# Monetary Policy Transmission Through Cross-Selling Banks

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We show theoretically and empirically how banks' opportunities to cross-sell their depositors loans affect monetary policy transmission. Expected later lending profits motivate banks to accept lower deposit spreads now to onboard and retain depositors, more the lower policy rates and the greater a bank's cross-selling opportunities. With data on the universe of Norwegian bank household relationships, we exploit that loan cross-sales vary with demographics and so across municipalities. Comparing municipalities within each bank-year, thus with fixed refinancing needs, we find that banks with greater deposit-loan-conversion cut deposit spreads more following policy rate cuts and exhibit higher deposit and loan growth.

**Keywords:** deposit pricing, deposit spread, deposit channel of monetary policy, cross-selling, multi-product banking, multi-period banking

**JEL Classification:** D14, D43, E52, G21, G51

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# 1 Introduction

Since many central banks started raising policy rates in 2022, a large public discussion ensued on the limited pass-through from policy to deposit rates. One predominant narrative is that the resulting positive deposit spread reflects bank market power, as formalized e.g. in the "Monti-Klein model" of banking (e.g. Freixas and Rochet 2008). Drechsler, Savov, and Schnabl (2017), henceforth DSS 2017, took this further and showed how deposit market power, which they empirically approximated as deposit market concentration, allows banks not only to earn on average a positive deposit spread, but leads them also to adjust deposit rates less than 1-1 with policy rates, resulting in a *deposit beta (DB)* below 1[1] and a positive *deposit spread beta (DSB)*. This positive DSB has been argued to be one of the key ways in which banks can hedge against the decreases of their fixed-rate asset values that occur when policy rates rise (Drechsler, Savov, and Schnabl 2021; Drechsler et al. 2023).

In this paper we explore the determinants of the DSB, focusing on one particular, novel source of bank market power which we refer to as *cross-selling.* Cross-selling refers to the case when banks sell future services, such as future mortgages, to existing depositors due to a depositor preference for having bank products at the same bank. Such cross-selling was initially explored in Basten and Juelsrud (2023), henceforth BJ 2023, who showed that an existing deposit relationship makes a household about 20 percentage points (pp) more likely to later cross-buy a mortgage from the same bank, compared to an otherwise comparable household with no deposits at that bank. They also showed that depositors' hesitance to switch banks allows banks to charge a premium on such cross-selling, and that this is driven by depositor demand rather than bank supply. In this paper, we explore the implications of this form of market power for the DSB from a theoretical and empirical point of view. We show that cross-selling is a source of market power for banks which explains a significant fraction of variation in the DSB. We find variation in cross-selling quantitatively at least 10 times as important for understanding variation in the DSB as more traditional measures of bank market power like deposit market shares or the Herfindahl Hirschmann Index (HHI).

[1] Greenwald, Schulhofer-Wohl, and Younger (2023), GSY 2023, recently showed that in practice deposit betas may be increasing in market rates. This could more strongly reduce banks' incentives to lend (GSY 2023) or weaken the increase in deposit spread betas and hence the reduction in deposit and resulting loan volumes in the DSS 2017 lens, thus either strengthening or weakening monetary policy transmission. Given our focus on cross-selling incentives rather than deposit profits alone, we ignore this at the baseline although different estimates for different policy rate levels between 50bp and 500bp are an easy extension.

Our analysis consists of four steps. First, we theoretically analyze how cross-selling affects the DSB. We build a simple model of a monopolistic bank similar to the Monti-Klein model and DSS 2017, and focus on the determinants of deposit spreads set by that bank, where the latter is defined as the policy rate minus the deposit rate. In line with the empirical results in BJ 2023, we model cross-selling opportunities as a positive relationship between deposit volumes today and future loan volumes. Deposit supply is modeled as an increasing function of deposit rates, alternatively a decreasing function of the deposit spread in line with DSS 2017. When setting the deposit spread, the bank trades off the marginal cost of a lower deposit volume *and* future cross-selling profits against the marginal benefit of higher deposit margins today. As a result, the optimal deposit rate is a mark-down over the policy rate that depends not only on current deposit market power as in standard models, but also on the net present value of expected future cross-selling profits. The key theoretical result is that cross-selling dampens the impact of policy rate changes on deposit rates and thereby increases the response of deposit spreads to policy rates, i.e. it increases a bank's DSB. Cross-selling affects the DSB through two distinct channels. First, when the policy rate increases, future cross-selling profits are discounted more. As a result, the marginal benefit of accepting lower deposit spreads in return for higher future cross-selling profits on the clients thus onboarded or retained declines. Second, we show that empirically the loan spread is declining in policy rates. When policy rates increase, also the flow profits from cross-selling a loan in the future decline ceteris paribus. As a result, monetary policy affects the present value of cross-selling through both cross-selling margins and the discounting thereof. Both factors reduce the marginal benefit of attracting a depositor, which in turn implies a lower pass-through to deposit rates and a higher DSB.

Second, we assemble a rich annual dataset on the population of household depositors and borrowers for Norway for the period 2004 – 2018 with the ultimate purpose of testing the theoretical predictions from the first step, i.e. whether cross-selling intensity affects the DSB both qualitatively and quantitatively. The data allow us to also link a rich set of demographics, balance sheet and income statement variables for all households. This is crucial, as key determinants of cross-selling potential are demographics (BJ 2023). For instance, especially younger households are associated with higher cross-selling potential. For each bank-municipality pair, we compute measures of a bank's potential to sell its depositors future loans. Specifically, we compute different expectations of future borrowing relative to current deposits for all clients of a bank. Our measures are meant to pragmatically capture how many Norwegian Kroners (NOK) in future loans 1 NOK of deposits generate from the bank's perspective. In line with BJ 2023, we show that there is a large degree of cross-selling and that – importantly – there is sizable variation in these cross-selling measures across bank municipality pairs, primarily reflecting the demographic composition of the area.

So we explore whether this variation in cross-selling opportunities affects the DSB. We run this analysis at the bank-municipality-year (BMY) level. We compare the importance of our cross-selling measures compared to more traditional measures of bank market power such as market shares or the Herfindahl Hirschmann Index. Our first key result is to show that cross-selling is important, both qualitatively and quantitatively, for understanding variation in the DSB. Quantitatively, variation in cross-selling proxies explains at least 10 times as much of the dispersion in the DSB as variation in banks' deposit market shares. Consistent with this, we show that cross-selling proxies matter quantitatively also for deposit growth.

We take numerous steps to explore the robustness of these finding. A key empirical challenge is that banks' willingness to pay for deposits might depend on refinancing needs following from current bank lending opportunities. When policy rates go up, it is plausible that lending opportunities decrease. This in turn can affect banks' willingness to compete for deposits. To the extent that banks with higher cross-selling opportunities experience a larger decline in lending opportunities when policy rates go up, this could confound our estimates. To deal with this issue, we focus on a narrow within-bank-year analysis. In this analysis, all of the results remain economically and statistically significant. We also conduct further robustness checks and analyses, including using different measures of cross-selling, different ways to aggregate these from the bank-household to the bank-municipality level, comparing cross-selling to other measures of bank market power, and different ways to compute the outcome deposit growth.

Third, we explore the channels through which cross-selling affects the DSB. In line with the conceptual framework discussed above, we focus on two channels: future loan profits and their discounting. While we cannot rule out that discounting is part of the way through which cross-selling affects the DSB, we show that empirically future loan profits are even more substantially affected. A 100 basis point (bp) increase in policy rates decreases future loan spreads by up to 50 bp. Given the sheer size of future loans, this constitutes a large reduction in expected profits from selling a loan to an existing depositor.

Fourth, we show that variation in deposit spread changes and resulting variation in deposit growth leads also to variation in loan growth and so in monetary policy transmission.

Instrumenting deposit growth with cross-selling and deposit profit drivers of a bank's DSB, we find each percentage point (pp) of additional deposit growth associated with half a percentage point of additional loan growth.

*Contributions to the Existing Literature*

Our paper contributes chiefly to three strands of the literature. First, a large literature has explored the transmission of monetary policy. Recently, an influential part of this literature is the strand on the Deposits Channel of Monetary Policy (DSS 2017, Begenau and Stafford 2021, Drechsler, Savov, and Schnabl 2021, Drechsler et al. 2023). One key insight of that literature is that the response of deposit pricing and flows to policy rate changes may be key for understanding how monetary policy transmits to the real economy. Our paper contributes to that literature, by being the first to explore how cross-selling affects the response of deposit pricing and deposit flows, and ultimately lending, to monetary policy. As such, our paper provides a new perspective on the determinants of bank market power and on how bank market power affects monetary policy transmission through banks.

Second, we contribute to the broader literature in industrial organization which shows the value to firms of onboarding clients at lower prices for the sake of higher follow-on profits after lock-in, see e.g. Klemperer (1995) for a theoretical and general motivation, or Carbo-Valverde, Hannan, and Rodriguez-Fernandez (2011) for a more specific empirical application to the bank deposit market. Motivated by the findings of BJ (2023), we contribute to the literature by elucidating how that trade-off changes with current policy and resulting discount rates and may thus matter for monetary policy transmission.[2]

Third, we contribute to the merging literature on how cross-selling of different products to the same bank clients connects asset and liability side of the bank balance sheet within individual bank client relationships (BJ 2023, Qi 2023). The rest of the paper is structured as follows: Section 2 outlines our theoretical framework. Section 3 discusses the data and Section 4 our empirical strategy. Section 5 presents our empirical results and Section 6 concludes.

[2] A separate literature has emphasized the benefits of multi-period or relationship banking of reducing asymmetric information problems in bank lending, see e.g. Norden and Weber (2010), Neuhann and Saidi (2018), Berger et al. (forthcoming), or Qi (2023). As BJ 2023 found a limited role for this in the collateralized and standardized mortgage lending to households, we do not discuss this in more detail here.

## 2 Conceptual Framework

In this section, we outline a conceptual framework which theoretically analyzes how future cross-selling opportunities affect deposit pricing today. The purpose of this section is to motivate the key testable predictions that we later test in the data.

Consider the following model. There are two periods, "today" and "tomorrow". Banks set deposit rates $r_d$, which ultimately also affect the spread $s_d = r - r_d$ between deposit rates and the policy rate $r$, where the latter is exogenous. We consider a monopolistically competitive bank, which is facing a downward sloping demand curve for deposit savings $D(s_d)$ today.

Tomorrow, part of the bank's depositors generates cross-selling profits. This is in line with BJ 2023, who document that for demand-driven reasons a Norwegian household is about 20 pp more likely to cross-buy a loan from their deposit bank than an otherwise identical household would be to borrow from an otherwise identical bank if they have no prior deposit relationship there. A priori, cross-selling of other banking products such as wealth management advice, transaction services or credit cards, seems also plausible but BJ 2023 had no suitable data to analyze this empirically. Denoting the loan volume, which can be zero, as $L$ and the loan spread between loan and policy rate (given mostly adjustable rate loans, see BJ 2023) as $l$, this implies future cross-selling profits $L*l$.[3] We assume that future loan volumes $L$ are an increasing and concave function of the deposit volume $D$, as a higher deposit rate (lower spread) today attracts more depositors, some of whom demand a loan tomorrow.

With cross-selling, banks set deposit spreads considering both profits on deposits *today* and cross-selling profits tomorrow. The bank is risk-neutral and discounts future cross-selling profits at the discount rate $\frac{1}{1+r}$. It is convenient to focus on banks' choice of deposit rate $r_d$, which also fully determines the deposit spread $s_d$. The optimization problem of the bank can then be written as

$$\max_{r_d} \ (r - r_d) * D(r - r_d) \ + \frac{1}{1+r} * l(r) * L\big(D(r - r_d)\big) \qquad (1)$$

[3] BJ 2023 show also cross-selling of future deposits to current depositors, or depositor stickiness, but cross-selling of loans yields on average both greater volumes and higher spreads. Therefore we omit here the term for profits from future deposits, but note that it would not change our key analyses.

The first part of the bank's objective function is the standard monopolistic bank objective function (see e.g. Freixas and Rochet 2008, or DSS 2017), whereas the second part comes from cross-selling opportunities. The net present value of cross-selling depends on current policy rates in potentially two ways.

First, as BJ 2023 showed cross-selling profits in a bank household relationship to occur on average only several years after the client has been onboarded as a depositor, cross-selling profits are discounted at a rate that can be approximated with the current policy rate r. Depending on how many years in the future cross-selling profits are expected to occur, banks may in fact want to discount at a rate with maturity longer than the overnight maturity of the policy rate, where the exact maturity may vary across banks, times, clients or products and is unobservable to us. Given an on average positive correlation between overnight and longer maturity rates, in this conceptual framework we focus on the policy rate, but ***Figure 1*** shows positive DBSs also when relating the deposit spread to the 5- or 10-year government bond rate.

Second, given findings of a link between policy rates and loan spreads in prior work, for example Delis, Hasan, and Mylonidis (2017), we allow also loan spreads to vary with the policy rate here, and we will examine empirically below how loan spreads and loan incidence do vary with policy rates in our setup. In line with the empirical evidence presented below, the most relevant case is when loan spreads depend negatively on the policy rate, i.e. $l' < 0$.

In general, when setting deposit spreads, the bank trades off the marginal cost of a lower deposit spread with the marginal benefit of a net deposit *inflow*. Assuming a constant elasticity of deposit demand with respect to the deposit spread $\epsilon_d$, it is straightforward to show that the optimal deposit rate is then implicitly defined by

$$r_d^* = 1/\mu\left(r + \frac{1}{1+r} l(r) L'\big(D(r - r_d^*)\big)\right) \qquad (2)$$

where $1/\mu \equiv \frac{\epsilon_d}{\epsilon_d + 1}$ is the markdown on deposits.

Armed with this equation, it is straightforward to derive the *deposit spread beta DSB* as the marginal effect of a change in the policy rate on the deposit spread. This is formalized in Proposition 1 below, which contains our key testable predictions.

**Proposition 1.** *(Comparative statics on DSB). The deposit spread beta DSB is given by*

$$DSB \equiv \frac{\partial s}{\partial r} = 1 - \frac{\partial r_d}{\partial r} = 1 - \frac{1/\mu\left(1-\frac{1}{1+r}L'\left(D\left(r-r_d^*\right)\right)\left(\frac{1}{(1+r)}l(r)-l'(r)\right)\right)}{1-\frac{1}{(1+r)\mu}l(r)L''\left(D\left(r-r_d^*\right)\right)D'\left(r-r_d^*\right)} \tag{3}$$

*and is*

a. *increasing in deposit market power* $\mu$

b. *increasing in market power from cross-selling loans* $L'\left(D\left(r_d^*\right)\right)$.

***Proof:*** This follows from the Implicit Function Theorem to Equation (2).

Why does cross-selling increase the DSB? The intuition is as follows. When the policy rate increases, the net present value of future cross-selling potential declines both because of higher discounting and potentially lower loan spreads. As a result, the marginal benefit of increasing deposit rates declines, the pass-through to deposit rates is lower, and deposit spreads increase.

## 3 Data and Summary Statistics

Here we describe the main data sources and the measurement of key variables, before providing and discussing some summary statistics of the variables most relevant to our analysis.

### 3.1 Data Sources and Preparation

Our raw dataset is largely similar to that used in BJ 2023 and builds on three different sources.

*Deposit and loan accounts*

The first data source is relationship-level data on all household-bank pairs for the period 2004 – 2018. It covers the population of Norwegian individuals and banks, and contains information on outstanding deposit and loan balances, in addition to interest paid and interest received over the course of the year. The data is annual and reported at the end of the year. The data is reported by banks and is required by Norwegian authorities for tax purposes. As described in BJ 2023, roughly 85 % of the loans in Norway to households are mortgages, while more than 99 % of the outstanding deposits covered by our data have a maturity of less than a year. Importantly, these data include relationship level deposit and loan amounts, and *effective* rates and spreads.

*Other household information*

The second data source is a comprehensive account of individual-level information for all Norwegian tax payers. At an annual frequency, we observe balance sheet and income statement information. We also observe various pieces of demographic information, including postcode of residence, age and education. The data covers the period 2004 – 2018.

*Bank-level information*

Third, we add bank-level information from the supervisory database ORBOF, which contains all major balance sheet and income statement variables for all banks operating in Norway.

*Combining the data*

All data sources described above have individual identifiers, both for individuals and for banks. Moreover, all individuals can be combined into unique households. Following BJ 2023, we first aggregate information from individual-bank relationships to household-bank relationships. After having created some key statistics described below, we then aggregate deposit volumes (as sum), deposit spreads (as mean), market shares (as sum) and conversion information (as averages) to the bank municipality year (BMY) level in line with our identification strategy described in more detail in Section 4 below.

### 3.2 Variable Definitions

*Cross-selling indicators*

A key variable for us at the bank-household level, later aggregated to the bank-municipality level, is a measure of cross-selling of loans to depositors. As the profitability thereof depends on the (loan spread times the) loan volume, while the cost of onboarding and retaining a depositor before depends on the (deposit spread times the) deposit volume, we measure this with the ratio of loan over deposit amount. At the baseline we use the mean positive loan amount across all relationship years we observe, scaled by the deposit amount at onboarding. Variations use the maximum or final year loan amount, or scale by the average deposit amount in a relationship. As some initial or average deposit amounts are rather small relative to loan amounts, this ratio exhibits a skewed distribution. Therefore we use its natural log, or equivalently use the difference between logged loan volume and logged deposit volume.

*Measuring market power*

Given the importance of bank market power in both the existing theoretical and empirical literature on bank deposit pricing, we focus on each bank's market shares in local deposit markets across municipality-years. As an alternative, we follow DSS 2017 and use deposit market HHI, i.e. the sum of squared market shares in each municipality. We note, however, that given the granularity of our data, focusing on market shares yields bank-municipality-year variation, whereas HHIs vary only by municipality and year but not simultaneously by bank.

### 3.3 Summary Statistics

***Table 1*** presents our Summary Statistics at the BMY level. The setup contains up to 165 banks and up to 439 municipalities over the period 2004 - 2018, or 2005-18 when the outcome of interest is a change, yielding a priori a bit over 72'000 bank-municipality combinations and a bit over 1 mio. bank municipality year observations. In practice, most banks have clients only in a subset of municipalities and years so that our baseline analyses can draw on about 340'000 observations. We see that during the 14 years we can use for our analysis the policy rate varied between 0.5 and 5.32pp. Year-on-year changes in the policy rate ranged from -3.375 to +1.75pp. These changes induced banks to vary the effective deposit spread averaged by BMY, between -12.883 and +12.072 and on average -0.038pp, and this resulted in deposit growth in the average BMY cell of 7.8% using a log-difference approximation, or 1.4% using a symmetric growth approximation. Both growth measures include also very large values coming especially from BMY cells with few clients. Therefore we test whether results are robust to using different growth rate computations and find them to be so. Our baseline measure for loan growth is observed in only about one-sixth as many BMY cells as deposit growth, as many BM pairs contain in some years positive deposit but zero loan volumes so that log volumes and the log difference approximation to growth rates is not defined. It averages 3.8% p.a. Conversion on our baseline measure averages 97%, meaning that in the average relationship the mean positive loan volume is about twice as large as the initial deposit volume. Scaling by mean rather than first or onboarding deposits yields similar ranges but slightly negative means, reflecting that mean deposit volumes including that just prior and in the year of loan initiation, tend to be larger than initial deposit volumes. While all four of these measures aggregate conversion from relationship to BM level weighting by the mean deposit volume in each relationship, the next four lines show unweighted averages and here all four means are higher than their weighted analogues. So relationships with smaller deposit volumes exhibit on average larger conversion. Finally, the last two lines show that the mean bank has a 1.5% market share in its  mean municipality, and the mean municipality exhibits a HHI of 37.8%.

# 4 Empirical Strategy

## 4.1 Analyzing deposit pricing and growth

The focus of our empirical analysis of deposit pricing and growth is to explore the role of cross-selling. We contrast the impact of cross-selling with more traditional measures of bank market power such as market shares. A key empirical challenge is to hold fixed a bank's refinancing needs or "lending opportunities". Those are likely to change with policy rate changes. For instance, an increase in the policy rate could reflect high lending opportunities, or even, to the extent that monetary policy has a relatively fast transmission, reflect lower lending opportunities. Lending opportunities in turn could affect banks' need for financing and hence their deposit pricing. To the extent that these are not randomly allocated across banks, they could also confound our estimates.

This empirical challenge is not new and has in the literature been addressed by Drechsler, Savov, and Schnabl (2017) by comparing the deposit pricing of US bank branches within the same bank, arguing that deposit prices may vary across branches within the same bank while deposits raised are then pooled at the bank level to refinance lending. More recently, Begenau and Stafford (2021) have criticized this strategy for the reason that many US banks, including some of the largest ones, may not set branch-specific deposit prices, thus possibly limiting the external validity of the DSS 2017 strategy to banks with branch-specific deposit pricing.

Our new identification approach is to exploit two key findings of BJ 2023: First, while the Norwegian banks we study in this paper do to our knowledge not explicitly set different deposit rates for different branches, they do offer accounts with different rates and different eligibility criteria such as age, consistent with offering more attractive deposit prices to potential new clients who are more likely to cross-buy other banking products later. In addition to banks' offers varying across demographics, different demographics may be differently eager to switch accounts within their bank, or even to switch banks, to earn more deposit interest. Both of these lead to the BJ 2023 observation that effective deposit spreads vary with demographics.

This correlation then translates into different deposit spread distributions across different municipalities within each bank, as municipalities differ inter alia by their age distribution. The two mechanisms together result in us observing significant differences in deposit spreads across municipalities within banks, while we argue that we can expect Norwegian banks to pool their funding at the bank level. As such, we control for bank lending opportunities by adopting a within bank-year analysis.

To gauge the plausibility of this approach, we note that there are no geographical restrictions on internal capital markets in banks. In addition, it is useful to check how geographically diversified the average bank in our sample is. For a bank active in only 1 or 2 municipalities would arguably have very limited potential to redistribute deposit funding from one municipality to finance lending in another. To check this, we start by examining the number of municipalities across which the business of each of the banks in our sample is spread out. While this number does range all the way from 1 to 439, the 5$^{th}$ percentile is already 42 municipalities, the median is 340 and the mean 329 municipalities.

On these grounds our baseline estimation takes the following form:

$$Y_{b,m,y} = \alpha + \beta_1 \ * \Delta PR_y \ * MS_{b,m} + \beta_2 \ * \Delta PR_y \ * CS_{b,m} + \delta_{b,y} + \varepsilon_{b,m,y} \qquad (4)$$

where the subscript *b* stands for bank, *m* for municipality, and *y* for year. Our key outcomes of interest are deposit spread changes and deposit growth. Policy rate changes are denoted $\Delta PR$ and are computed at the year level, while the relevant market share MS and cross-selling CS variables are computed at the bank-municipality level.

The bank-year fixed effects $\delta_{b,y}$ control for lending opportunities pooled at the bank level. At the same time, a comparison across municipalities but within each bank accounts for the fact that on average different banks may select into different types of municipalities, as in the observation by d'Avernas et al. (2023) that in the US larger banks are often present in more urban areas where they sell deposits at higher prices but with greater liquidity services.

### 4.2 Linking borrowing propensity and spread to policy rates

Our conceptual framework made it clear that lower policy rates are associated with on average lower discounting of future cross-selling profits and this alone should lead banks to choose bigger discounts on their deposit spreads, but the flow profit of this cross-selling may also vary with policy rates depending on how policy rates are associated with borrowing propensity and spread. For this analysis we are not necessarily interested in inter-municipality variation, nor do we need to average across a sufficient number of relationships to obtain meaningful growth rates. Therefore we analyze these relationships at the more granular relationship rather than at the bank municipality level. At the baseline we control for bank-municipality fixed effects, although we note that not doing so yields qualitatively very similar estimates.

### 4.3 Analyzing implications for loan growth

By the arguments made above, whereby deposit pricing may coincidentally vary across municipalities while lending opportunities are pooled at the bank level, the use of bank-year fixed effects alone may not suffice to control for lending opportunities when analyzing the outcome loan growth. Therefore our analysis of loan growth outcomes relates loan growth not to all variation in deposit growth but only to the part thereof explained by the deposit market behavior of interest, i.e. to deposit pricing responses to policy rate changes explained by either cross-selling strategies or market power within deposit markets. By so instrumenting deposit growth with the component explained by the interactions of policy rate changes with deposit loan conversion and deposit market shares, we seek to exclude the variation in deposit growth that may inter alia be caused by the omitted variable lending opportunities.

# 5 Results

In the following, we start in ***Subsection 5.1*** by discussing the presence of positive DSB in Norway and showing the large heterogeneity therein which we shall later discuss through the lense of cross-selling. We then in ***Subsection 5.2*** present how this differs across banks with different cross-selling intensity as well as across banks with different deposit market shares. Thereafter, ***Subsection 5.3*** analyzes the channels through which cross-selling affects the DSB, before ***Subsection 5.4*** explores the implications of deposit pricing and growth for loan growth. ***Subsection 5.5*** concludes by discussing our extensive set of robustness checks.

## 5.1 Average effects of policy rate changes

***Table 2*** starts by investigating the effects of policy rate changes on deposit spread changes (columns 1 and 2) and deposit growth (columns 3 and 4) across all banks. We show for either outcome first the results obtained without controls and then those obtained using bank fixed effects, i.e. comparing responses to different policy rate changes across years but within the same bank and hence within largely the same business model and strategy. Since the unit of observation is bank-year, here we cannot include bank-year fixed effects and hence cannot distinguish to what extent changes in deposit pricing and volumes are deposit market power, cross-selling or a third omitted factor such as refinancing needs. Instead the coefficients obtained here may stem from any combination of these three channels. Yet the presence of a relationship between policy rate changes and the deposit market would seem a precondition for the existence of any type of Deposit Channel of Monetary Policy.

In columns 1 and 2, we show that a 100bp policy rate hike (cut) is on average associated with a 30bp deposit spread increase (decrease) within the same calendar year. Put differently, deposit rates are on average increased (decreased) by no more than 70% of the policy rate change, at least within the same calendar year.

In the language of DSS 2017, this value of about 30% may be deemed an average DSB of Norwegian banks, although with regression observations here coming from each bank-municipality-year cell, it is a weighted average, essentially weighting each bank with the number of municipalit- year combinations in which it serves at least one household client. In columns 3 and 4 of ***Table 2,*** we show that the price response is associated also with quantity adjustments: the growth of deposits is reduced by between 0.6 and 1.25pp for each 100bp increase in policy rates.

Next, ***Figure 3*** shows the results in ***Table 2*** to mask substantial heterogeneity. In that figure, we show the distribution of the DSB across banks, weighting each bank equally. We find the DSB to range from close to zero to more than 1.5. Below, we explore the role of cross-selling in understanding this heterogeneity and compare the impact of cross-selling to other, more traditional measures of market power.

### 5.2 Effects by Deposit-Loan Cross-Selling and Deposit Market Power

***Table 3*** starts in column 1 by exploring how the DSB varies with a bank's deposit loan conversion. For each percentage point by which the expected mean positive loan amount in a bank's household relationships exceeds the first-year deposit amount, the DSB is (rounded to 2 digits) 2pp higher before we control for bank lending opportunities in the form of bank-year fixed effects. Once we do control for those in column 2, the coefficient falls to 1pp, but remains both statistically and economically significant. In particular, one standard deviation (SD) of about 4.7 of our conversion variable is associated with a 0.01*4.7 = 0.047pp or 4.7bp higher DS increase and hence with a 4.7bp higher DSB. Compared to this, column 3 finds each percentage point extra municipal deposit market share associated with a 0.45pp higher DSB, which given a SD of 0.01 or 1pp market share implies an increase of the DSB by 0.45*0.01 = 0.0045pp or 0.45bp. As such, a 1SD increase in market power as captured by the market share affects the DSB by only about 10% of the effect of a 1SD increase in deposit loan conversion. When in column 4 we include interactions of the policy rate change with both conversion and deposit market share at the same time, the coefficient on market share increases marginally from 0.45 to 0.47, that on conversion stays unchanged.

That said, columns 5-8 repeat the same exercises for the outcome deposit growth. Column 5 finds each percentage point of higher conversion associated with 0.46pp lower deposit growth. This increases to 0.50pp when in column 6 we control for bank-year fixed effects, and to 0.51pp when our preferred specification in column 8 includes additionally the interaction of policy rate changes with the deposit market share. This means that a 1SD higher conversion (4.7) is associated with 4.7*0.5 = 2.35pp lower deposit growth. Compared to that, a 1 SD (0.01 units) higher deposit market share is associated with a deposit growth reduction by 0.01*12.85 =

0.13pp, only about 5% as large and, in contrast to the effect of market share on pricing, not statistically significant.

Taking stock, both market shares and deposit loan conversion explain the cross-sectional variation of the DSB across banks. Quantitatively, deposit loan conversion seems to matter even more than market share, suggesting that deposit loan conversion is an important factor for understanding how banks adjust deposit pricing in response to monetary policy.

### 5.3 Why Does Cross-Selling Affect the Deposit Spread Beta?

When discussing our Conceptual Framework in Section 2, we pointed out that cross-selling incentives and resulting deposit spreads may be related to current policy rates both because of the discounting of future cross-selling profits and because monetary policy might affect the flow profit from lending. The analyses discussed so far have essentially explored the net effect of policy rates on deposit spreads.

In ***Table 4,*** we next explore whether not only how deposit spreads but also how loan spreads are empirically related to policy rates. We also explore whether the policy rate affects the incidence of deposit-loan conversion. For this, we do not need to exploit inter-municipality variation in demographics, nor do we need to control for banks' refinancing needs, and so these regressions follow BJ 2023 in using observations at the even more granular level of individual bank-household relationships for each calendar year. As we are explicitly interested in policy rate levels and changes here, we cannot use year fixed effects, but we can and do use bank-municipality fixed effects. For space reasons, our table focuses on results from the most conservative specification, with bank-municipality fixed effects, but we note that using only fixed effects for bank or for municipality or for neither yields similar results. Furthermore, for robustness we use both policy rate levels and changes on the right-hand side.

Column 1 (2) shows that a 1pp higher policy rate (change) is associated with a 3pp (0.7pp) higher borrowing propensity, and column 5 (6) finds it also associated with a 58 (34) bp lower loan spread. However, BJ 2023 showed that the average household in our sample starts borrowing only about 5 years after first bringing deposits to their bank.[4] Therefore we relate borrowing propensity and conditions in the first loan year not only to policy rates in the

[4] The mean "wait time" between first observed loan year (if any) and first observed deposit year across all relationships in our sample is 4.2 years. This will be downward-biased as relationships we first observe in our first sample year 2004 may have started earlier. Therefore we use 5 years as an approximation.

concurrent year but also to those in the onboarding year. Given the time lag between those years, here the link is weaker, but it maintains the same direction and statistical significance. In particular, column 3 (4) finds a 100pp higher policy rate level (change) in the onboarding year associated with a 0.3 (0.1) pp higher propensity to borrow later, while column 7 (8) finds it associated with a 12.6 (6.4) bp lower loan spread.

What can we infer from these coefficients? The positive association between policy rate and borrowing propensity in column 1 need not yet reflect a causal effect of policy rates on borrowing propensity. In fact, we would expect a causal effect to more likely have the opposite sign. By contrast, we attribute it to the fact that central banks will often raise (cut) policy rates when they deem bank lending excessive (insufficient). To the extent to which this monetary policy is effective, we would expect the causal effect of policy rates on borrowing propensities to be negative, and if we relate monetary policy in the onboarding year to whether that household will ever borrow from that bank in any of the years we observe, we find the positive association to fall to about one-tenth of the concurrent one. Then a 1 SD or 1.3pp (1.1) higher PR level (change) is associated with a 0.4 (0.1) higher borrowing propensity. That seems economically negligeable, even if the large sample size results in statistical significance. We attribute this finding to the fact that whether and when a household decides to buy a home may at least for the majority of households depend significantly also on that household's lifecycle stage including job security and family situation and hence less on policy rates. Relatedly, whether the household switches banks or stays with their deposit bank may depend a lot also on the household characteristics analyzed in BJ 2023 and hence less on current policy rates.

By contrast, effects on loan profitability for the bank are economically very significant. To start with, the coefficient in column 5 implies that a 1SD or 1.3pp higher (lower) policy rate is associated with a 0.75pp lower (higher) concurrent loan spread, also visualized in the upper panel of ***Figure 4***. In principle, part of this relationship may be due to fixed-rate loans preventing instantaneous loan rate adjustments because the loan spreads we observe here are effective ones on all loans, not just those offered on new loans. In practice, Imf (2012) reports most Norwegian household loans to be adjustable rate.

And in line with that we find the association with loan spreads on loans started a few years later to be only about one-fifth as big: The coefficient in column 7 implies that a 1SD or 1.3pp higher (lower) policy rate is associated with a 16 bp lower (higher) loan spread, visualized in the lower panel of ***Figure 4.*** Hence in the setup studied the difference in loan spread effects of policy rate changes between concurrent and cross-sold loans can be explained pretty much with the still positive but reduced persistence of policy rate increases, rather than with loan rate fixation before the policy rate change.

Quantitatively, the effect on future loan spreads is likely to be important for the overall net present value of a deposit relationship. For instance, BJ 2023 report an average loan volume of NOK 160k, an average loan spread of 1.54 pp, an average policy rate of 1.82 pp, and an average wait time between depositor onboarding and the first loan year of about 5 years. Starting from these means would yield discounted cross-selling profits of $(1/1.0182)^5$*0.0154*160k or about NOK 2'250 for the first loan year alone. If we now discount that by a 100 bp higher policy rate, it falls by about 100NOK or 4.7%. By comparison, decreasing loan spreads by about 13bp in response to a 100bp higher policy rate (***Table 6***, column 7) would decrease the cross-selling term by about NOK 190 or 8.4%. Hence the "loan spread sub-channel" is about twice as important as the "discounting sub-channel", despite the on average 5 years between depositor onboarding and borrowing and despite the predominance of adjustable rate loans.

### 5.4 Implications for Loan Growth

***Table 5*** analyzes the implications of the ***Table 3*** analyses for loan growth and thereby for the real economy. As a benchmark, column 1 estimates an "Endogenous Regression" (ER) by relating loan growth in each BMY cell to deposit growth therein and finds each percentage point of additional deposit growth associated with 0.67pp higher loan growth, or 0.65pp when we control for bank-year fixed effects (column 2). Yet this association is not guaranteed to isolate a causal effect from deposit to loan growth, because loan demand as an omitted variable may lead to both higher loan growth and also lead banks to offer lower deposit spreads and thereby intentionally increase deposit growth. To address this, Column 3 estimates an Instrumental Variable (IV) regression of loan growth on deposit growth instrumented with the interactions of policy rate changes with conversion and deposit market share. The underlying first stage (FS) here is essentially the same as the estimates displayed in ***Table 3***, column 8. When using only that part in the variation in deposit growth which is explained by deposit and cross-selling profit optimization, the association between deposit and loan growth falls by about one third from 0.65 to 0.49pp, but it so remains both statistically and economically significant. This confirms the findings already made by DSS 2017 that banks' deposit market behavior matters for their lending and so for the real economy, also when said deposit market behavior has been shown above to optimize not only deposit but also cross-selling profits.

### 5.5 Robustness Checks

Here we briefly discuss the extensive battery of robustness checks on our core results, which we present in our Online Appendix. To start with, ***Appendix Table (AT) 1*** follows amongst others DSS 2017 in measuring deposit market power with the sum of squared market shares (HHI) in each municipal market, rather than with the pricing bank's own market share. While, given our granular data, we prefer to use the acting bank's own market share for our baseline estimations, it is comforting to see that using instead the HHI yields very similar results. In particular, the effect of the policy rate (PR) change interacted with conversion in column 4 remains unchanged at 0.007 when we control for the interaction with deposit market HHI rather than with market shares, and the corresponding effect on deposit growth in column 8 falls merely from -0.496 to -0.494. As in our baseline analysis in ***Table 3***, we find deposit market concentration to also have its own statistically significant effect on deposit pricing, whereas the effect on deposit growth is not statistically significant. While we prefer to measure market power within the deposit market with market shares due to its variation also across banks within each municipality, we take these additional analyses to confirm our baseline ones.

Next, ***AT2*** uses alternative conversion measures. While columns 1 and 4 start with the effect of our baseline measure of conversion from first-year deposit to mean positive loan amounts on deposit pricing and growth respectively, columns 2 and 5 scale by mean instead of first deposits, before columns 3 and 6 use maximum instead of mean positive loan volume. For pricing, the effect of varying the conversion measure is limited, with the coefficient of interest falling from 0.007 only to 0.005 or 0.004. For deposit growth the effect of scaling by mean rather than by first-year deposits is bigger, reducing the effect to about half its baseline, whereas focusing on the maximum loan volume reduces the effect by only about 10%. Overall this shows that results do not hinge on how exactly we measure the relationship between deposit and loan amounts in a bank household relationship or in a bank municipality cell with a set thereof. We deem the scaling by first-year deposit amount most relevant because BJ 2023's finding of great depositor inaction after onboarding means that onboarding a client in the first place is more costly to the bank than retaining him or her thereafter, hence the choice of our baseline measure. Yet offering sufficiently attractive conditions to also retain a client thereafter is not irrelevant and so it is good to see that all effects of interest remain both statistically and economically significant also if we scale conversion by mean instead of first-year deposits.

While both ***T3*** and ***AT2*** aggregated the conversion measures from the relationship to the BM level as weighted averages, weighting by mean deposits in each relationship, next ***AT3*** uses alternatively measures obtained as unweighted averages. Columns 1-3 find coefficients of 0.007, 0.007 and 0.006 compared to 0.007, 0.005 and 0.004 in ***AT2***, while Columns 4-6 find coefficients of -0.65, -0.29 and -0.28 compared to respectively -0.49, -0.22 amd -0.21 in ***AT2*** . This means that across the board using unweighted conversion measures yields the same or larger effects. While a priori we deem the weighted averages more precise, it is good to see that our results do not depend thereon and if anything become more conservative by this choice.

Next, ***AT4*** uses alternative formulas to compute deposit growth. Our baseline results, for easier reference repeated in columns 1 and 2 for the version without and with bank-year fixed effects respectively, approximate deposit growth with a log difference formula, a common choice in empirical research. One potential drawback thereof is that the formula is known to be less precise the bigger growth rates are in absolute terms. Since some BMY cells contain only few clients, some such outliers do exist. Furthermore, this formula by default cannot compute growth rates when volumes in either the lagged or the current year are zero. To test how this affects our results, columns 3 and 4 use instead percentage growth. The drawback of that formula is that it can also produce extreme outliers in case of very high or very low negative growth and so, in comparison to our LD and subsequent ARC growth rates we chose to winsorize percentage growth until its lower bound is -100%, which required fairly aggressive winsorizing at P15 and P85, given also our choice to winsorize symmetrically. With this choice, regression coefficients are -0.34 and -0.40 without and with bank-year fixed effects respectively, not too far from the baseline. We note that with less aggressive winsorizing we obtain the same sign and statistical significance but larger coefficients. Finally, columns 5 and 6 use unstead the average rate of change (ARC), a.k.a. symmetric growth, i.e. they scale the change in deposits not by the level in the lagged year but by the average in lagged and current year. Doing so produces again slightly smaller coefficients of -0.17 and -0.16 respectively. We infer from this that the exact size of coefficients does depend on exactly which formula we use to compute growth rates, and so we make for our baseline those choices that seem to us most sensible a priori. But luckily signs and statistical significance do not depend on those choices.

Finally, ***AT5*** varies not the measures but the specification by including in addition to bank-year also municipality-year fixed effects. Given that triple-interaction fixed effects would by definition not be possible as the triple interaction is our level of observation, this is the most conservative specification possible. For easier comparison we repeat in columns 1 and 2 for pricing and in 4 and 5 for deposit growth the known estimates with no and with only bank-year fixed effects respectively, before columns 3 and 6 add also the municipality-year fixed effects. We see that doing so does barely change our estimates of interest, justifying the omission of municipality-year fixed effects from our baseline estimations.

# 6 Conclusion

In this paper, we have shown how the potential for banks to cross-sell their household depositors mortgages and other loans later affects the pass-through of monetary policy to deposit rates. Specifically, cross-selling reduces the pass-through from policy to deposit rates and thereby amplifies the impact of policy rate changes on deposit spreads. The estimates are quantitatively large, suggesting that variation in cross-selling is important for understanding pass-through to deposit spreads. Ultimately, differential pass-through to deposit spreads results in a differential transmission to deposit volumes, highlighting that cross-selling is important for the overall transmission of monetary policy through the banking system.

This means that taking into account how banks price deposits today in reference to the expected sale, within the same relationship, of other products tomorrow, provides a way through which the Deposits Channel of Monetary Policy operates. ShThis channel gives a role to the multi-product and multi-period character of most bank relationships.

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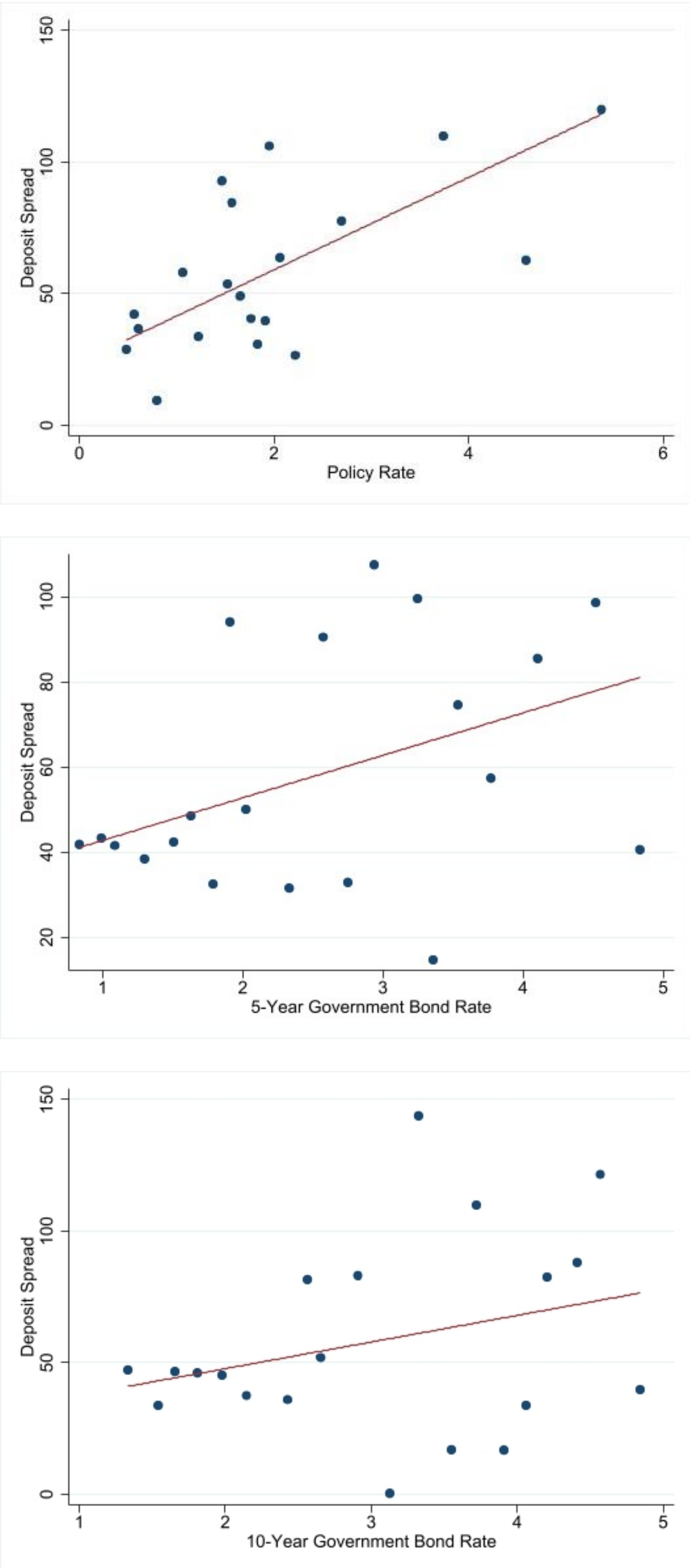
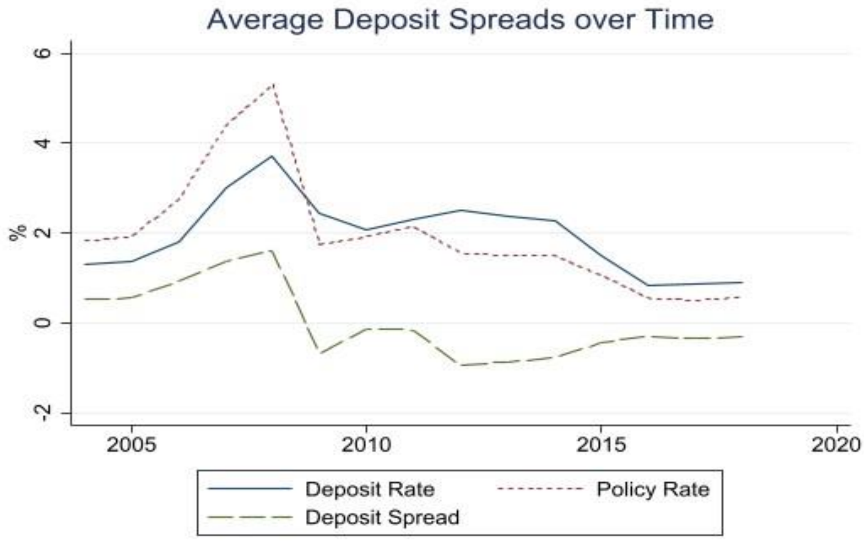
# Figures

**Figure 1: Deposit Spread, Policy Rate, and 5- and 10-year Government Bond Rates**



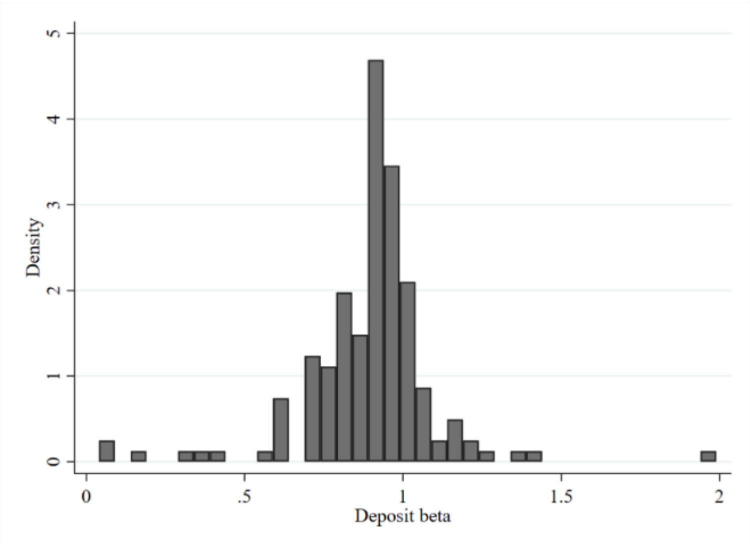

Panel A plots the spread between policy rate and effective deposit rate (deposit interest received in that year over the average deposit volume in that and the prior year) against the policy rate. Panel B plots it against the 5- and Panel C against the 10-year government bond rate.

**Figure 2: Average Deposit Spreads in Norway**



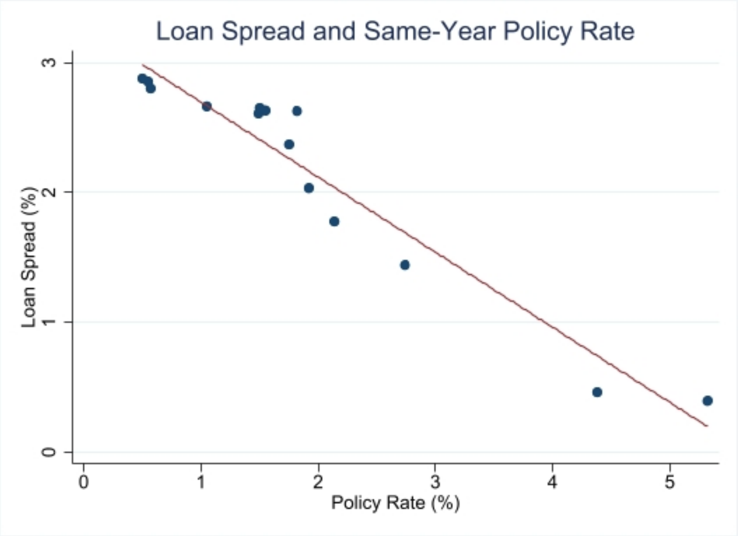

This figure plots Norwegian policy rates, average deposit rates taken from Finansportalen, and their difference by year.

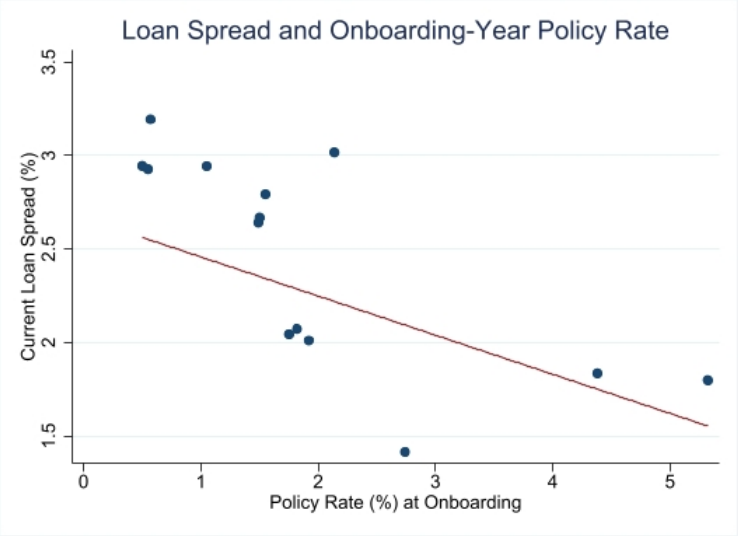
**Figure 3: Distribution of Deposit: Spread Betas Across Banks**




This figure plots the distribution of deposit spreads across Norwegian banks.

**Figure 4: Loan Spread by Same-Year and by Onboarding-Year Policy Rate**




Panel A plots the spread of effective loan rate (loan interest paid in that year over the average loan amount in the current and the previous year) over the overnight policy rate, considering that most loans are adjustable-rate, against said policy rate. Panel B plots the same outcome against the policy rate in the year in which the same household was first observed to hold deposits at the same bank. On average the wait time between deposit onboarding and loan start is about 5 years, so the average wait time until the average borrowing year plotted here is above 5 years.

# Tables

### Table 1: Summary Statistics

| | Obs | Mean | Median | SD | Min | Max |
|---|---|---|---|---|---|---|
| Policy Rate (PR) | 340’261 | 1.947 | 20090.000 | 1.340 | 0.500 | 5.320 |
| Policy Rate Change (DPR) | 340’261 | -0.107 | 0.000 | 1.088 | -3.375 | 1.750 |
| Monetary Policy Shock | 340’261 | 0.136 | -0.019 | 0.422 | -0.506 | 0.696 |
| Deposit Spread Change (DDS) | 340’261 | -0.038 | -0.013 | 4.803 | -12.883 | 12.072 |
| Deposit Growth (LD) | 264’467 | 7.809 | 3.012 | 337.228 | -1455.812 | 1686.321 |
| Deposit Growth (P) | 295’586 | 159.002 | 0.097 | 364.950 | -99.755 | 915.078 |
| Deposit Growth (ARC) | 322’706 | 1.357 | 2.299 | 145.245 | -200.000 | 200.000 |
| Loan Growth (LD) | 45'452 | 3.788 | -1.930 | 291.310 | -1560.026 | 1514.923 |
| Conv First Dep Mean Pos. Loan | 340’261 | 0.974 | 1.449 | 4.762 | -19.115 | 15.405 |
| Conv Mean Dep. Final Loan | 340’261 | -1.607 | -0.861 | 4.265 | -19.115 | 15.225 |
| Conv Mean Dep. Max Loan | 340’261 | -0.244 | 0.432 | 3.805 | -19.115 | 15.233 |
| Conv Mean Dep. Mean Pos. Loan | 340’261 | -0.672 | -0.019 | 3.752 | -19.115 | 15.229 |
| UW Conv First Dep Mean Pos. Loan | 340’261 | 1.796 | 2.102 | 4.072 | -19.115 | 15.405 |
| UW Conv Mean Dep. Final Loan | 340’261 | 0.035 | 0.283 | 3.869 | -19.115 | 15.225 |
| UW Conv Mean Dep. Max Loan | 340’261 | 1.325 | 1.516 | 3.497 | -19.115 | 15.420 |
| UW Conv Mean Dep. Mean Pos. Loan | 340’261 | 0.933 | 1.100 | 3.482 | -19.115 | 15.229 |
| Deposit Market Share | 340’261 | 0.017 | 0.000 | 0.087 | 0.000 | 0.998 |
| Deposit HHI | 340’261 | 0.378 | 0.358 | 0.132 | 0.114 | 0.864 |

This table shows summary statistics for the datasets across all years 2005-18. Policy rate levels and changes, monetary policy shock, deposit spread change and all growth rates in percentage points. All deposit volume weighted as well as unweighted (UW) measures of deposit loan conversion express the growth from deposit to loan amounts with 1 unit signifying a 100% growth rate. Deposit market shares and the Herfindahl Hirschmann Index (HHI) as the sum of squared deposit market shares are scaled between 0 and 1.

**Table 2: Main Effects of Policy Rate Changes on deposit spreads and growth**

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | ΔDS | ΔDS | DG | DG |
| ΔPR | 0.298*** | 0.304*** | -1.048** | -0.864* |
| | (0.009) | (0.009) | (0.472) | (0.453) |
| Constant | -0.027** | -0.027** | 172.668*** | 172.592*** |
| | (0.011) | (0.010) | (0.525) | (0.501) |
| Observations | 318’704 | 318’704 | 310’096 | 310’094 |
| R2 | 0.003 | 0.022 | 0.000 | 0.091 |
| BankFE | No | Yes | No | Yes |

The outcome variable ΔDS is the year-on-year difference in the deposit spread between policy rate and the average deposit rate paid by that bank in that municipality and year, while DG is the year-on-year deposit growth rate in that bank municipality cell. ΔPR is the year-on-year difference in the policy rate. Columns include bank fixed effects as indicated. Standard errors in parentheses * $p<0.1$, ** $p < 0.05$, *** $p<0.01$.

**Table 3: Effects of DPR on Deposit Spreads and Growth by Deposit-Loan Cross-Selling**

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| | ΔDS | ΔDS | ΔDS | ΔDS | DG | DG | DG | DG |
| Conv * ΔPR | 0.019*** | 0.007*** | | 0.008*** | -0.459*** | -0.496*** | | -0.506*** |
| | (0.005) | (0.002) | | (0.002) | (0.127) | (0.131) | | (0.135) |
| MShare * ΔPR | | | 0.453*** | 0.473*** | | | -10.268 | -12.850 |
| | | | (0.113) | (0.114) | | | (8.939) | (9.130) |
| Conv | -0.007** | -0.003* | | -0.003* | -0.595*** | -0.473*** | | 0.199 |
| | (0.003) | (0.002) | | (0.002) | (0.171) | (0.162) | | (0.164) |
| ΔPR | -0.091** | | | | 1.621** | | | |
| | (0.039) | | | | (0.731) | | | |
| MShare | | | -0.173 | -0.188 | | | 365.184*** | 364.738*** |
| | | | (0.125) | (0.126) | | | (12.036) | (12.130) |
| Constant | -0.039 | -0.034*** | -0.026*** | -0.030*** | 9.871*** | 9.585*** | 2.001*** | 2.062*** |
| | (0.031) | (0.002) | (0.002) | (0.003) | (0.950) | (0.147) | (0.205) | (0.289) |
| Observations | 340’265 | 340’261 | 373’939 | 340’261 | 279’586 | 279’557 | 310’066 | 279’557 |
| R2 | 0.001 | 0.051 | 0.050 | 0.051 | 0.000 | 0.011 | 0.019 | 0.020 |
| BYFE | No | Yes | Yes | Yes | No | Yes | Yes | Yes |

The outcome variable ΔDS is the year-on-year difference in the deposit spread between policy rate and the average deposit rate paid by that bank in that municipality and year, while DG is the year-on-year deposit growth rate in that bank municipality cell. ΔPR is the year-on-year difference in the policy rate. Conv for deposit-loan conversion is the percentage by which the final-year loan amount exceeds the first year deposit amount in a bank household relationship, aggregated up to the bank municipality level. MShare denotes the deposit market share of that bank in that municipality and year. Columns include bank-year fixed effects as indicated. Standard errors in parentheses clustered by bank-year. * p<0.1, ** p < 0.05, *** p<0.01.

**Table 4: Borrowing Propensity and Spreads by Policy Rate**

| | (1)<br>I(Borrow) | (2)<br>I(Borrow) | (3)<br>I(Borrow) | (4)<br>I(Borrow) | (5)<br>LS | (6)<br>LS | (7)<br>LS | (8)<br>LS |
|---|---|---|---|---|---|---|---|---|
| PR | 0.032*** | | | | -0.577*** | | | |
| | (0.000) | | | | (0.001) | | | |
| ΔPR | | 0.007*** | | | | -0.341*** | | |
| | | (0.000) | | | | (0.001) | | |
| O PR | | | 0.003*** | | | | -0.126*** | |
| | | | (0.000) | | | | (0.001) | |
| O ΔPR | | | | 0.001*** | | | | -0.064*** |
| | | | | (0.000) | | | | (0.001) |
| Constant | 0.092*** | 0.150*** | 0.142*** | 0.156*** | 3.273*** | 2.158*** | 2.485*** | 2.157*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.001) | (0.001) | (0.002) | (0.001) |
| Obs | 82’079’164 | 62’620’963 | 82’079’164 | 74’265’106 | 24’940’663 | 20’046’004 | 24’940’663 | 23’384’297 |
| R2 | 0.085 | 0.068 | 0.075 | 0.073 | 0.080 | 0.067 | 0.051 | 0.052 |
| BFE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| BMFE | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

The level of observation in this table is bank household year, rather than bank municipality year. The outcomes of interest are I(Borrow), an indicator of whether the household in question is ever observed to become a borrower of the same bank, and the loan spread (LS) where it does. The regressors or interest are the concurrent policy rate (PR) level or change, as well as their respective equivalents in the year in which the household was onboarded by that bank. Standard errors in parentheses clustered by bank-year. * $p<0.1$, ** $p < 0.05$, *** $p<0.01$.

**Table 5: Instrumental Variable (IV) analyses of resulting Loan Growth**

| | (1)<br>Loan Growth | (2)<br>Loan Growth | (3)<br>Loan Growth |
|---|---|---|---|
| Deposit Growth | 0.668*** | 0.654*** | 0.489*** |
| | (0.010) | (0.018) | (0.107) |
| Constant | -3.379** | -3.379*** | |
| | (1.351) | (0.043) | |
| Observations | 40’910 | 40’895 | 38’859 |
| R2 | 0.095 | 0.148 | 0.086 |
| F | 4291.140 | 1361.850 | 20.680 |
| Reg | OLS | OLS | IV |
| BYFE | No | Yes | Yes |

The outcome is loan growth in each bank municipality year cell, computed with a log difference approximation. We relate this to deposit growth at the same level. Columns 1 and 2 use Ordinary Least Squares (OLS) regressions without and with bank year fixed effects respectively, while column 3 uses Instrumental Variable (IV) regressions, instrumenting deposit growth with the regressors from Table 3, column 4. Standard errors in parentheses clustered by bank-year. * p<0.1, ** p < 0.05, *** p<0.01.

# Robustness Checks

**Appendix Table 1: Horse Racing Conversion against HHI**

| | (1) ΔDS | (2) ΔDS | (3) ΔDS | (4) ΔDS | (5) DG LD | (6) DG LD | (7) DG LD | (8) DG LD |
|---|---|---|---|---|---|---|---|---|
| Conv * ΔPR | 0.019*** | 0.007*** | | 0.007*** | -0.459*** | -0.496*** | | -0.494*** |
| | (0.005) | (0.002) | | (0.002) | (0.127) | (0.131) | | (0.130) |
| HHI * ΔPR | | | -0.586*** | -0.603*** | | | 4.424 | 5.054 |
| | | | (0.076) | (0.082) | | | (3.294) | (3.599) |
| Conv | -0.007** | -0.003* | | -0.003 | -0.595*** | -0.473*** | | -0.475*** |
| | (0.003) | (0.002) | | (0.002) | (0.171) | (0.162) | | (0.162) |
| ΔPR | -0.091** | | | | 1.621** | | | |
| | (0.039) | | | | (0.731) | | | |
| MHHI | | | 0.221*** | 0.234*** | | | -12.171*** | -8.283* |
| | | | (0.079) | (0.086) | | | (4.381) | (4.846) |
| Constant | -0.039 | -0.034*** | -0.136*** | -0.146*** | 9.871*** | 9.585*** | 13.103*** | 12.915*** |
| | (0.031) | (0.002) | (0.030) | (0.033) | (0.950) | (0.147) | (1.671) | (1.829) |
| Observations | 340’265 | 340’261 | 373’939 | 340’261 | 279’586 | 279’557 | 310’066 | 279’557 |
| R2 | 0.001 | 0.051 | 0.050 | 0.051 | 0.000 | 0.011 | 0.010 | 0.011 |
| BYFE | No | Yes | Yes | Yes | No | Yes | Yes | Yes |

The outcome variable ΔDS is the year-on-year difference in the deposit spread between policy rate and the average deposit rate paid by that bank in that municipality and year, while DG is the year-on-year deposit growth rate in that bank municipality cell. ΔPR is the year-on-year difference in the policy rate. Conv for deposit-loan conversion is the percentage by which the mean positive loan amount exceeds the first-year deposit amount in a bank household relationship, aggregated up to the bank municipality level. HHI is the Herfindahl-Hirschmann Index, i.e. the sum of squared deposit market shares in the municipality from which each bank municipality year observation is taken. Columns include bank-year fixed effects as indicated. Standard errors in parentheses are clustered by bank-year. * $p<0.1$, ** $p < 0.05$, *** $p<0.01$.

**Appendix Table 2: Alternative Conversion Measures**

| | (1)<br>ΔDS | (2)<br>ΔDS | (3)<br>ΔDS | (4)<br>DG | (5)<br>DG | (6)<br>DG |
|---|---|---|---|---|---|---|
| Conv(F-MP) * ΔPR | 0.007*** | | | -0.496*** | | |
| | (0.002) | | | (0.131) | | |
| Conv(M-MP) * ΔPR | | 0.005*** | | | -0.223** | |
| | | (0.002) | | | (0.111) | |
| Conv(M-Max) * ΔPR | | | 0.004*** | | | -0.209* |
| | | | (0.002) | | | (0.110) |
| Conv(F-MP) | -0.003* | | | -0.473*** | | |
| | (0.002) | | | (0.162) | | |
| Conv(M-MP) | | -0.003* | | | -0.529*** | |
| | | (0.002) | | | (0.153) | |
| Conv(M-Max) | | | -0.003* | | | -0.587*** |
| | | | (0.002) | | | (0.152) |
| Constant | -0.034*** | -0.038*** | -0.037*** | 9.585*** | 8.235*** | 8.454*** |
| | (0.002) | (0.001) | (0.000) | (0.147) | (0.100) | (0.031) |
| Observations | 340’261 | 363’972 | 363’972 | 279’557 | 300’098 | 300’098 |
| R2 | 0.051 | 0.050 | 0.050 | 0.011 | 0.010 | 0.010 |
| BYFE | Yes | Yes | Yes | Yes | Yes | Yes |

The outcome variable ΔDS is the year-on-year difference in the deposit spread between policy rate and the average deposit rate paid by that bank in that municipality and year, while DG is the year-on-year deposit growth rate in that bank municipality cell. ΔPR is the year-on-year difference in the policy rate. Conv(F-MP) denotes our baseline relationship between first-year deposit and mean positive loan amount. Subsequently we first reokace the first-year deposit with the mean deposit amount, then we also replace the mean positive with the maximum loan amount. Columns include bank-year fixed effects as indicated. Standard errors in parentheses * p<0.1, ** p < 0.05, *** p<0.01.

**Appendix Table 3: Unweighted Conversion Measures**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | ΔDS | ΔDS | ΔDS | DG | DG | DG |
| UWConv(F-MP) * ΔPR | 0.007*** | | | -0.645*** | | |
| | (0.002) | | | (0.146) | | |
| UWConv(M-MP) * ΔPR | | 0.007*** | | | -0.289** | |
| | | (0.002) | | | (0.130) | |
| UWConv(M-Max) * ΔPR | | | 0.006*** | | | -0.284** |
| | | | (0.002) | | | (0.128) |
| UWConv(F-MP) | -0.004** | | | -0.768*** | | |
| | (0.002) | | | (0.188) | | |
| UWConv(M-MP) | | -0.004** | | | -0.790*** | |
| | | (0.002) | | | (0.170) | |
| UWConv(M-Max) | | | -0.004** | | | -0.809*** |
| | | | (0.002) | | | (0.169) |
| Constant | -0.029*** | -0.031*** | -0.029*** | 10.370*** | 9.086*** | 9.426*** |
| | (0.003) | (0.002) | (0.003) | (0.314) | (0.116) | (0.185) |
| Observations | 340’261 | 363’972 | 363’972 | 279’557 | 300’098 | 300’098 |
| R2 | 0.051 | 0.050 | 0.050 | 0.011 | 0.010 | 0.010 |
| BYFE | Yes | Yes | Yes | Yes | Yes | Yes |

The outcome variable ΔDS is the year-on-year difference in the deposit spread between policy rate and the average deposit rate paid by that bank in that municipality and year, while DG is the year-on-year deposit growth rate in that bank municipality cell. ΔPR is the year-on-year difference in the policy rate.
UWConv(F) replaces the baseline conversion measure used in Tables 3ff. with one in which aggregation from the relationship to the bank municipality level is done as the unweighted average rather than by weighting each relationship with its volume of deposits. UWConv(M) is the unweighted average of conversion to the maximum rather than the final year loan amount, while UWConv(MP) uses conversion to the mean positive loan amount. Columns include bank-year fixed effects as indicated. Standard errors in parentheses are clustered by bank-year. * p<0.1, ** p < 0.05, *** p<0.01.

**Appendix Table 4: Alternative Deposit Growth measures**

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| | DG LD | DG LD | DG P | DG P | DG ARC | DG ARC |
| Conv * ΔPR | -0.459*** | -0.496*** | -0.339** | -0.398*** | -0.170*** | -0.159*** |
| | (0.127) | (0.131) | (0.146) | (0.138) | (0.053) | (0.051) |
| ΔPR | -0.595*** | -0.473*** | 0.211 | 0.256 | -0.254*** | -0.228*** |
| | (0.171) | (0.162) | (0.188) | (0.163) | (0.066) | (0.062) |
| Conv | 1.621** | | 0.570 | | 0.794* | |
| | (0.731) | | (0.915) | | (0.433) | |
| Constant | 9.871*** | 9.585*** | 155.073*** | 154.984*** | 2.319*** | 2.215*** |
| | (0.950) | (0.147) | (1.315) | (0.155) | (0.569) | (0.062) |
| Observations | 279’586 | 279’557 | 314’909 | 314’865 | 346’709 | 346’665 |
| R2 | 0.000 | 0.011 | 0.000 | 0.019 | 0.000 | 0.021 |
| BYFE | No | Yes | No | Yes | No | Yes |

The outcome variable DG is deposit growth as used in Tables 3ff: It is computed with the average rate of change (ARC) formula, i.e. by dividing the year-on-year change by the average level in the prior and the current year, so as to smooth out outliers in either year. DG P by contrast computes standard percentage growth, dividing the year-on-year change by the prior year level. DG LD computes deposit growth as the year-on-year difference in logs. ΔPR is the year-on-year difference in the policy rate. Conv for deposit-loan conversion is the percentage by which the final-year loan amount exceeds the average deposit amount in a bank household relationship, aggregated up to the bank municipality level. Columns include bank-year fixed effects as indicated. Standard errors in parentheses are clustered by bank-year * $p<0.1$, ** $p < 0.05$, *** $p<0.01$.

**Appendix Table 5: Including additionally Municipality*Year Fixed Effects**

| | (1) ΔDS | (2) ΔDS | (3) ΔDS | (4) DG | (5) DG | (6) DG |
|---|---|---|---|---|---|---|
| Conv * ΔPR | 0.019*** | 0.007*** | 0.006*** | -0.459*** | -0.496*** | -0.506*** |
| | (0.005) | (0.002) | (0.002) | (0.127) | (0.131) | (0.130) |
| Conv | -0.007** | -0.003* | -0.002 | -0.595*** | -0.473*** | -0.512*** |
| | (0.003) | (0.002) | (0.002) | (0.171) | (0.162) | (0.163) |
| ΔPR | -0.091** | | | 1.621** | | |
| | (0.039) | | | (0.731) | | |
| Constant | -0.039 | -0.034*** | -0.035*** | 9.871*** | 9.585*** | 9.621*** |
| | (0.031) | (0.002) | (0.002) | (0.950) | (0.147) | (0.148) |
| Observations | 340’265 | 340’261 | 340’261 | 279’586 | 279’557 | 279’557 |
| R2 | 0.001 | 0.051 | 0.068 | 0.000 | 0.011 | 0.031 |
| BYFE | No | Yes | Yes | No | Yes | Yes |
| MYFE | No | No | Yes | No | No | Yes |

Except for the inclusion of municipality-year fixed effects (MYFE) in columns 3 and 6 of the table, as indicated in the bottom row, the table follows columns 1,2, 5 and 6 of Table 6. Standard errors in parentheses are clustered by bank-year * p<0.1, ** p < 0.05, *** p<0.01.