interest rates and hence insulate bank funding costs to some extent from fluctuations in market interest rates. Li, Loutskina, and Strahan (2019) emphasize that deposits are associated with limited liquidity risk, while e.g., Mester (1987), Kashyap, Rajan, and Stein (2002), Gatev, Schuermann, and Strahan (2009) or Robles-Garcia, Benetton, and Buchak (2022) emphasize different synergies from engaging in both deposit-taking and lending. This paper focuses on a complementary benefit of deposits, namely *cross-selling.* Cross-selling is the idea that the value of attracting a depositor from a bank's perspective not only entails the deposit spread the bank earns on that depositor for the period of the deposit but also an increase in the probability that the client will be a borrower or depositor in the future. Cross-selling can help rationalize why banks have accepted negative deposit spreads in times of low policy rates, as evidence for the US in DSS 2017, Figure IA, or for much of the Euro area or Norway in our ***Figure 1*** and ***Figure 2*** suggests.[1] Such negative deposit spreads are in contrast to standard price setting models by monopolistic banks like the Monti-Klein model presented in Freixas and Rochet (2008), where there are no incentives to set deposit rates higher than the policy rate.

Our main contribution to the literature is to use administrative account-level data on the population of Norwegians to document that banks have sizable cross-selling benefits in attracting depositors, both in terms of future deposits and future loans. These cross-selling benefits arise because existing depositors like to remain at their deposit bank and have an increased probability of becoming bank borrowers. Conditional on having a deposit account at a bank in the previous year, the likelihood of being a depositor there the following year is approximately 84 percent, also when controlling for depositors' outside options. The cumulative increase in the probability of borrowing from a bank over a 14-year horizon is roughly 20 percentage points for existing depositors compared to other households. Consistent with that, we show that banks pay higher deposit rates to households that are more likely to become subsequent borrowers. We show that variation in loan cross-selling incentives thus explains part of the variation in deposit rates. It can also explain cross-sectional variation in the strength

[1] These deposit spreads make the deposit business on its own even more loss-making when we attribute a share of recurring fixed costs to the maintenance of the deposit franchise, as suggested by Drechsler, Savov, and Schnabl (2021).

of monetary policy pass-through at the bank level. When banks have high cross-selling motives, the pass-through of monetary policy to deposit rates is muted and transmission strengthened.

Our empirical analysis is based on account-level data on the universe of Norwegian individuals and their bank relationships. We observe all outstanding loan and deposit relationships for each year from 2004 until 2018, including both volumes and interest paid or received. We match this with detailed data on household balance sheets, demographics, and bank-level information. This data-rich environment allows us to document the importance of cross-selling for bank behavior and explore its implications. The analysis consists of five main steps.

First, we show that deposit relationships tend to be sticky. The probability of remaining a depositor from one year to another is 84 percent, conditional on both bank x year and household x year characteristics. Depositors are likely to stay with the same bank even when other banks pay more attractive deposit rates. For households below 30 - which we show is typically an attractive depositor due to future loan cross-selling – the best outside deposit rate is two percentage points higher than what they earn at the current bank. An implication is that banks have *deposit cross-selling incentives:* Forward-looking banks may want to set lower deposit spreads to onboard clients whose deposits become sticky and more profitable in the future.

Second, we find that, once onboarded, households are also about 20% more likely to take out a loan from the same bank in the next 14 years compared to a household in the same municipality, age group, salary group, and education group but with deposits elsewhere. We refer to this as "depositor borrower conversion." Depositor borrower conversion also holds when households move within or even across municipalities and in the subsample of densely populated municipalities or municipalitites where bank competition is high. This suggests that conversion is unlikely to be driven by location alone.

Third, we show that cross-selling is important to understand deposit pricing. Banks tend to offer more attractive deposit spreads to households who, in expectation, borrow more in the future. In particular, we find lower deposit spreads for those aged below 30, for parents, and those with more income. For instance, on average, deposit accounts for households aged below 30 have almost a 60 basis point lower deposit spread than other accounts. This implies that banks, on average, lose money on these accounts all else equal.

Fourth, we investigate whether depositor borrower conversion is driven primarily by supply or demand complementarities. By supply complementarities, we mean that banks find it cheaper

or more reliable to screen loan applicants they already know as depositors. In such a case, we expect banks to pass on some of these cost savings to their clientsthrough lower loan rates. With demand complementarities, by contrast, we mean that clients may prefer to borrow within existing bank relationships due to, for instance, convenience. Banks can charge for that preference via higher loan rates in such a case.

Supply or cost complementarities from selling different products to the same client have been emphasized in work on relationship banking such as Petersen and Rajan (1994) and Mester, Nakamura, and Renault (2007), focusing on corporate clients. We investigate bank *household* relationships. Most household loans are fairly standardized and collateralized mortgages, so screening-based supply complementarities may matter less a priori. Consistent with this, we find existing depositors to pay *more* for future loans, supporting demand complementarities as the key driver of depositor borrower conversion in our retail banking setup.

Fifth and finally, we argue that future cross-selling profits – due to discounting – affect banks pricig decisins differentally when rates are high versus low. When rates initially are low, future cross-selling profits are relatively valuable and thus affect bank price setng more. Consistent with this, we find that deposit spreads are increasing in current policy rates. On these grounds, we also argue that cross-selling can rationalize a zero lower bound on deposit rates even when policy rates are negative, see e.g. Heider, Saidi, and Schepens (2019), Eggertsson et al. (2019), or Basten and Mariathasan (2020).

We also discuss how the prediction of a positive link between policy rates and deposit spreads coincides with that made by DSS 2017, who term it “deposit spread β”. DSS 2017 explain this beta with banks exercising market power in concentrated deposit markets rather than with time-varying discounting of a client's future profitability. We test how the beta varies with different market concentration measures and cross-selling incentives. We find it to be increasing in both. This implies that the deposit channel of monetary policy may work through both sub-channels, with their relative importance depending on the setup of interest.

Contributions to the Existing Literature

Our paper relates to the broad literature on the role of deposits in banking. DSS 2017 emphasize that deposits are a cheap and stable financing source for lending. Berlin and Mester (1999) and Drechsler, Savov, and Schnabl (2021) stress that deposit interest rates have a low sensitivity to market interest rates and hence insulate bank funding costs to some extent from fluctuations in

market interest rates. Li, Loutskina, and Strahan (2019) point out that deposits are associated with limited liquidity risk, while e.g., Mester (1987), Kashyap, Rajan, and Stein (2002), Gatev, Schuermann, and Strahan (2009) or Robles-Garcia, Benetton, and Buchak (2022) emphasize different synergies from engaging in both deposit-taking and lending. Our paper is the first paper, to the best of our knowledge, that documents how deposits add value for banks via generating scope for cross-selling of loans and deposits, explores heterogeneity in cross-selling potential across different households, shows its implications for price setting in deposit and loan markets and explores its implications for monetary policy.

The concept of cross-selling different products to the same customer is used in industrial organization and marketing[2] and its implications for pricing are discussed amongst others by Tirole (1988). Cross-selling and its implications for pricing in banking, however, have to our knowledge received limited attention.. Three exceptions in the banking literatureare Laux and Walz (2009), Santikian (2014) and Qi (2017) who investigate cross-selling of underwriting (Laux and Walz) and non-loan products (Santikian, 2014 and Qi 2017) to firms through corporate loan pricing. Our paper provides a comprehensive overview of cross-selling to households - who account for the larger share of deposits and loans in many countries - and explores its implications both at the micro and at the macro level.[3] In comparison to many papers on cross-selling in other sectors, which must rely on data from a single firm, we can observe for each household also relationships with the universe of other banks with a banking licence to lend to that household.

Our paper also provides new evidence on the drivers of lending relationships , as in Petersen and Rajan (1994) or Mester, Nakamura, and Renault (2007), and to that on bank switching costs. Bank switching costs were earlier considered for US deposit markets by Sharpe (1997), for US loan markets by Kim, Kliger, and Vale (2003) and for Spanish deposit markets by Carbo-Valverde, Hannan, and Rodriguez-Fernandez (2011). In contrast to papers that focus on switching costs within the market for one specific product, we cover also the relationship

[2] For example Gupta et al. (2006) compute the customer lifetime value (CLV) as net present value to a business from each customer and discuss different models to estimate for each client the optimal acquisition cost in order to optimize profits from the sum of acquisition, retention and cross-selling. They focus on acquisition through marketing, we focus on initial prices.

[3] Kamakura, Ramaswami, and Srivastava (1991) stress with a focus on financial services for households that it is often easier to cross-sell to existing customers than to acquire new ones, that customer switching costs [and so presumably resulting market power] will often increase when a client uses multiple products, and that the typical timing of financial objectives over the lifecycle enhances the potential for financial cross-selling, an aspect that will become important when we identify age as one of the key determinants of cross-selling below.

between deposit and loan business and explore whether it is driven by supply or demand complementarities.

Third, our analyses on how the pricing of household loans depends amongst others on whether the household has held deposits with that bank before eluciates not only banks' optimal pricing strategies and the transmission of monetary policy, but also how households may pay more for their loans if banks can exploit their hesitance to switch banks.

Below, Section 2 introduces our data and setup. Section 3 presents our findings on customer stickiness within the deposit market before Section 4 shows how existing depositors in expectation borrower more from their deposit bank in the future. Section 5 then shows implications for deposit pricing and Section 6 for loan pricing. Finally, Section 7 explores the implications for monetary policy, while Section 8 concludes.

2 Data

2.1 Data Sources and Preparation

Our primary data source is the Norwegian tax register covering all outstanding loan and deposit relationships between 2004 and 2018 between Norwegian individuals and Norwegian banks. In addition to observing the amount deposited or borrowed, we also observe interest received or paid over the year.

We aggregate our data from the individual to the household level, as major financial decisions like mortgage borrowing are often decided at the household level.

In our data we observe the end-of-year deposit balance, debt balance. In addition, we observe the interest paid on debt and interest received on deposits. To impute deposit (loan) rates, we divide the interest a household received (paid) from (to) a bank in a given year by the deposits (debt) it holds there. We compute debt and deposits as the average between the outstanding balances at t-1 and t.[4] To compute loan and deposit spreads, we use the imputed and policy rates.

[4] While we see deposit volumes and interest by individual or household and bank and year, we do unfortunately not see it by account type and can hence not sensibly distinguish between "core" and "non-core deposits".

As we see the universe of Norwegian deposit and loan balances, we can compute each bank's market share in each market and municipality to approximate market concentration.[5]

We merge our account-level data with balance sheet and income statement information. Due to a wealth tax, the Norwegian tax authorities receive a breakdown of household balance sheets and income statements each year. Importantly, the data is third-party reported by employers and banks, so data quality is high. The data allow us to shed light on how households characteristics affet bank cross-selling incentives, as well as holding different characteristic fixed to better isolate cross-selling from other factors. The data also contain a breakdown of each household member's education level and other demographic information such as age and location.

We also merge our data with bank-level balance sheets to explore whether cross-selling incentives are affected by banks.

When analyzing depositor borrower conversion, i.e. the propensity for household *h* to take out a loan with bank *b* in year *t* conditional on having had deposits there anytime between one and or more years ago, we do not count deposit accounts opened in the year in which the loan is initiated. By dropping those (few) cases, we may slightly underestimate the positive effect of a deposit relationship on starting another relationship with the same bank. Still, we wish to avoid artificial inflation of the importance of the relationship by counting deposit accounts opened because the bank required the household to do so in connection with the loan.

We also complement our data with daily interest rates at the product level from the price comparison website Finansportalen.no. All banks are obliged by law to report – each day – the interest rate on their outstanding deposit products, as well as different contractual terms such as volume limits and age restrictions. These data allow us to get an accurate picture of the actual interest rates set by banks and analyze how banks introduce different contractual terms to price depositors different based on the likelihood of future cross-selling.

2.2 Descriptive Statistics

Table 1 provides in ***Panel A*** summary statistics on the bank x household x year triplets underlying most of our analyses. To start with, we see that the policy rate varies between 0.50 and 5.32 and averaged 1.82 percentage points (pp) in our sample. Imputed deposit rates vary

[5] Many Norwegian municipalities are also physically distant from neighboring ones rather than contiguous, so treating them as separate local markets seems more appropriate than in more densely populated countries like e.g. the Netherlands.

between 0.07 and 4.92 pp, which implies deposit spreads of between -2.84 and 4.76, with an average of 0.54 pp. Loan rates range between 1.23 and 9.01 and average 3.59 pp, which results in loan spreads (not controlling for interest rate risk) of between 3.12 and 7.19, with an average of 1.54 pp. Average deposit volumes correspond to NOK 140'000, or roughly about '14'000 USD or Euro worth of deposits, while loan volumes are on average NOK '160'000 and in the last observed relationship year NOK 1.1 million. Household debt to all banks used by that household averages NOK 970'000.

In ***Panel B***, we report household characteristics independent of a particular bank relationship. We see that 34% of households have at least one member aged below 30 when we first observe their bank relationship[6]. In addition, 15% fall into education group 1, 42% into group 2, 30% into group 3, and 13% into group 4, where the different education groups correspond to no school, high school, undergraduate level or graduate level. In the relationship x years in which we observe them, about 53% of households own real estate, which the tax authorities value on average (including zeros) at NOK 1.2 million. Households use between 1 and 7 and on average close to 3 bank. The average population density across municipalities is 1'000 capita per km2.

Finally, in ***Panel C*** we report key bank and municipal market characteristics. To start with, we find that the average bank converts in its average relationship each NOK of deposits into 3.4 NOK of loan volume. In terms of bank size, we see the average bank holding about NOK 86 billion deposits. Municipal deposit (loan) markets have Herfindahl-Hirschmann Indices (HHI) of market concentration of on average 0.3 (0.18). Bank-level weighted HHI values differ from bank to bank but their averages are the same as the municipal ones. Finally, banks have average weighted deposit (loan) market shares of 31 (16)%.

[6] When aggregating from individual to household level we use the birth year and hence the age of the younger spouse reasoning that one spouse being aged below 30 will suffice for access to more attractive deposit accounts as discussed below.

3 Depositor Stickiness

3.1 Hypotheses on Depositor Stickiness

In the canonical Monti-Klein model, banks set deposit spreads to maximize one-period deposit profits, i.e., the product of spreads *s* and resulting volumes $D_i(s)$, which is a downward sloping function of the deposit spread *s*:

$$\max_s D_i(s) * s \qquad \text{(T1)}$$

Casual observation of reality and prior work including by Carbo-Valverde, Hannan, and Rodriguez-Fernandez (2011), Kim, Kliger, and Vale (2003), and Sharpe (1997), however, suggest that depositors may have bank switching costs, in which case they may fail to switch banks in a second period even if other banks offer more attractive deposit rates. Empirically, this could materialize as an increased likelihood of seeing a deposit relationship if the relationship was present previously conditional on the set of deposit rates available to the depositor, or the observation that depositors retain their deposit accounts at a given bank despite losing money on that compared to the most attractive outside option.

> ***H1 on Depositor Stickiness:*** *Once onboarded, depositors will accept to lose some deposit interest to avoid switching banks. The interest thus lost to clients increases in characteristics associated with greater switching costs or lower price sensitivity.*

One implication of such stickiness is that deposit volumes in one or more periods after a client onboarding will depend negatively not only on contemporaneous deposit spreads but also on earlier ones: A more attractive deposit spread now will attract more depositors now, who, given some stickiness, are more likely to be around also next period even after conditioning for next period's deposit spreads. In this vein, it makes sense to extend banks' optimization problem to at least two periods and have deposit volumes in period 2 depend on both deposit spreads then and deposit spreads in period 1:

$$\max_{s_{i,1},s_{i,2}} D_{i,1}(s_{i,1}) * s_{i,1} + \frac{1}{R} D_{i,2}(s_{i,1},s_{i,2,}) * s_{i,2} \qquad \text{(T2)}$$

In addition to adding subscripts for two periods, we also add subscripts *i* to differentiate between client groups with possibly different switching costs or price sensitivity. For simplicity we omit the expectations operator even if future volume responses are uncertain, but we do discount future profits at 1/R, which will turn out to matter below. Then we see

that the prospect of current depositors bringing in additional profits also in later periods can motivate banks to accept lower and even negative deposit profits today:

H2 on Negative Deposit Profits: *Banks may sometimes choose negative deposit spreads.*

This hypothesis is still vague on how banks can discriminate between deposit spreads for new clients vs. those who already have switching costs, or on whether they might want to accept lower spreads in some periods than in others. We shall address both points below.

3.2 Empirical Strategy on Depositor Stickiness

To investigate the role of deposit stickiness, we first run an exploratory regression where we regress a dummy $I_{t,h}$ which is one if household *h* has a deposit account at bank *b* on a lag of itself, in addition to bank x year fixed effects and municipality x salary group x age group x year fixed effects. The combination of fixed effects captures the best possible rate the client could obtain at bank *b* and the best rate available to that household group from any other bank. Specifically, we estimate

$$I_{h,t} = \alpha + \beta I_{h,t-1} + \gamma X_{h,t} + \epsilon_{h,t} \quad (E1)$$

where $X_{h,t}$ captures the two sets of fixed effects described below. The key coefficient is β, which captures our notion of depositor stickiness.¨

We then proceed to investigate ***H1***,. To do so,we first compute the difference between the deposit rate in that relationship for each bank household relationship and the maximum deposit rate paid by any bank that year. We then multiply this difference for each relationship with the average deposit amount held to also obtain the amount of NOK the household lost by not switching. This is a rough approximation in that the maximum deposit interest rate paid in a given year may often be restricted to accounts with limited eligibility, as discussed below, requiring e.g., a certain age or residency. So the absolute size of interest lost is likely overstated, yet differences in who loses more vs. less are meaningful when we relate them to household characteristics:

$$Y_h = \alpha + \beta * X_h + \varepsilon_h \ (E2)$$

For ***H2***, we simply look at the time series of deposit spreads.

3.3 Results on Depositor Stickiness

Table 2 investigates the presence of depositor stickiness. In Column 2 we report the strictest specification, where we compare observationally equivalent depositors within the same bank x year. The probability of observing a deposit account for household *h* at bank *b* increases by 84 pp if the household had a deposit account at the same bank in t-1, suggesting substantial depositor stickiness.

Figure 3 shows us visually in ***Panel A*** the results of relating to household observables the deposit rate lost and in ***Panel B*** deposit income lost. To start with, we see that those aged below 30 and those with children lose respectively more than 40 and more than 10 basis points (bps) *less.* This can be rationalized firstly with the young having fewer bank products and hence lower switching costs and secondly with them being more price-sensitive. In addition, we shall see later that and why it likely reflects also banks' provision of accounts with better deposit rates for which these two groups are often eligible when others are not. Their search for better spreads is also reflected in ***Panel B*** where parents and those under 30 lose a bit over 20% less in terms of NOK deposits. By contrast, results for retirees and the wealthy are more ambiguous in that they manage to get less bad rates and yet lose more in terms of NOK, presumably because precisely those with more money seem less eager to search for better rates. Overall we take these results to be consistent with our ***H1***, showing less money lost for groups with plausibly lower switching costs or greater price sensitivity, even though it does not and need not prove switching costs to be the only underlying reason. But it provides a first possible rationale for banks sometimes to endure negative deposit spreads in the spirit of ***H2***, which we do see in ***Figure 1*** for the euro area and in ***Figure 2*** for Norway. Yet the question remains whether and how banks can differentiate between clients with different switching costs, and why ***Figures 1*** and ***2*** show negative average deposit spreads in some periods and not in others.

4 Cross-Selling

4.1 Hypothesis on Cross-Selling

In the Monti-Klein model and DSS 2017, deposits and loans are considered as two separate bank buinesses. Their only connection is that the deposit volume raised can be used to refinance lending. If the optimal deposit volume is greater or smaller than the optimal loan volume, the difference is lent or borrowed in the interbank market. In the previous section, we have shown deposit relationships to be sticky. We argued that this alone could motivate banks to accept

lower deposit spreads in period 1 to onboard or retain depositors for later profits within the deposit business itself. The same implication may also follow if banks seek to onboard or have depositors for future refinancing benefits as e.g. in Ritz and Walther (2015).

Practice[7], however, suggests that banks strive to sell different products to the same client over time. One reason for this to be attractive is that the same kind of switching costs that lead households to keep their deposits with the same bank may also lead them to apply for a loan to that same bank. In this case we have *demand complementarities.* These complementarities can be due to efforts to *align bank incentives* as in Laux and Walz (2009), due to *physical switching costs* as in Sharpe (1997) or due to *loyalty* as in Ongena, Paraschiv, and Reite (2021). Regardless of households' exact motivation, we obtain the following hypothesis:

> ***H3 on Cross-Selling:*** *An existing deposit relationship makes it more likely that the bank will cross-sell the same household a loan later.*

4.2 Empirical Strategy to Investigate Cross-Selling

While ***H3*** posits an effect from an existing deposit to a later borrowing relationship, a correlation between these two could also arise through reverse causality whereby a client opens a deposit account only to facilitate borrowing. To alleviate this, we focus on using only loan relationships started at least 1 calendar year after the client established the deposit account.

Furthermore, the deposit and the loan relationship may be driven by a third common confounding factor. For example, a household and a bank that are present in a municipality with few other banks may be more likely to have a deposit and a loan relationship simply because there are few alternatives. To account for that, we use municipality fixed effects and focus on within-municipality variation, comparing later borrowing between a current depositor to someone not currently depositing with that bank but who lives in the same municipality. Relatedly, loans – most of which are mortgages – may be more likely in a specific phase of the lifecycle. We therefore also partition households into age groups and focus on within municipality x age group variation. Finally, we also consider the case that the propensity to open a deposit account now, possibly even at a particularly advantageous rate, and the propensity to buy a house later are also driven by the same unobservable personality trait or education. Therefore, we interact the product of municipality and age group fixed effects with

[7] For example Kane (2005) writes in the practitioner-oriented American Bankers Association Banking Journal: "Since the late 1980s, cross-selling has been the holy grail of large banks, particularly in the retail area."

salary group and education group fixed effects. To conclude, we regress an indicator *I* for a loan to household *h* from bank *b* in years $\tau = 1,\ldots,14$ on an indicator for a deposit start between *h* and *b* in year *t*:

$$I(Loan)_{h,b,t+\tau} = \alpha + \beta * I(DepositStart)_{h,b,t} + \gamma_{m,a,s,e} + \varepsilon_{h,b,t} \quad \text{(E3)}$$

Although I(Loan) is a binary outcome, our baseline analysis uses a linear probability model (LPM) to make it computationally feasible to include our highly granular fixed effects and so compare a household with deposits at bank *b* to one that has its deposits elsewhere but is otherwise as much as possible comparable to the former household.

4.3 Empirical Results on Cross-Selling

Figure 4 visually displays the results from regressing an indicator for a loan relationship on indicators for an existing deposit relationship in the same household bank in any of the past 1 through 14 years. As the figure illustrates, the existence of a deposit relationship increases the propensity to take up a loan at the same bank by about 4 pp in the year after the deposit account opening. In year 2 the marginal effect is still a bit over 2 pp and then gradually falls year by year but remains significant and positive throughout the full 14 years for which we can observe each bank household relationship. Cumulatively this makes an existing depositor close to 20 pp more likely to borrow from its deposit-taking bank compared to a observationally similar household with no deposits at that bank. Overall this suggests significant effects of an existing deposit relationship on the likelihood of a loan relationship which banks may want to take into account also when onboarding and retaining depositors.

Robustness

In ***Appendix Table 6*** we provide further evidence on the impact of existing deposit relationships on the propensity to borrow. In the top panel, we compare the effects of using different estimation approaches to estimating the effect of a deposit relationship in any observed year on the propensity to start a loan one year later. While LPM estimations without any fixed effects yield an effect of 2.2pp, logit yields marginal effects of 2.4 and probit of 2.3pp. Adding the full set of fixed effects reduces the estimate to 2.1pp. This suggests that using LPM with fixed effects is, if anything, slightly more conservative but does not differ significantly from the discussed alternatives.

Our baseline sample includes all existing bank household relationships only. So the counterfactual of a depositor *h* of bank *b* starting to borrow is a depositor *h'* of bank *b* that does not start to borrow. By contrast, the baseline sample does not include the counterfactual of a household *h''* who does not borrow from *b* either, nor hold deposits at *b*, because a hypothetical household bank pair that entertains no relationship is not in the sample. One may argue that this ignores relevant potential alternatives the household has. Therefore, we also include an analysis where we fill in for each household all potential relationships with all banks that have at least one relationship in thehousehold's municipality. ***Panel B*** of ***AT6*** shows that doing so significantly increases the sample size by about 28%. The estimates increase from 2.1 to 2.3pp when using fixed effects or 2.2 to 2.7pp when not using fixed effects. The difference is arguably not huge because we know from ***T1*** that the average household has already close to 3 bank relationships and the maximum is 7, reflecting that most municipalities exhibit a limited number of banks present.

To foreshadow our results resulting from these choices, we find a strong link from deposit to loan relationships, and this is not significantly weakened by any of our fixed effects. This does not prove but does make it very plausible that results are not driven by unobservables. Yet one may still be concerned that both relationships are driven by the geographical distance between a household's exact address and the address of its bank's closest branch, neither of which we can observe beyond the postcode. To explore whether this is a problem despite our conservative set of fixed effects, we analyze also the lender choices of households that move within or even across municipalities and who presumably do not choose their new address on the grounds of bank branch distances alone. Then we explore lender choices amongst the subset of households residing in the most densely populated municipalities with many bank branches nearby. As we report in more detail below, results turn out to be robust to both restrictions.

5 Deposit Pricing with Cross-Selling

5.1 Hypotheses on Deposit and Loan Pricing

This section asks whether banks' deposit and loan pricing is consistent with internalizing future cross-selling opportunities. Conceptually, we add loan profits as a second refinement to the bank's problem:

$$\max_{s_{i,1},s_{i,2},l_{i,2}} D_{i,t=1}(s_{i,1}) * s_{i,1} + \frac{1}{R} D_{i,2}(s_{i,1},s_{i,2}) * s_{i,2} + \frac{1}{R} L_{i,2}(s_{i,1} l_{i,2}) * l_{i,2} \quad \text{(T3)}$$

Not only do higher first-period deposit spreads s_1 then decrease period-2 deposit volumes, but also period-2 loan volumes.[8]

To see why it is profitable for banks to internalize the likelihood of cross-selling, we note that our summary statistics in ***Table 1*** show that the average loan amount in our sample was about NOK '20'000 or USD '2'000 higher than the average deposit amount. At the same time, an average deposit spread of 54bps compares to an average loan spread of 154bps. While about 95% of these loans are adjustable-rate, see IMF (2012), so that we can use as reference the overnight rate, assessing loan profitability does require subtracting an appropriate credit risk premium. With most of these household loans collateralized with real estate, the credit risk premium is negligible. Considering these factors and the fact that about one in five depositors brings in extra loan business, we expect cross-selling potential tomorrow to affect deposit pricing today. A way to gauge this empirically is if banks set higher deposit rates for groups where the cross-selling potential is higher.

> ***H4 on Deposit Pricing with Cross-Selling Potential:*** *Bank b sets a lower deposit spread s_i if client group i has a greater elasticity of later loan demand to current deposit spreads, i.e. has lower* $\frac{dL_i}{ds_i}$.

5.2 Empirical Strategy on Deposit Pricing

To investigate to what extent banks offer more attractive deposit rates to clients who in expectation will bring in more loan profits later, we reduce our panel to a cross-section of relationships as observed in the first year. We then regress an indicator for later borrowing, the log of final debt, and the initial deposit spread on relevant household characteristics while controlling for a conservative set of fixed effects:

$$Y_{h,b} = \alpha + \beta X_h + \gamma_h + \varepsilon_{h,b} \text{ (E4)}$$

Household characteristics of interest include a parenthood indicator, a retirement indicator, an indicator for being aged below 30 in the first relationship year, the logs of household income, household wealth, and the relationship-level deposit volume. We also include the household's total number of bank relationships that year. In the deposit spread column, we additionally have

[8] We do not include loans already in period 1, as empirically less than 5% of Norwegian household bank relationships start with a loan, see ***Figure 5***.

an indicator for whether the household is already a multi-product" household in the sense of using both the bank's deposit and the bank's loan business.

5.3 Empirical Results on Deposit Pricing

Table investigates in columns 1 and 4 the determinants of whether a current depositor will later also borrow from the same bank, in columns 2 and 5 the amount in the last observed year of the household bank relationship, and in columns 3 and 6 the initial deposit spread. While columns 1-3 investigate only the determinants explicitly displayed and cluster standard errors by bank relationship, columns 4-6 control additionally for municipality x salary group x education group fixed effects and cluster standard errors by these same clusters. Overall, the results are qualitatively similar but tend to be slightly smaller when adding the full battery of fixed effects. We deem the latter version more conservative and focus our discussion on that.

Column 4 shows that each percentage point of additional income (wealth) increases the borrowing propensity only negligibly, but according to column 5 it increases the amount by 0.6 (0.9) %. By contrast, higher deposit volumes, conditional on having a deposit relationship, increase the borrowing propensity similarly marginally and, in addition, are associated with, if anything, slightly smaller expected loan amounts.

Quantitatively, we find a bigger impact of being a parent, associated with a 2.3pp lower borrowing propensity but a 45% bigger expected loan amount. Arguably this reflects that conditional on borrowing for a home. After controlling for income and wealth, parents tend to buy bigger houses and, therefore more expensive homes and hence tend to borrow more. Relatedly, we find those aged below 30 at the observed relationship start to exhibit a 7.4pp higher borrowing propensity and to borrow a full 83% more in expectation. Lifecycle considerations plausibly drive this: While those under 30 are likely to buy or refinance their first home, those already retired borrow on average 124% smaller amounts, plausibly because they have already largely repaid their mortgages at that point.

Having noted parenthood and age as key predictors of future borrowing, we notice in column 6 that parents get on average 14 bps lower deposit spreads, while those below 30 get an additional discount of on average 28 bps. These estimates appear significant. We note that these associations are driven not by client-specific deposit rates but by each bank and year offering several different deposit products with different rates and eligibility criteria, often featuring parenthood and age, as illustrated in ***Figure 5***. This pricing is consistent with banks making

more attractive deposit offerings to clients expected to bring in more follow-on business in the spirit of ***H3***.

Beyond this core finding, the subsequent regressors yield interesting additional insights. To start with, we find that for each additional bank a household interacts with, it is 1.4 pp less likely to borrow from the bank in the observed relationship but borrows in expectation 48% more. Therefore the deposit spread discount of about 8 bps per extra bank relationship can be driven either by the bank knowing that the household has more alternatives, by the bank being more eager to retain that depositor for follow-on business, or both. We also find that a multi-product household already borrowing from the bank in addition to holding deposits gets an on average 8 bps higher deposit spread, possibly because it will find it harder to switch banks.

The ***Online Appendix*** contains a comprehensive set of robustness checks on ***Table 4***, which we briefly discuss here. To start with, one may wonder whether the impact of client observables like parenthood on later borrowing from the observed bank operates primarily through whether the household borrows at all or whether it borrows from that specific bank. ***Appendix Table 1*** explores this by focusing on the subset of relationships by households that become borrowers in the 14 years we study. The key results are similar to those in ***Table .***

While the distinction between debtors and no debtors is only about the *channel* of the effect of an existing deposit on a new loan relationship, more serious is the concern that both could be driven by proximity to the closest bank branches. Although both our year-by-year conversion estimates in ***Figure 4*** and the cross-sectional estimations in ***Table*** contain municipality fixed effects and thereby control for population and bank branch density, we may imagine that within the same municipality each household is more likely to do business with that bank that offers the branch closest to the household's place of residence. To investigate this, we exploit that – as visualized in ***Figure 7*** – about 50% of households move either within or even across municipalities between opening their deposit account and between taking out a loan. On these grounds. ***Appendix Table 2*** focuses on the close to 50% or about 8 million household bank relationships where the household moves postcodes[9] between we first see the household to have deposits with that bank and the year in which we first see him borrow there. While some coefficients become slightly larger and others slightly smaller than in the twice as big baseline sample, none change significantly, refuting the concern that our results are due to branch

[9] We do not see address changes within the same postcode area, but there bank branch distance may remain the same anyway.

distance. The same holds when in ***Appendix Table 3*** we reduce the sample further to focus only on households who move across municipalities.

An alternative robustness check focuses on municipalities with high population density and typically higher bank branch density. ***Appendix Table 4*** focuses on households in municipalities with above-median density. As these tend to be larger municipalities with more households, this still includes about 14 mio. of the initial about 17 mio. observations. Again we can summarize this robustness check as confirming our baseline estimates. The same holds when in ***Appendix Table 5*** we focus instead on municipalities with below-median deposit market concentration.

6 Loan Pricing and Demand vs. Supply Complementarities

In addition to *demand complementarities*, as discussed in Section 4 above, several papers including Gilligan, Smirlock, and Marshall (1984) and Mester (1987) find evidence for *supply complementarities* based on the cost functions of commercial banks. Some supply complementarities, e.g. from using the same branch building and staff to sell different products or from making the refinancing of loans more stable, do not require both products to be sold to the same client. Of more interest to us are complementarities from selling different products to the same client. This could be due to more reliable borrower screening as emphasized by Petersen and Rajan (1994) or Mester, Nakamura, and Renault (2007). From the economics of ***multi-product pricing***[10] e.g.Tirole (1988), it is clear that either demand or supply complementarities can motivate firms to price the initial product below marginal cost for future profits on other products.

In contrast to the corporate lending studied in much of the literature on relationship banking, loans to the households we study are typically fairly standardized mortgages collateralized with real estate in a full-recourse environment. This raises the question of how important screening is in our context and whether demand or supply complementarities matter more. On these grounds, we posit the following hypothesis.

> ***H5 on Loan Pricing:*** *If cross-selling is driven more by supply complementarities, we expect banks to pass on a non-negative fraction of their cost savings via lower loan spreads. If demand complementarities matter more, we expect bigger loan spreads for existing clients.*

6.1 Empirical Strategy on Loan Pricing

To investigate loan pricing, we employ as outcomes both the raw loan rate and the spread between loan rate and policy rate. We regress loan prices on relevant household observables, most notably an indicator for whether the household is already a depositor of that bank.

6.2 Empirical Results on Loan Pricing

Table 5 shows loan pricing, measured in columns 1 and 3 as the rate and in 2 and 4 as the spread over the policy rate. Given that about 95% of Norwegian mortgages are adjustable rate (IMF

[10] More specifically in a banking setup, "cross-selling" and the resulting "multi-product pricing" may also be referred to as "relational banking". But as the latter may be understood to include also borrower monitoring, we stick to the term "cross-selling". By contrast, we do not view our setup as one with pure or mixed *"bundling"*, wherein a product is sold respectively only or at least optionally *together* with another, as deposit accounts are often opened one or more years before a decision on a loan or other business is made.

(2012)), the overnight policy rate seems an acceptable benchmark. We control for credit risk by controlling for the debt amount and the tax-assessed house value to approximate loan to value and the salary to approximate loan to income. Columns 1 and 2 also indicate whether the household holds real estate, in which case the loan is more likely to be collateralized, while 3 and 4 focus on the subset of households that we observe to hold real estate and include the tax-assessed value thereof.

Our results indicate that banks charge existing depositors between 19 and 24 bps more on average. Based on the considerations of ***H4***, this speaks for depositor borrower conversion to be driven primarily by demand complementarities rather than supply complementarities..

If loan relationships were more likely given existing deposit relationships because banks find it easier to screen depositors, as in Thadden (2004), we would expect banks to pass on part of the lower costs to clients to the extent to which loan markets are competitive, not to charge higher rates than to otherwise identical clients with deposits elsewhere. While such informational rents are very plausible in many contexts of corporate lending like those discussed in Thadden (2004), they may also exist but are plausibly smaller in collateralized mortgage lending to households where less borrower screening may be required. The findings are consistent also with recent findings by Ongena, Paraschiv, and Reite (2021) whereby a representative Norwegian bank charges extra for existing relative to new mortgage borrowers.

Looking at other pricing determinants, we find a 1% larger loan volume to decrease rather than increase loan rate and spread, suggesting that economies of scale dominate risk considerations. Still, the economic size of that effect seems negligible. More importantly, borrowers with real estate, whose loan will more likely be collateralized, pay between 42 and 44 bps less, while a higher salary is associated with a marginally lower loan rate.

7 Discounting of Future Cross-Selling

7.1 Hypotheses on Discounting of Future Cross-Selling Profits

Above, we have discussed how banks may want to accept lower deposit spreads in return for higher cross-selling profits. We have already refined banks' deposit pricing optimization to include two rather than just one period. However, both ***Figure 4*** on year-on-year depositor-borrower conversion propensities and ***Figure 6*** with the distribution of wait times between deposit and loan initiation suggest that in practice the lag between these 2 periods is often longer than just one year. For instance, many households may start a deposit relationships before their first job and borrowing to buy their first home only in or after their first year with significant income of their own. For banks' optimization however this means that they need to discount the benefits of onboarding or retaining a potential future borrower, as indicated in equation ***T3*** by dividing future profits by the gross discount rate R.

The importance of the discount rate would grow even more if we considered more than one future period and discounted deposit or profit profits with client group i in τ periods from now at rate R^{τ}. Still, we simplify by considering only two periods. Even then, we see the following:

> ***H5 on the Link between Policy Rates and Deposit Spreads:*** *The bank will ceteris paribus accept a lower deposit spread the lower current interest rates.*

While we emphasize that banks discount future cross-selling profits less when rates are low a priori, it is also plausible that the depositor borrower conversion is policy rate dependent. It is unclear, however, how the policy rate would affect conversion probabilities. On the one hand, it is plausible to expect more borrowing and higher conversion when rates are lower. But, on the other hand, we could also expect the central bank to raise rates when credit demand is excessive, resulting in an on average negative contemporary association between policy rates on the one hand and lending and conversion on the other. The link between deposit spreads and conversion is complicated further by the fact that we care about deposit spreads when a household is onboarded or retained as a depositor, but about conversion into borrowers later by which policy rates may already have changed. To get a sense of which, if any, of the two mechanisms dominates, we correlated lifetime conversion rates of each relationship with deposit rates in the first year in which we observe a deposit relationship. The correlation is close to zero, so we do not favor an explanation based on rate-dependent conversion over that based on rate-dependent discounting.

More generally, the positive deposit spread beta predicted in ***H5*** as result of cross-selling considerations – whether it operates through discount rates, conversion rates, or non-deposit spreads — coincides with the predictions in DSS 2017, except that there the link is driven by market concentration rather than by rate dependent discounting of future cross-selling benefits. Nevertheless, a priori the two explanations are not mutually exclusive, so we want to test for both and posit:

H6 on Cross-Selling vs. Market Concentration as Drivers of the Deposit Spread Beta:
We expect the link between deposit spreads and policy rates to be stronger the …

(a) … greater banks' deposit market power, following DSS 2017.

(b) … greater banks' cross-selling incentives.

7.2 The Empirical Deposit Spread Beta

Figure 8 presents a bin scatter of deposit spreads against policy rates in the top panel and illustrates a very clear upward sloping relationship. To quantify the magnitude of the relationship we regress the deposit spread on the policy rate. As highlighted by column 1 of ***Table 6***, we find a β of 0.66, confirming ***H5***. This is similar to the mean beta of 0.54 reported for the US in DSS 2017, although slightly larger. As we posit the relationship to be due at least partly to discounting future profits, one may also argue that the relevant discount factors are real, i.e. inflation-adjusted rates. The midpanel of ***Figure 8*** plots deposit spreads against real instead of nominal policy rates and finds a similar relationship. We also find similar results when focusing on changes in the bottom panel. All graphs confirm a non-zero deposit spread beta.[11]

7.3 Deposit Spreads by Policy Rate and Business Model

After having confirmed lower spreads in times of lower discounting rates, we next investigate whether that mechanism is stronger for banks in more concentrated markets, as predicted and empirically confirmed by DSS 2017, or whether it is stronger for banks more interested in cross-selling, as predicted by our new complementary mechanism. For this, we need a measure of the extent to which a bank cross-sells loans to depositors within the same bank relationship. Hence we compute the relationship-specific ratio between average loan amounts (zero for relationships with no loan ever) and average deposit amounts. We then compute the volume-weighted averages at the bank level to denote banks that are more or less active in cross-selling. Finally,

[11] DSS 2017 analyze also the first difference in deposit spreads, but this makes less sense for our relationship level data as we would then lose a significant portion of observations, and the initial deposit price at onboarding is arguably most interesting.

to make our estimates more robust to outliers we classify banks by whether they exhibit above- or below-median conversion.

To ensure our conversion measure does not incidentally capture any variant of market concentration, ***Table 6*** controls in column 2 for the HHI in municipal deposit markets, closest in spirit to the measure used in DSS 2017, and then replaces this in columns 3-7 with respectively the municipal loan market HHI, the bank- rather than municipality level deposit and loan market HHI; and finally with bank-level weighted deposit and loan market shares. The effect of operating in a more concentrated market on the deposit spread β in Norway is found to vary somewhat with the concentration measure used, but lies on average between 1 and 2 pp, thus confirming the DSS findings in our setting. On the other hand, we find an average effect of over 3 pp for banks with greater cross-selling incentives, regardless of which concentration measure we control for. We take these findings to support both ***H6a*** and ***H6b.*** We note that both operating in more concentrated markets and being able to lock in depositors for future loan business can capture different dimensions of bank market power. Importantly, our results suggest that market power is exercised not within single-product markets on their own but that banks can and do take into account customer lifetime values for their product pricing.

Beyond explaining negative deposit spreads in periods of low or negative policy and interbank rates, and lower spreads in periods of lower discounting rates, cross-selling can also explain the finding by DSS 2017 of a less pronounced deposit spread beta for younger clients, high-income clients, or college graduates, as shown in their Table V. These relationships may indeed reflect clients' financial sophistication, as DSS sensibly consider, but may also reflect banks' expectations of greater cross-selling profits from younger, better earning or better educated clients given their greater propensity t o take out a mortgage later. As shown in DSS 2017, the positive deposit spread beta can explain all monetary policy transmission to the real economy. Our additional micro foundation for the deposit spread beta does not only matter for the optimization of both banks and bank clients but also has implications of monetary policy. We consider this an important avenue for further research.

8 Conclusion

In this paper we have shown that once onboarded as a depositor a household is more likely both to retain deposits with that bank and to buy other banking products, in particular loans, from the same bank. We refer to this as "cross selling. We have then shown that this can motivate banks to accept lower deposit margins in some periods to increase profits from deposits, cross-selling of loans, or both in future periods. In particular, we find Norwegian banks to offer more attractive deposit rates specifically to several types of households which can be expected also to bring in more cross-selling profits.

We discuss that such household bank stickiness can a priori be explained either with demand complementarities or supply complementarities. The latter has received more emphasis in the literature on corporate banking. We then argue that in a world where bank relationship stickiness is driven primarily by supply complementarities, we would expect existing depositors to pay, if anything, lower loan spreads. They might pay higher loan spreads in a world with more important demand complementarities. Our empirical analyses show higher loan spreads for existing customers, suggesting demand complementarities to matter more, at least in financial intermediation for households.

Finally, we consider to what extent incentives to accept lower current deposit spreads to increase future deposit or loan spreads may be more pronounced in times of lower policy rates. We confirm this empirically and show how it may matter for the transmission of monetary policy, providing an additional micro foundation for the deposit channel.

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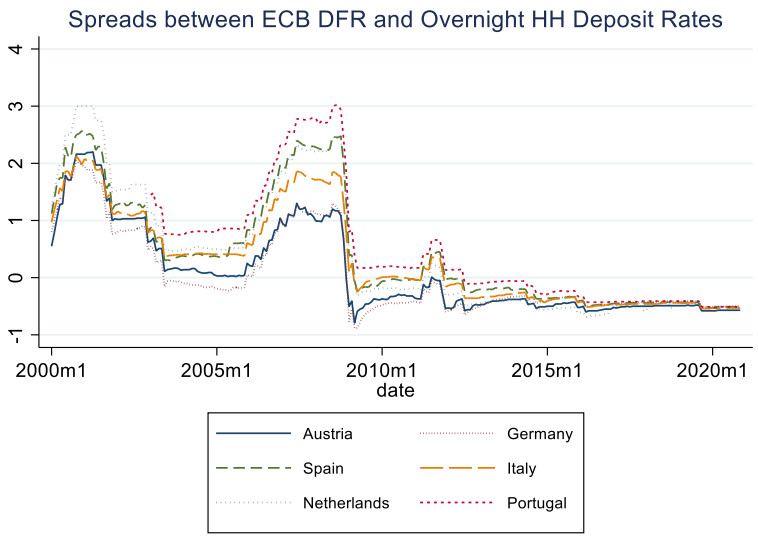
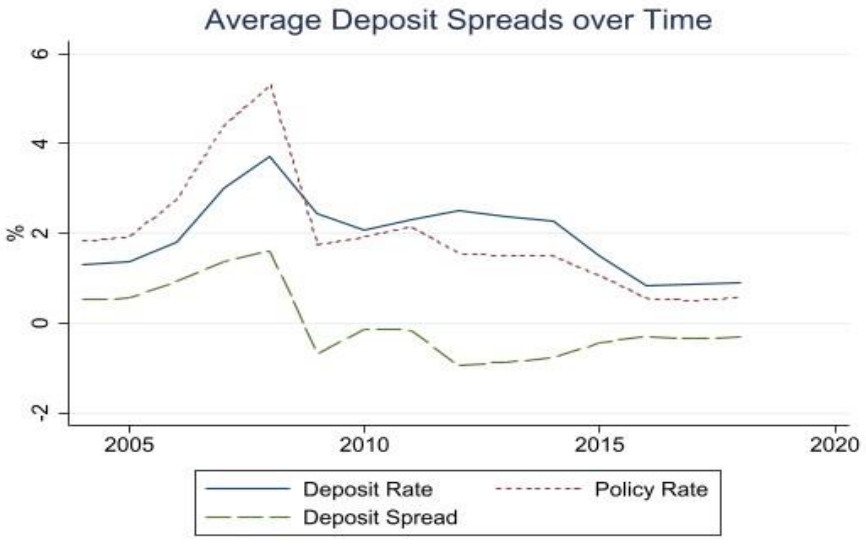
Figures and Tables

Figure 1: Deposit Spreads in Selected European countries



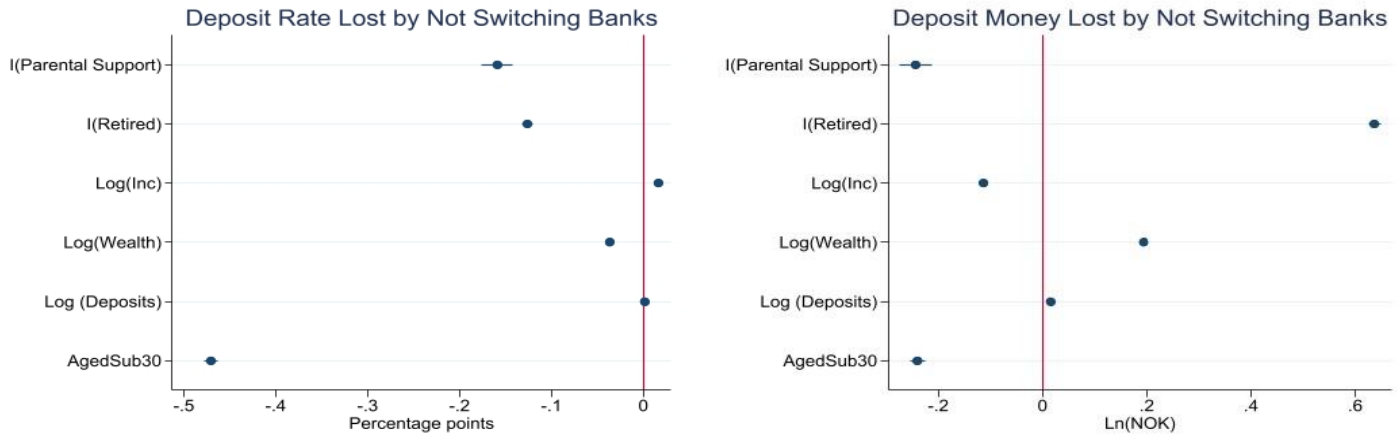
This figure plots the European Central Bank (ECB)'s Deposit Facility Rates (DFR) less average deposit rates for 6 exemplary euro area economies by month. Source: ECB Statistical Data Warehouse.

Figure 2: Average Deposit Spreads in Norway



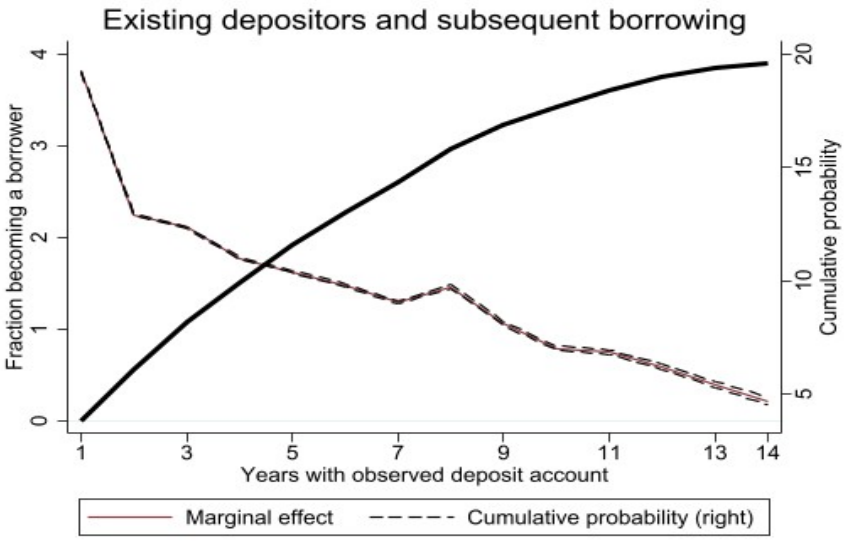
This figure plots Norwegian policy rates, average deposit rates taken from Finansportalen, and their difference by year.

Figure 3: Determinants of Deposit Rate and Deposit Money Lost by Not Switching Banks



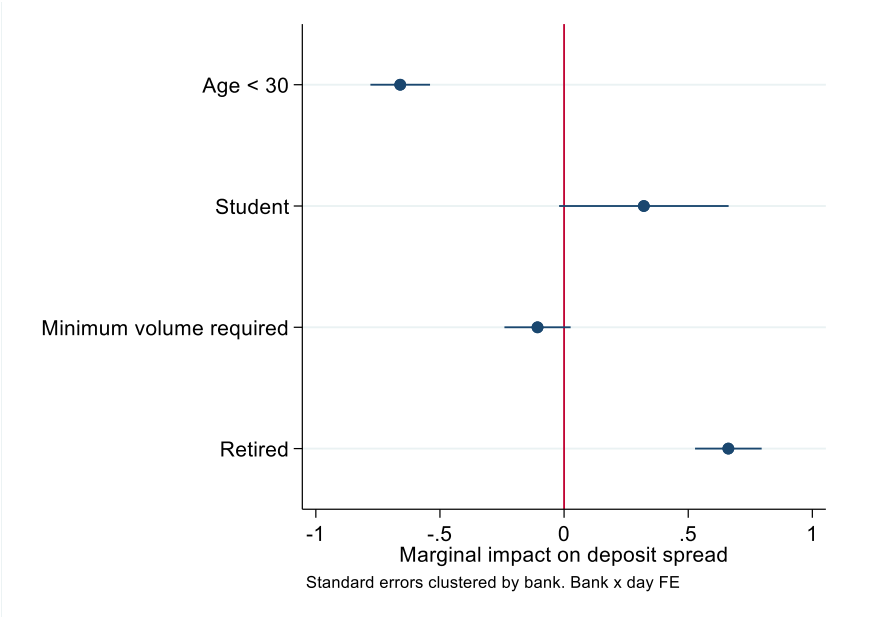
See footnotes of Table 3, as well as text, for details on the methodology.

Figure 4: Existing depositors and subsequent borrowing



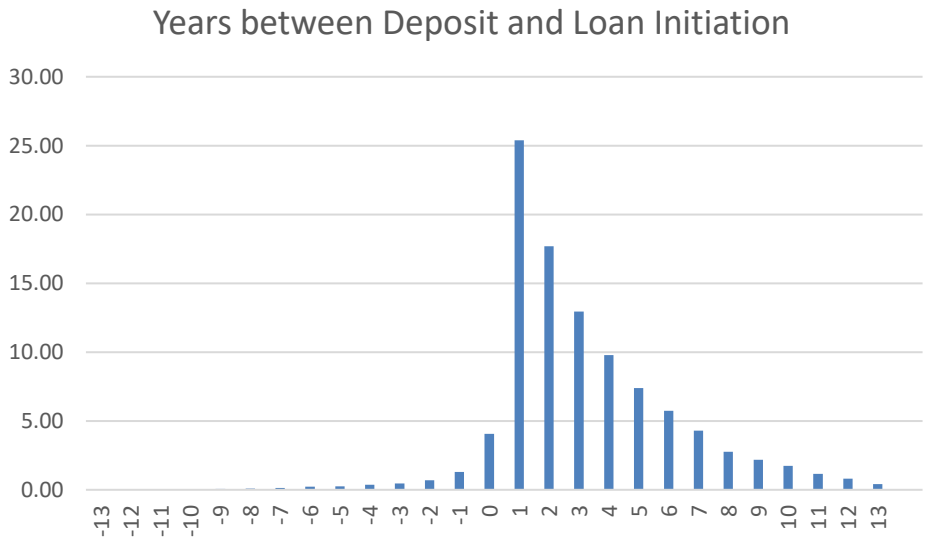
This figure plots our estimates of the marginal and cumulative effect of a household's opening of a deposit account with a bank on the propensity for that household to borrow from that bank in each of the subsequent 14 years, along with 95% confidence intervals. Regressions control for municipality * salary group * age group fixed effects.

Figure 5: Deposit Spreads by Account Type



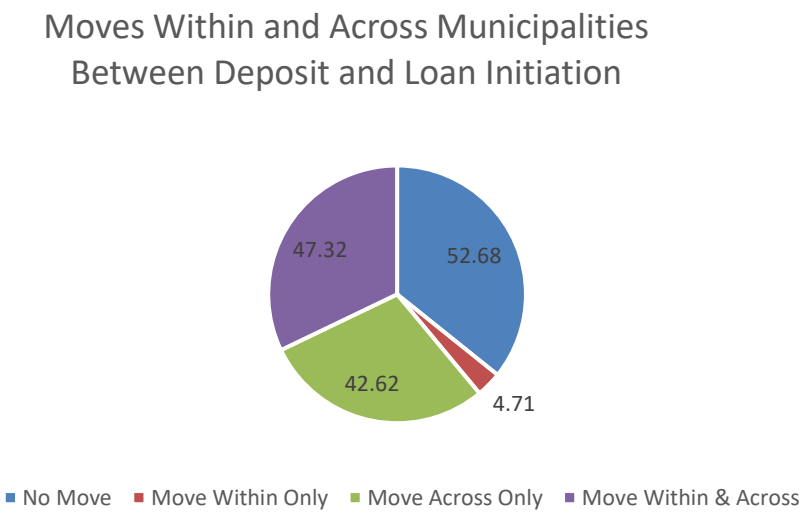
Coefficients from regressing deposit spreads on different account types, based on datza from Finansportalen.

Figure 6: Years between deposit account and loan start in the same bank household pair



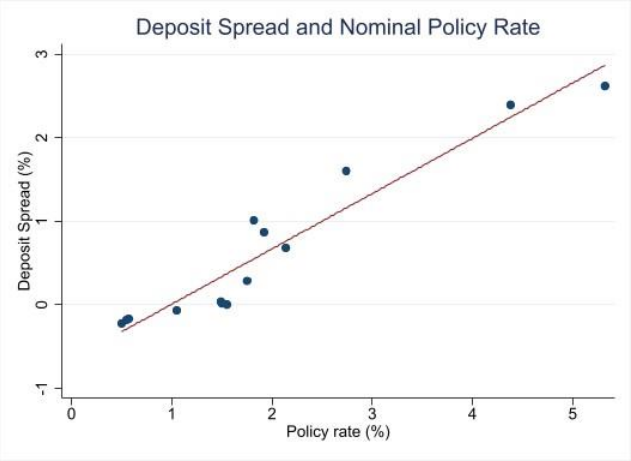
The figure shows the number of years between a relationship's first deposit and its first loan for all relationships where we observe a loan in 2004-2018. We exclude deposit relationships first observed in 2004 to avoid left-censoring. Right-censoring remains possible. Note relationship age and household age are only 11% correlated.

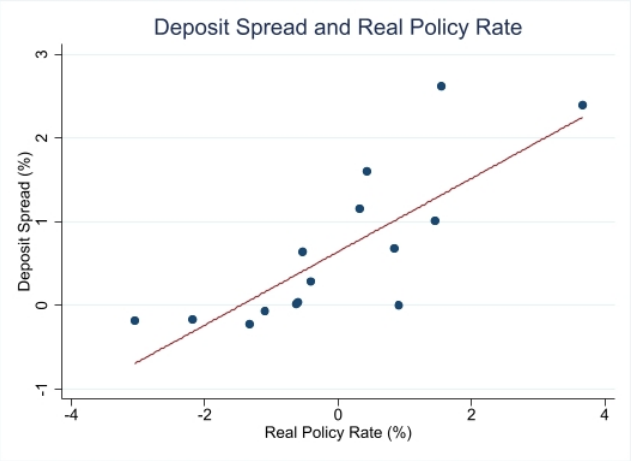
Figure 7: Fraction of bank relationships started before a move

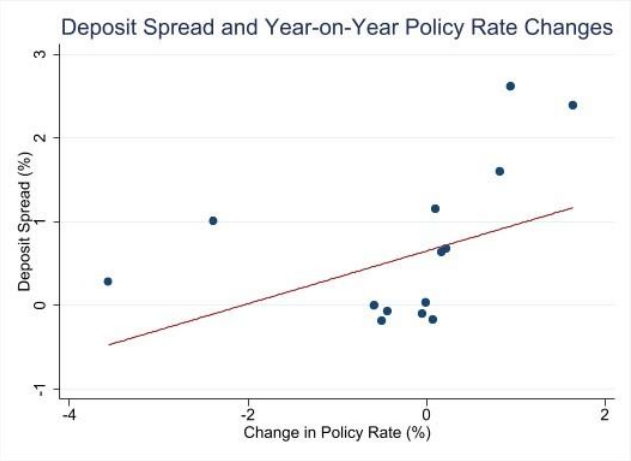


This figure considers for all new debt a household owes to a bank which fraction of households have already moved to a different postcode area within or across municipalites since starting to deposit at that bank.

Figure 8: The Deposit Spread Beta







The top panel plots deposit spreads against Norwegian nominal policy rates, the intermediate one against real policy rates (nominal rates less CPI inflation), the bottom panel against year-on-year changes in nominal policy rates.

Table 1: Summary Statistics

	Observations	Mean	SD	Min	Max
A. Relationship Characteristics					
Policy Rate (pp)	46'132'510	1.82	1.23	0.50	5.32
Deposit Rate (pp)	46'132'510	1.29	1.18	0.07	4.92
Deposit Spread (pp)	46'132'510	0.54	1.37	-2.84	4.76
Loan Rate (pp)	11'883'905	3.59	1.66	1.23	9.01
Loan Spread (pp)	11'883'905	1.54	1.65	-3.12	7.19
Mean Deposit Volume (NOK)	46'132'510	140'000	300'000	0	2'000'000
Mean Loan Volume (NOK)	46'132'510	160'000	510'000	0	4'000'000
Final Loan Volume (NOK)	46'132'510	1'100'000	1'500'000	0	6'900'000
Mean Household Debt (NOK)	46'132'510	970'000	1'300'000	0	6'900'000
Deposit Interest Lost (pp)	46'132'510	2.40	1.22	-3.06	4.82
Deposit Money Lost (NOK)	46'132'510	320'000	480'000	0	1'800'000
Relationship Duration (years)	46'132'510	8.91	4.26	1.00	15.00
B. Household Characteristics					
I(Age < 30)	46'132'510	0.34	0.47	0.00	1.00
I(Education Group 1)	45'754'686	0.15	0.35	0.00	1.00
I(Education Group 2)	45'754'686	0.42	0.49	0.00	1.00
I(Education Group 3)	45'754'686	0.30	0.46	0.00	1.00
I(Education Group 4)	45'754'686	0.13	0.34	0.00	1.00
I(Has Real Estate)	46'132'510	0.53	0.50	0.00	1.00
House Value (NOK)	46'132'510	1'200'000	1'900'000	-5'000'000	440'000'000
HH's # of Banks	46'132'510	2.88	1.60	1.00	7.00
Population Density	12'918'625	1.00	0.87	0.00	2.40
C. Bank and Market Characteristics					
Conversion	46'132'508	3.41	2.52	0.00	8.93
Bank Deposits (NOK mio)	46'132'510	86'000	110'000	0	310'000
HHI(D)	46'132'510	0.30	0.12	0.11	0.86
HHI(L)	46'132'510	0.18	0.09	0.08	0.86
WHHI(D)	46'132'510	0.30	0.07	0.13	0.69
WHHI(L)	46'132'510	0.18	0.05	0.00	0.49
WMS(D)	46'132'510	0.31	0.16	0.00	0.69
WMS(L)	46'132'510	0.16	0.10	0.00	0.52

Panel A shows household bank relationship characteristics. Rates and spreads (against the policy rate) are expressed in percentage points (pp), volumes in Norwegian Kroners (NOK). Panel B shows household characteristics, mostly with indicators denoted as I. Panel C shows bank and municipal market characteristics. There HHI(D) and HHI(L) stand for the household municipality's Herfindahl-Hirschmann Index (HHI) for the deposit (D) and loan (L) market respectively. WHHI(D) and WHHI(L) stand for the corresponding bank level values, weighted by the bank's portfolios across municipalities, while WMS stand for each bank's weighted market share. The conversion variable summarizes the bank-level means of each relationship's mean loan over mean deposit volume.

Table 2: Depositor Stickiness

	(1) $I_{h,t}$	(2) $I_{h,t}$
$I_{h,t-1}$	0.92***	0.84***
	(0.00),	(0.00)
Constant	0.07***	0.14***
	(0.00)	(0.00)
Observations	809303	799079
R2	0.875	0.890
Fixed Effects	N	Y

Column 1 regresses a dummy on observing a positive deposit amount for household h at bank b in time t on a similar dummy for t-1. The results in Column 2 is from a regression where we additionally include fixed effects for each combination of municipality, salary quarter, and education group. Standard errors clustered by relationship in parentheses. * p<0.1, ** p < 0.05, *** p<0.01.

Table 3: Determinants of Deposits Lost by Not Switching Banks

	(1) Deposit Rate Lost	(2) Deposit Money Lost	(3) Log Deposit Money Lost	(4) Deposit Rate Lost	(5) Deposit Money Lost	(6) Log Deposit Money Lost
I(Parent)	-0.18***	-81514.91***	-0.15***	-0.15***	-95727.68***	-0.23***
	(0.00)	(535.47)	(0.00)	(0.00)	(539.69)	(0.00)
I(Retired)	-0.06***	223072.04***	0.74***	-0.10***	191828.03***	0.72***
	(0.00)	(456.80)	(0.00)	(0.00)	(564.35)	(0.00)
Ln(Inc)	0.02***	-16157.10***	-0.08***	0.02***	-9266.45***	-0.09***
	(0.00)	(145.89)	(0.00)	(0.00)	(167.29)	(0.00)
Ln(Wealth)	-0.05***	62689.26***	0.31***	-0.04***	60492.42***	0.30***
	(0.00)	(80.85)	(0.00)	(0.00)	(82.67)	(0.00)
Ln(Deposits)	0.00***	2764.00***	0.02***	0.00***	2730.35***	0.02***
	(0.00)	(20.66)	(0.00)	(0.00)	(20.18)	(0.00)
I(Age<30)	-0.26***	-51784.92***	0.14***	-0.28***	-34712.80***	0.18***
	(0.00)	(364.15)	(0.00)	(0.00)	(373.29)	(0.00)
Constant	2.87***	-297807.82***	7.87***	2.76***	-351155.39***	8.14***
	(0.00)	(1815.22)	(0.01)	(0.00)	(2082.78)	(0.01)
Observations	46134493	46134493	44257652	45756649	45756649	43888934
R2	0.019	0.107	0.183	0.039	0.121	0.200
Fixed Effects	N	N	N	Y	Y	Y

The deposit rate lost for each relationship*year is the difference between the maximum rate paid by any bank in that year and the rate earnt in that relationship and year. The money lost is computed as the product of that rate loss and the average deposit volume in each relationship and year. We then regress the rate lost, the amount lost, and the log of the latter on client observables. Columns 4-6 include additionally fixed effects for each combination of municipality, salary quarter, and education group. Standard errors clustered by relationship in parentheses. * p<0.1, ** p < 0.05, *** p<0.01.

Table 4: Household and Bank Determinants of Loan Probability, Loan Amount, and Deposit Pricing

	(1) I(Loan)	(2) LN(FinalDebt)	(3) Dspread	(4) I(Loan)	(5) LN(FinalDebt)	(6) Dspread
I(Parent)	-0.022***	0.635***	-0.156***	-0.023***	0.446***	-0.135***
	(0.000)	(0.005)	(0.003)	(0.000)	(0.005)	(0.009)
I(Retired)	0.013***	-2.797***	-0.040***	0.029***	-1.235***	-0.029***
	(0.000)	(0.003)	(0.001)	(0.000)	(0.004)	(0.004)
Ln(Inc)	0.008***	0.932***	-0.011***	0.003***	0.590***	-0.016***
	(0.000)	(0.002)	(0.000)	(0.000)	(0.002)	(0.002)
Ln(Wealth)	0.001***	0.142***	-0.027***	0.001***	0.086***	-0.027***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)
Ln(Deposits)	0.003***	-0.062***	-0.005***	0.003***	-0.059***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
I(Age<30)	0.075***	0.999***	-0.258***	0.074***	0.827***	-0.281***
	(0.000)	(0.003)	(0.001)	(0.000)	(0.003)	(0.007)
HH's # of Banks	-0.013***	0.582***	-0.086***	-0.014***	0.478***	-0.078***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)
Multi-Product HH			0.086***			0.082***
			(0.001)			(0.010)
Constant	-0.027***	-3.759***	1.608***	-0.007***	1.229***	1.644***
	(0.001)	(0.020)	(0.003)	(0.001)	(0.025)	(0.013)
Observations	17'090'102	17'090'102	7'806'169	16'860'604	16'860'604	7'684'772
R2	0.047	0.199	0.027	0.058	0.229	0.041
M*S*E FE	N	N	N	Y	Y	Y
Cluster	Rel	Rel	Rel	M*S*E	M*S*E	M*S*E

Household characteristics until the indicator for age below 30 as above. "HH's # of Banks" is the number of banks with which the household entertains a relationship in that year. "Multi-Product HH" is an indicator for households that have both deposits and a loan in that bank relationship. Columns 1-3 without fixed effects and with standard errors clustered by bank relationship. Columns 4-6 include municipality * salary * education fixed effects and cluster standard errors by these same categories. * p<0.1, ** p < 0.05, *** p<0.01.

Table 5: Loan Pricing

	(1) Loan Rate	(2) Loan Spread	(3) Loan Rate	(4) Loan Spread
I(Depositor)	0.24***	0.23***	0.19***	0.19***
	(0.03)	(0.03)	(0.03)	(0.03)
Ln(Loan Volume)	-0.14***	-0.14***	-0.15***	-0.15***
	(0.01)	(0.00)	(0.00)	(0.00)
I(HasRE)	-0.44***	-0.42***		
	(0.02)	(0.02)		
Ln(House Value)			-0.01	-0.01
			(0.01)	(0.01)
Ln(Salary)	-0.01***	-0.01***	-0.02***	-0.02***
	(0.00)	(0.00)	(0.00)	(0.00)
Ln(Deposits)	0.00**	0.00**	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)
Year of Birth	-0.00***	-0.00***	-0.01***	-0.01***
	(0.00)	(0.00)	(0.00)	(0.00)
1000Pop/km2	-0.08***	-0.08***	-0.06***	-0.06***
	(0.01)	(0.01)	(0.01)	(0.01)
HH's # of banks	-0.09***	-0.09***	-0.05***	-0.05***
	(0.01)	(0.00)	(0.00)	(0.00)
Constant	13.71***	11.90***	17.36***	16.15***
	(0.66)	(0.65)	(0.81)	(0.81)
Observations	5'036'794	5'036'794	2'573'645	2'573'645
R2	0.234	0.292	0.206	0.157
Bank*Year FE	Y	Y	Y	Y

Columns 1 and 3 use as outcome the loan rate, columns 2 and 4 the spread thereof over the policy rate, see text for the rationale. "I" stands for indicators, "Ln" for natural logarithms, "Pop" for population and "km2" for square kilometers. "HH's # of banks" is the number of banks with which the household does business in that year. Standard errors clustered by bank*year in parentheses. * p<0.1, ** p < 0.05, *** p<0.01.

Table 6: The Deposit Spread Beta by Deposit-Loan Conversion and Market Concentration

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Dspread	Dspread	Dspread	Dspread	Dspread	Dspread	Dspread
Policy Rate (PR)	0.66***	0.64***	0.63***	0.65***	0.59***	0.65***	0.58***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
I(Conv > P50)		0.04***	0.04***	0.11***	0.02**	0.04***	-0.05***
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
PR*I(Conv > P50)		0.03***	0.03***	-0.00	0.05***	0.03***	0.05***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
I(Conc > P50)		-0.04***	-0.03***	-0.20***	-0.04***	0.04***	0.16***
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
PR*I(Conc > P50)		-0.02***	0.01*	0.02***	0.05***	-0.02***	0.03***
		(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	-0.65***	-0.63***	-0.64***	-0.58***	-0.63***	-0.68***	-0.66***
	(0.00)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)
Observations	661'706	661'706	661'706	661'706	661'706	661'706	661'706
R2	0.375	0.377	0.376	0.380	0.377	0.377	0.381
MC Measure	None	HHI(D)	HHI(L)	WHHI(D)	WHHI(L)	WMS(D)	WMS(L)

Dspread is deposit spread between the policy rate and the deposit rate by household-bank relationship and year. "I(Conv > P50)" is an indicator for whether the bank has a conversion (bank level average of relationship level mean loan over mean deposit volume) above the sample median. "I(Conc > P50)" is an indicator for market concentration above the sample median, where market concentration (MC) is measured as the municipal deposit market Herfindahl Hirschmann Index (HHI) in column 2, the municipal loan market HHI in column 3, the bank level weighted deposit (loan) market HHI in column 4 (5), and the bank-level weighted deposit (loan) market share in column 6 (7). All columns control for age group * salary group * education group fixed effects. Standard errors clustered by relationship in parentheses. * p<0.1, ** p < 0.05, *** p<0.01.

Online Tables

Appendix Table 1: Conversion and Deposit Pricing Robustness for Debtors Only

	(1) I(Loan)	(2) LN(FinalDebt)	(3) Dspread	(4) I(Loan)	(5) LN(FinalDebt)	(6) Dspread
I(Parent)	-0.022***	0.588***	-0.157***	-0.023***	0.456***	-0.135***
	(0.000)	(0.005)	(0.003)	(0.000)	(0.005)	(0.009)
I(Retired)	0.023***	-2.027***	-0.028***	0.032***	-1.043***	-0.029***
	(0.000)	(0.003)	(0.001)	(0.000)	(0.004)	(0.004)
Ln(Inc)	0.006***	0.787***	-0.009***	0.002***	0.547***	-0.014***
	(0.000)	(0.002)	(0.000)	(0.000)	(0.002)	(0.002)
Ln(Wealth)	0.001***	0.140***	-0.030***	0.001***	0.114***	-0.027***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.002)
Ln(Deposits)	0.003***	-0.042***	-0.005***	0.003***	-0.042***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
I(Age<30)	0.072***	0.649***	-0.265***	0.072***	0.611***	-0.282***
	(0.000)	(0.003)	(0.001)	(0.000)	(0.003)	(0.008)
HH's # of Banks	-0.016***	0.351***	-0.091***	-0.016***	0.308***	-0.082***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)
Multi-Product HH			0.089***			0.083***
			(0.001)			(0.010)
Constant	0.009***	-0.786***	1.627***	0.010***	2.748***	1.641***
	(0.001)	(0.020)	(0.004)	(0.001)	(0.025)	(0.014)
Observations	16'268'828	16'268'828	7'156'739	16'120'814	16'120'814	7'084'633
R2	0.055	0.138	0.029	0.063	0.155	0.043
M*S*E FE	N	N	N	Y	Y	Y
Cluster	Rel	Rel	Rel	M*S*E	M*S*E	M*S*E

This table repeats the estimations from Table on the subsample of households who hold debt with at least one counter-party in at least one of the years observed. Clustered standard errors in parentheses. * p<0.1, ** p < 0.05, *** p<0.01.

Appendix Table 2: Conversion and Deposit Pricing Robustness for Postcode Movers

	(1) I(Loan)	(2) LN(FinalDebt)	(3) Dspread	(4) I(Loan)	(5) LN(FinalDebt)	(6) Dspread
I(Parent)	-0.051***	0.619***	-0.241***	-0.050***	0.426***	-0.201***
	(0.000)	(0.008)	(0.005)	(0.000)	(0.008)	(0.010)
I(Retired)	-0.004***	-3.164***	-0.058***	0.016***	-1.705***	-0.056***
	(0.000)	(0.005)	(0.002)	(0.000)	(0.006)	(0.004)
Ln(Inc)	0.003***	0.811***	-0.010***	-0.002***	0.501***	-0.017***
	(0.000)	(0.002)	(0.001)	(0.000)	(0.003)	(0.002)
Ln(Wealth)	0.000***	0.050***	-0.030***	0.000***	0.009***	-0.026***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)
Ln(Deposits)	0.005***	-0.062***	-0.005***	0.005***	-0.060***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
I(Age<30)	0.086***	1.535***	-0.198***	0.083***	1.372***	-0.222***
	(0.000)	(0.004)	(0.002)	(0.000)	(0.004)	(0.007)
HH's # of Banks	-0.027***	0.532***	-0.092***	-0.027***	0.458***	-0.081***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)
Multi-Product HH			0.083***			0.079***
			(0.002)			(0.010)
Constant	0.128***	-0.756***	1.667***	0.214***	3.153***	1.675***
	(0.001)	(0.029)	(0.005)	(0.002)	(0.035)	(0.014)
Observations	8'037'148	8'037'148	3'680'822	7'967'085	7'967'085	3'648'899
R2	0.078	0.184	0.028	0.091	0.216	0.044
M*S*E FE	N	N	N	Y	Y	Y
Cluster	Rel	Rel	Rel	M*S*E	M*S*E	M*S*E

This table repeats the estimations from 4 on the subsample of households who move postcode areas, either within or across municipalities, at least once between we first observe their deposit account and their first loan with the same bank. Columns 4-6 include fixed effects for municipality by salary group by education group. Standard errors in columns 1-3 are clustered by household bank relationship, those in columns 4-6 by municipality by salary group by education group. * p<0.1, ** p < 0.05, *** p<0.01.

Appendix Table 3: Conversion and Deposit Pricing Robustness for Municipality Movers

	(1) I(Loan)	(2) LN(FinalDebt)	(3) Dspread	(4) I(Loan)	(5) LN(FinalDebt)	(6) Dspread
I(Parent)	-0.033***	0.382***	-0.188***	-0.029***	0.208***	-0.141***
	(0.000)	(0.007)	(0.004)	(0.000)	(0.007)	(0.008)
I(Retired)	0.020***	-1.428***	0.066***	0.014***	-0.586***	0.038***
	(0.000)	(0.006)	(0.002)	(0.000)	(0.006)	(0.005)
Ln(Inc)	-0.005***	0.631***	-0.024***	-0.005***	0.429***	-0.023***
	(0.000)	(0.002)	(0.001)	(0.000)	(0.003)	(0.003)
Ln(Wealth)	-0.001***	0.163***	-0.021***	0.001***	0.112***	-0.017***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)
Ln(Deposits)	0.005***	-0.039***	-0.005***	0.005***	-0.037***	-0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
I(Age<30)	0.061***	0.592***	-0.259***	0.058***	0.566***	-0.292***
	(0.000)	(0.004)	(0.002)	(0.000)	(0.004)	(0.007)
HH's # of Banks	-0.027***	0.318***	-0.100***	-0.025***	0.257***	-0.087***
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.002)
Multi-Product HH			0.073***			0.066***
			(0.002)			(0.010)
Constant	0.228***	1.125***	1.716***	0.223***	4.301***	1.641***
	(0.001)	(0.028)	(0.006)	(0.002)	(0.035)	(0.016)
Observations	7'264'316	7'264'316	2'975'270	7'170'649	7'170'649	2'934'841
R2	0.084	0.117	0.030	0.097	0.133	0.045
M*S*E FE	N	N	N	Y	Y	Y
Cluster	Rel	Rel	Rel	M*S*E	M*S*E	M*S*E

This table repeats the estimations from 4 on the subsample of households who move municipalities at least once between we first observe their deposit account and their first loan with the same bank. Columns 4-6 include fixed effects for municipality by salary group by education group. Standard errors in columns 1-3 are clustered by household bank relationship, those in columns 4-6 by municipality by salary group by education group. * p<0.1, ** p < 0.05, *** p<0.01.

Appendix Table 4: Conversion and Deposit Pricing Robustness for Densely Populated Municipalities

	(1) I(Loan)	(2) LN(FinalDebt)	(3) Dspread	(4) I(Loan)	(5) LN(FinalDebt)	(6) Dspread
I(Parent)	-0.045***	0.563***	-0.153***	-0.044***	0.380***	-0.130***
	(0.000)	(0.006)	(0.004)	(0.000)	(0.006)	(0.010)
I(Retired)	0.003***	-2.902***	-0.041***	0.019***	-1.499***	-0.032***
	(0.000)	(0.004)	(0.001)	(0.000)	(0.005)	(0.004)
Ln(Inc)	0.004***	0.788***	-0.011***	-0.001***	0.491***	-0.015***
	(0.000)	(0.002)	(0.000)	(0.000)	(0.002)	(0.002)
Ln(Wealth)	0.001***	0.109***	-0.028***	0.001***	0.059***	-0.027***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)
Ln(Deposits)	0.005***	-0.062***	-0.005***	0.005***	-0.059***	-0.004***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
I(Age<30)	0.089***	1.250***	-0.249***	0.085***	1.090***	-0.276***
	(0.000)	(0.003)	(0.001)	(0.000)	(0.003)	(0.008)
HH's # of Banks	-0.025***	0.551***	-0.088***	-0.026***	0.455***	-0.080***
	(0.000)	(0.001)	(0.000)	(0.000)	(0.001)	(0.002)
Multi-Product HH			0.074***			0.067***
			(0.001)			(0.011)
Constant	0.113***	-1.336***	1.624***	0.197***	2.964***	1.653***
	(0.001)	(0.020)	(0.004)	(0.001)	(0.025)	(0.014)
Observations	14'777'262	14'777'262	6'760'770	14'554'676	14'554'676	6'654'256
R2	0.073	0.176	0.027	0.085	0.203	0.040
M*S*E FE	N	N	N	Y	Y	Y
Cluster	Rel	Rel	Rel	M*S*E	M*S*E	M*S*E

This table repeats the estimations from Table on the subsample of households residing in municipalities with above-median population density. Columns 4-6 include fixed effects for municipality by salary group by education group. Standard errors in columns 1-3 are clustered by household bank relationship, those in columns 4-6 by municipality by salary group by education group. * p<0.1, ** p < 0.05, *** p<0.01.

Appendix Table 5: Conversion and Deposit Pricing Robustness for Low-Concentration Markets

	(1) I(Loan)	(2) LN(FinalDebt)	(3) Dspread	(4) I(Loan)	(5) LN(FinalDebt)	(6) Dspread
I(Parent)	-0.060***	0.334***	-0.178***	-0.060***	0.167***	-0.172***
	(0.001)	(0.017)	(0.009)	(0.001)	(0.016)	(0.011)
I(Retired)	-0.006***	-3.518***	-0.037***	0.025***	-1.920***	-0.009**
	(0.000)	(0.009)	(0.002)	(0.001)	(0.011)	(0.004)
Ln(Inc)	0.010***	0.941***	-0.006***	0.002***	0.608***	-0.015***
	(0.000)	(0.004)	(0.001)	(0.000)	(0.005)	(0.002)
Ln(Wealth)	0.001***	0.063***	-0.023***	0.001***	0.010***	-0.024***
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
Ln(Deposits)	0.006***	-0.079***	-0.007***	0.006***	-0.073***	-0.007***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
I(Age<30)	0.119***	1.969***	-0.235***	0.114***	1.655***	-0.252***
	(0.001)	(0.008)	(0.002)	(0.001)	(0.008)	(0.006)
HH's # of Banks	-0.032***	0.714***	-0.088***	-0.030***	0.594***	-0.083***
	(0.000)	(0.002)	(0.001)	(0.000)	(0.002)	(0.002)
Multi-Product HH			0.070***			0.084***
			(0.002)			(0.010)
Constant	0.024***	-4.028***	1.518***	-0.117***	0.899***	1.613***
	(0.003)	(0.052)	(0.008)	(0.004)	(0.068)	(0.016)
Observations	2'881'946	2'881'946	1'355'904	2'849'102	2'849'102	1'341'155
R2	0.102	0.219	0.025	0.120	0.256	0.042
M*S*E FE	N	N	N	Y	Y	Y
Cluster	Rel	Rel	Rel	M*S*E	M*S*E	M*S*E

This table repeats the estimations from Table on the subsample of households residing in municipalities with below-median deposit market concentration. Columns 4-6 include fixed effects for municipality by salary group by education group. Standard errors in columns 1-3 are clustered by household bank relationship, those in columns 4-6 by municipality by salary group by education group. * p<0.1, ** p < 0.05, *** p<0.01.

Appendix Table 6:Conversion Regressions with Different Methodology, Controls and Samples

A. Actually Observed Bank Household Relationship Only

	(1) I(Loan)	(2) I(Loan)	(3) I(Loan)	(4) I(Loan)	(5) I(Loan)	(6) I(Loan)
	Logit	Logit ME	Probit	Probit ME	LPM	LPM FE
I(Depositor)	0.689***	0.024***	0.299***	0.023***	0.022***	0.021***
	(0.002)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
Constant	-3.719***		-1.983***		0.024***	0.024***
	(0.001)		(0.001)		(0.000)	(0.000)
Observations	48'944'109	48'944'109	48'944'109	48'944'109	48'944'109	48'612'208

B. Filling In for Each Household Also Potential Relationships with All Other Banks In Town

	(1) I(Loan)	(2) I(Loan)	(3) I(Loan)	(4) I(Loan)	(5) I(Loan)	(6) I(Loan)
	Logit	Logit ME	Probit	Probit ME	LPM	LPM FE
I(Depositor)	0.758***	0.030***	0.333***	0.029***	0.027***	0.023***
	(0.002)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
Constant	-3.672***		-1.964***		0.025***	0.027***
	(0.001)		(0.001)		(0.000)	(0.000)
Observations	62'626'329	62'626'329	62'626'329	62'626'329	62'626'329	62'181'606

The upper panel uses only household bank relationships actually observed, while the bottom one fills in for each household also potential relationships with all other banks that serve at least one other household in that municipality. For simplicity we use as outcome only the borrowing propensity one year after each year for which we observe a deposit relationship. I both panels we display in column 1 Logit estimates, in 2 Logit marginal effects, in 3 Probit estimates and in 4 Probit marginal effects. Thereafter, 5 shows estimates of the linear probability model, while 6 includes, in contrast to any of the 5 previous columns, fixed effects for municipality * education group * salary group * age group. Clustered standard errors in parentheses. * p<0.1, ** p < 0.05, *** p<0.01.