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Chiara Canta, Øyvind A. Nilsen og Simen Ulsaker

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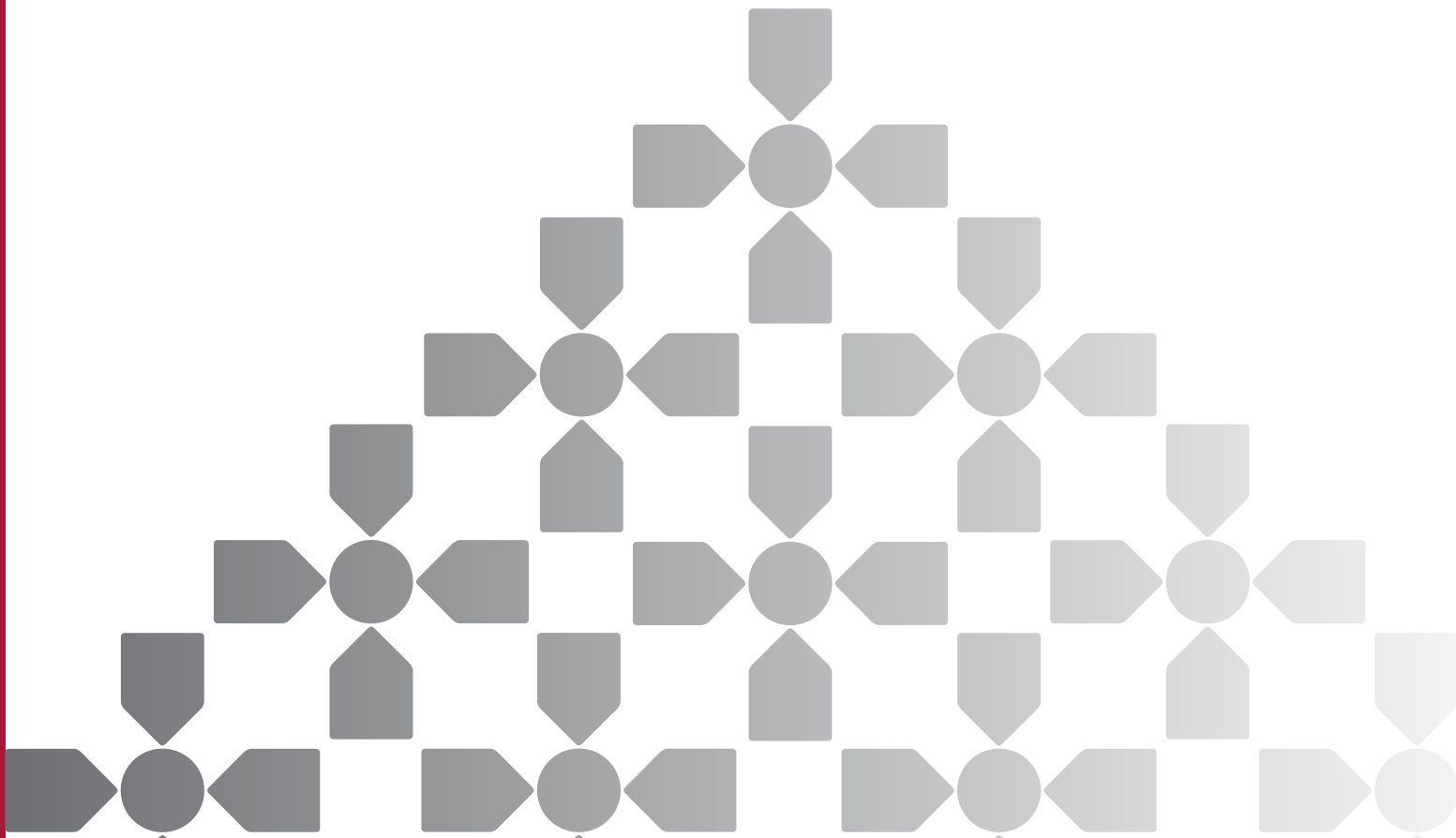

Competition in local bank markets: risk taking and loan supply*

Chiara Canta
(Toulouse Business School)

Øivind A. Nilsen†
(Norwegian School of Economics)

Simen A. Ulsaker
(Norwegian School of Economics)

Abstract

This paper studies empirically the relationship between competition and risk taking in banking markets. We exploit an unique dataset providing information about all bank loans to Norwegian firms over several years. Rather than relying on observed market shares, we use the distance between bank branches and firms to measure the competitiveness of local markets. The cross-sectional and longitudinal variation in competition in local markets are used to identify of the relationship between competition and risk taking, which we measure by the non-performing loans and loss provision rates of the individual banks. We find that more competition leads to more risk exposure. We also examine the effects of bank competition on the availability of loans. More competition leads to lower interest rates and higher loan volumes, but also makes it more difficult for small and newly established firms to obtain a loan.

JEL classification: G21, L11, L13

Keywords: banking; local competition; risk taking; firm behaviour

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†Corresponding author. Postal address: Norwegian School of Economics, Department of Economics, Helleveien 30, 5045 Bergen, Norway. E-mail: oivind.nilsen@nhh.no.

1 Introduction

Understanding the relationship between competition and risk taking is of primary importance for policy-makers and regulators. The potential conflict between competition and stability in financial markets has been the subject of major academic debates. Still, the effect of competition on risk taking is theoretically ambiguous and the empirical evidence is mixed. The banking system, and in particular the risk-taking behavior of banks, affects the financial stability of the economy. Severe financial crisis may arise if banks systematically take too much risk. To avoid excessive risk taking, countries regulate the capital requirements for banks (see the Basel regulatory framework). However, these requirements may have an anticompetitive effect through, for instance, reduced entry in the banking sector.[1] The effect of these kinds of regulations on the real economy are thus ambiguous and debated. On the one hand, the consequences of such anticompetitive regulatory interventions might be less lending, higher interest rates on loans, and less real activity in the economy. On the other hand, bank failures are likely to cause negative externalities through higher funding costs, and therefore, to affect the real economy negatively. Overall, the effect of bank competition on the economy is an empirical question. It is thus of great interest to look at the relationship between competition, bank behaviors, and stability in the banking market.

In this paper we empirically address the effects of competition in the banking market on risk taking and lending behavior by exploiting a unique dataset covering the population of Norwegian banks and firms in the period 2000-2013. The dataset includes information on interest payments and loan amount for every loan account. Together with the location of both bank branches and firms, we are able to measure the concentration in the local markets. The cross-sectional and longitudinal variation in competition in these local markets are used for identification of the relationship between competition and bank losses. In addition we analyse the effect of competition on the interest rate and volume

[1] See Vives (2016).

of new loans.

The main novelty of this paper lies in our ability to study the full population of loans to corporations in Norway. We are also able to follow both the bank and the firms for more than ten years, which gives us the possibility to control for both unobserved bank effects and unobserved firm effects. Additionally, information of both banks and firms, together with information about each loan, are based on official registers. Both the bank and firm information are audited by authorized auditors and tax authorities and are therefore of high quality. Information about the firms include age, industry classification and location. Together with information about the location about the bank branches, we obtain a unique dataset. Thus, to the best of our knowledge, our analysis is one of the few to address the question of competition in the banking sector and the firms with such linked data of the whole population of banks and firms.[2]

A potential problem with much of the earlier work is that the measure of competition (typically a concentration measure) may be correlated with unobservable factors that also affect risk taking. This may lead to biased results when one is comparing the riskiness across markets (or periods) with a high and low degree of concentration. To overcome this problem, our concentration measures are not based on actual demands, but on estimated demands obtained using the travel distance between bank branches and borrowing firms as the only determinant of firms' bank choices. This allows us to estimate demands functions and to predict concentrations measures that are correlated only with distances between firms and branches, and are arguably uncorrelated with variables also affecting risk taking by banks. Our results can thus be interpreted as causal effects of competition on banks risk taking.

We measure risk taking by the rate of nonperforming loans and loan loss provisions, while we measure concentration by the Herfindahl-Hirshman index. Our main findings indicate that higher concentration leads to a reduction in non-performing loan rates. Thus, there is a trade-off between competition and stability. Our results suggest that the

[2]Another example is Bonfim et al. (2018).

relationship between competition and risk taking may be U-shaped, as already pointed out in the literature. This latter finding suggests that the relationship between competition and risk taking is complex and multiple mechanisms are likely to be at work.

It is important to point out that there is a difference between risk taking and stability (i.e. bank failures). Banks that face though competition may hold higher amounts of capital to compensate for higher risk taking.[3] Then, our result that concentration increases risk taking does not ecessarily translate in a higher probability of bank failure. We also look at the impact of competition on bank loan loss provisions, which are the adjustments made by banks to their loan loss reserves with the purpose to cover potential loan losses. We find evidence that firms in more concentrated markets have lower loan loss provision rates, which suggests that the impact of competition on stability may be (at least partially) neutralized by loan loss provisions.

We also study the relationship beween competition and landing behavior of banks. We find that fiercer competition implies lower interest rates for small and new firms, but not for larger and established firm. Firms located in more competitive banking markets are less likely to obtain a loan, and this is particularly true for small and new firms. However, conditional on obtaining a loan, the amount of loans are higher in less concentrated markets, particularly for small and new firms. Our findings suggest that banks in more competitive markets reduce interest rates and tend to ration the loans at the extensive margin. At the extensive margin, fiercer competition eases firms' access to loans.

All in all, we find that competition increases risk taking and has a potentially negative effect on stability. The results on the impact of competition on the access to funds are mixed. On the one hand, competition reduces interest rates and increase the capital lended to small and newly established firms, which could find it hard to get funding in more concentrated landing markets. On the other hand competition reduces the probability of taking up a loan, particularly for small and newly established firms.

[3]See for instance Berger et al. (2009).

The remainder of the paper is structured as follows: Section 2 is a survey of the existing literature, while Section 3 presents the method used to mitigate potential endogeneity problems related to the use of concentration as measure of competition. Section 4 gives some institutional background about the banking sector in Norway, and presents the data used. Section 5 provides the empirical results, and discusses the results in light of existing findings. Finally, Section 6 gives some concluding remarks.

2 Related literature

The relationship between competition and risk taking in the bank sector is theoretically ambiguous. The theoretical literature has identified different channels through which competition may affect banks' risk taking.

The franchise value hypothesis states that banks with high franchise value (i.e. a high actualized stream of future profits) will take less risk because they have something to lose compared to banks with lower franchise value. Since competition reduces franchise values, it should also increase risk taking by banks. Hellmann et al. (2000), in a framework with dynamic moral hazard, consider the effect of prudential regulation on banks' risk taking. They show that regulatory interventions that dampen competition in the banking market increase the franchise value of banks, which reduces the banks' incentives for risk taking. For a review of the franchise value argument, see Demsetz et al. (1996). Competition may also increase risk taking through adverse selection. In less concentrated markets, bad projects may find it easier to get funded, since rejected applicants reapply to multiple banks (see Broecker, 1990).

Other theoretical models show that competition may have a negative effect on risk taking by banks through its effect on interest rates and on the riskiness of the projects receiving funding. In fact, competition entails lower interest rates which in turn should reduce the borrowers' bankruptcy risk and should lead borrowers to choose safer investments. This risk-shifting effect is put forward by Boyd and De Nicoló (2005). Other

authors emphasize banks' moral hazard as a source of risk taking in concentrated markets. Using a similar model, Martinez-Miera and Repullo (2010) predict a U-shaped relationship between bank failures and competition. In their model more competition always leads to lower risk taking, but may also lead to more bank failures due to lower margins. Other authors (Mishkin, 1999 and more recently Berger et al., 2018) emphasize the point that large banks may be "too big to fail", and that they therefore may take excessive risks since they expect their losses to be bailed out.

Carminal and Matutes (2002) develop a model where competition pushes banks to reduce costly monitoring and to rely on rationing of loans as a way to elicity the optimal selection of projects by firms. In their model firms are identical, but can choose between projects displaying different levels of risks. They find that competition in the banking market leads to higher interest rates and smaller loans (rationing) but does not affect the level of risk taken by funded firms.

The results of previous empirical research on the relationship between risk taking (and stability in general) and competition is mixed. Some cross-country studies indicate that more concentrated banking industries are more stable (see Beck et al., 2006 and Schaeck et al., 2009). Similarly, using US historical bank-level data, Keeley (1990) provides evidence of the franchise effect.

Of course, there may not be a simple, linear relationship between competition and risk taking. Beck et al. (2013) find that there is a large heterogeneity across countries. In some countries there seems to be a positive relationship between competition and stability, while in other countries the relationship is reversed. The relationship between competition and stability may also be non-linear, as predicted by Martinez-Miera and Repullo (2010). This is given some empirical support by Jimenez et al. (2013), who use Spanish loan data.

A number of papers have tackled the issue by studying the impact of deregulation in the banking market. The results are somewhat mixed. For instance, Dick (2006) shows that deregulation in the US led to higher risk taking. Salas and Saurina (2003) find

similar results for the Spanish case. Conversely, Jayaratne and Strahan (1998) find that deregulation reduced loan losses in the US.

Our paper contributes to this literature in two ways. First of all, our dataset does not only include the whole population of loans in Norway, but also allows us to match a rich set of register information on the borrowing firms. We can thus get a much clearer picture of how competition affects the *lending behavior* of banks, and not only some performance indicator. To our knowledge, this has no parallel in the empirical literature. Second, thanks to the richness of the dataset, we can address endogeneity problems and determine the *causal* relationship between competition, risk taking, and banks' landing behavior.

In line with most of the empirical literature, we find a negative relationship between risk taking and concentration. Looking more closely to the impact of competition on lending behavior, we find that more competition implies lower interest rates and more funding for firms that are granted a loan. However, the probability of obtaining a loan decreases with the intensity of competition in the banking market, and all these effects are stronger for small and newly established firms. These results are in line with the idea that banks in more competitive markets may try to save on costly monitoring by becoming more selective on which firms get a loan. This is the mechanism described by Carminal and Matutes (2002). However, in their model, firms are identical so that the only way to select is through rationing at the intensive margin. We show that banks in more competitive environment seem to ration credit at the extensive margin, while increasing access to credit at the intensive margin.

3 Empirical specifications

In this section we discuss the empirical strategy used to identify the causal relationship between competition, risk taking, and lending behavior. We also present the main empirical models that will be used in the analysis.

3.1 Firms' bank choices

Concentration measures, such as the Herfindahl-Hirschman Index (HHI), are commonly used as a measure of competition.[4] One problem with using the HHI computed from actual demands for loans is that they are likely to be correlated with unobserved variables that also explain risk taking, i.e. there might be an endogeneity problem. There are several reasons why HHI computed from actual demands for loans may lead to biased estimation results. First, a bank that gives out loans to risky borrowers (that would not be served by other banks) will increase both its market share (and consequently the HHI) and its riskiness. Second, the size of banks in a given market may also be correlated with both risk taking by these banks and concentration measures. For instance, large banks may be able to hold a riskier portfolio (too big to fail hypothesis), or conversely be more cautious (franchise value hypothesis). Other strategic decisions of banks, such as costumer services, marketing, and loans conditions may also affect the pool of borrowers, as well as market shares.

In order to solve this endogeneity problem, we estimate demand functions for each bank using only exogenous variation. Following Kessler and McClellan (2000), who apply the method to the hospital industry, we exploit the distance between the borrower and the closest branch of each bank as the exogenous variation explaining demands for loans. Travel distances between borrowing firms and branches can be argued not to depend on unobserved characteristics of the borrower or unobserved characteristics of the banks. We then use the adjusted concentration measures as explanatory variables for the loss measures. In addition to controlling for endogeneity, this method has the advantage not to rely on arbitrary definitions of local markets. Demands are estimated without imposing any restriction on the choice set of firms based on geographical criteria.

We estimate a conditional logit demand model where the probability that a firm k needing a loan i chooses bank j out of a total of J banks in year t is

[4]See for instance Boone (2008), Shaffer and Spierdijk (2017) and Vives (2016, p 88-89) for discussions about pros and cons of well-established competition measures.

$$p_{ijkt} = \frac{exp(RCS(km_{ijkt}))}{\sum_{j=1}^{J} exp(RCS(km_{ijkt})}, \tag{1}$$

where km_{ijkt} is the geodedic distance in kilometres from firm k to the closest branch of bank j in year t, and $RCS(\cdot)$ denotes a restricted cubic spline function. The restricted cubic spline function is used as a flexible way of modelling the relationship between distance and the likelihood to make a loan contract. This flexible function gives a continuous smooth function that is linear before the first knot, piecewise cubic polynomial between adjacent knots, and linear again after the last knot. In our estimates, we only include loans negotiated in the same year, since we are interested in the probability that a given firm takes up a loan at any given bank.

3.2 Competition and bank losses

Our main loss measure is the non-performing loan ratio (NPLR), which is the proportion of loans whose interest and principal payments have not been paid on time. A loan is considered non-performing if scheduled payments have not been made for a period of 90 days or more, or if the bank has performed an write-down of the loan based on an individual assessment. We also look at the impact of competition on the loan loss provisions rate (LPR). Loss provisions are allowances set aside to cover expected losses on loans considered to be at risk of not being repaid in full. A bank's LPR is the loss provisions divided by the value of the bank's loans.

The risk-measures used in the empirical analysis (non-performing loans ratio and loss provision rate) are available at the bank level. Then, we need to construct a bank-level concentration measure in order to assess the impact of competition on risk taking. The conditional logit demand model described by Equation 1 gives us the probability that a bank j is chosen by firm k seeking funding for loan i in year t. Multiplying the predicted probability p_{ijkt} with the loan amount x_i, and then summing over all loans granted in the local market in year t, I_{mt}, we obtain the predicted total demand for bank j in market m

in year t, $D_{mjt} = \sum_{i=1}^{I_{mt}}(p_{ijkt}x_i)$. Using these predicted demands, D_{mjt}, we can compute the adjusted HHI for each local market, as the sum of the squares of the predicted market shares:

$$HHI_{mt} = \sum_{j=1}^{J}\left[\frac{D_{mjt}}{\sum_{i=1}^{I_{mt}} x_i}\right]^2. \tag{2}$$

We want to measure the effect of a bank's competitive environment on its risk exposure. As a bank-level measure of competition, we use a weighted mean of the adjusted HHI in each of the local markets a bank is active:

$$HHI_{jt} = \sum_{m=1}^{M} w_{mjt} HHI_{mt}, \tag{3}$$

where w_{mjt} is the share of loans granted to firms located in market m relative to the total amount of loans granted by bank j (across all M markets).[5] HHI_{jt} is a measure of the aggregate competitive environment of bank j in year t, where a value equal to 1 corresponds to monopoly and 0 corresponds to perfect competition. Our adjusted measure of concentration is only based on observable exogenous characteristics of the bank-customer relationship. Thus, endogenous effects due for instance to the correlation between bank characteristic and risk taking should be minimized.

We model the relationship between the adjusted HHI and the risk exposure of the banks as follows:

$$loss_{jt} = \alpha + \beta_1 HHI_{jt} + \beta_2 HHI_{jt}^2 + \delta_t + a_j + \epsilon_{jt}. \tag{4}$$

where $loss_{jt}$ is the dependent variable of interest, which in the benchmark specification is the non-performing loans rate. δ_t are time dummies and a_j are bank fixed effects. As already mentioned, the potential U-shape of the relationship between risk taking and competition has been discussed and analysed in the existing literature. To allow for such a relationship we include our competition measure in quadratic from. Since our competitive

[5] In our empirical application, the local bank markets are the 46 labor market areas defined by Statistics Norway using commuting patterns (see Bhuller, 2009).

measure depends only on the location of a bank's branches (and the location of the firms demanding loans), we believe that is less likely to suffer from omitted variable bias than more standard concentration measures. Still, some unobserved bank characteristics that affect risk exposure may also be correlated with the number and location bank branches. We therefore include a bank fixed effect a_j in the model, which will account for any such characteristics, as long as they are time-invariant. Finally, we include a time fixed effect δ_t to control for time-varying shocks that are common to all banks.

3.3 Competition and loan supply

If intense competition in banking market s leads to excessive risk taking, this cost has to be weighted against the potential benefit of competition. As already mentioned, reduced competition in the banking sector may lead to higher interest rates, less lending, and in the end less real activity in the economy. Our objective is to analyze the effect of competition in the banking market on the access to credit of each firm, controlling for its characteristics. To quantify the potential benefits of competition, we then need to use firm-level concentration measures. We use again Equation 1 to obtain p_{ijkt}, which is the predicted probability that a loan i taken up by firm k is financed by bank j. For a given loan, the predicted choice probabilities tell us something about the intensity of competition for this loan, based on the location of the firm and the branches of all banks. If there are few banks with branches near a firm that needs the loan, the predicted probabilities will be concentrated among these banks. If, on the other hand, there are many banks close to a firm, the predicted probabilities will be more spread out. The predicted probabilities only depend on the location of the firms and the banks. Then, they are the same for all loans taken up by the same firm in a given year, implying that $p_{ijkt} = p_{jkt}$ for all loans i taken up by firm k. As a firm-level measure of competitiveness for loans, we therefore sum the squared choice probabilities across banks, to get a firm-

level HHI-measure:

$$HHI_{kt} = \sum_{j=1}^{J} p_{jkt}^2, \tag{5}$$

We relate this firm-level HHI measure to the interest rate paid by the firms and to the total volume of loans the firms take out. One advantage of having a firm-level measure of competitiveness is that we can include a range of firm specific and bank specific characteristics when we estimate the effect of competition on interest rates.[6]

We first estimate the relationship between bank competition and interest rates. Specifically, we estimate the following model, where i, j, k, m, s, t refer to loan accounts, banks, firms, local markets, sectors and years, respectively.

$$\begin{aligned} IR_{ijkmst} = {} & \beta_1 HHI_{kt} + \beta_2 New_{kt} + \beta_3 Small_{kt} \\ & + \beta_4 HHI_{kt} \times New_{kt} + \beta_5 HHI_{kt} \times Small_{kt} \\ & + \beta_6 Amount_{ijkt} + \lambda_t + \gamma_j + \theta_m + \sigma_s + \epsilon_{ijkmst}. \end{aligned} \tag{6}$$

In this equation, New_{kt} is a dummy variable equal to 1 if the firm is less than 5 years old, $Small_{kt}$ is a dummy variable equal to one if the firm has fewer than 10 employees, $Amount_{ijkt}$ is the (initial) amount of the loans, λ_t are year fixed effects, γ_j are bank fixed effects, θ_m are local markets fixed effects, σ_s are sector fixed effects, and ϵ_{ijkmst} is the error term.

Competition may also affect the amount a firm wants (or is able) to borrow. We model the relationship between loan volume and competition as follows.

[6]This is also why we do not aggregate the firm-level HHI-measure to the bank level which was the unit of observation in our model specified in Equation 4.

$$\begin{aligned}\ln(TL_{jkmst}) = &\beta_1 HHI_{kt} + \beta_2 New_{kt} + \beta_3 Small_{kt} \\ &+ \beta_4 HHI_{kt} \times New_{kt} + \beta_5 HHI_{kt} \times Small_{kt} \\ &+ \lambda_t + \gamma_j + \theta_m + \sigma_s + \epsilon_{ijkmst}.\end{aligned} \tag{7}$$

In this equation, $\ln(TL_{jkmst})$ is the natural logarithm of the total amount firm k in market m and sector s takes out from bank j in year t. Equation 7 models the intensive margin for loan supply: How does competition affect the amount of loans a firms takes out - given that the firm takes up a loan. We are also interested in the effect competition has on the probability that a firm takes up a loan. To investigate this, we specify the following linear probability model.

$$\begin{aligned}PL_{jmst} = &\beta_1 HHI_{kt} + \beta_2 New_{kt} + \beta_3 Small_{kt} \\ &+ \beta_4 HHI_{kt} \times New_{kt} + \beta_5 HHI_{kt} \times Small_{kt} \\ &+ \lambda_t + \theta_m + \sigma_s + \epsilon_{ijkmst}.\end{aligned} \tag{8}$$

In this equation, PL_{jmst} is the probability that firm j in market m from sector s takes out a loan in year t. Since the estimated choice probabilities are only a function of the location of the firms and the bank branches, we only need one loan observation per location in order to calculate a firm level HHI-measure that will be valid for all firms at that location (regardless of whether they took out a loan that year or not). In our empirical application we can therefore include firms which do not take up a new loan in a given year, as long as at least one other firm at that location took up a loan that year.

4 Institutional settings and data

4.1 The Norwegian bank market

Compared to other European countries, the Norwegian banking sector is small in terms of value added, with total assets amounting to only two times the GDP.[7] One explanation is that, in contrast to several European banks, Norwegian banks mainly lend to domestic customers. The development of the banking sector has been steady over the last years, also after the financial crisis in 2008. After the banking crisis in 1987-1993, the government forced cost cutting and other efficiency measures on banks to improve their results (Moe, Solheim, and Vale, 2004). The Basel regulations apply also to the Norwegian banking industry.

In 2016, the Norwegian banking market consisted of 136 banks of which 22 were registered as commercial banks while 10 were branches of foreign owned banks despite the large number of banks, there are a few banks that dominate the market.[8] Another contributing factor to increased concentration has been the mergers and acquisitions conducted by the partly state-owned bank DNB. Resulting from the merger between Norway's two largest banks, Bergen Bank and Den Norske Creditbank in 1990, DNB established itself as Norway's largest financial institution, controlling about one-third of both the private and commercial loan market. Foreign owned bank have had the opportunity to operate in Norway since 1985. The three largest foreign-owned banks operating in Norway (Nordea, Handelsbanken, and Danske Bank) have a combined market share in total lending of roughly 20% and close to 30% in the business segment.

Saving banks have historically focused their operations on personal banking in their respective local communities, whereas commercial banks have been more targeted towards the business segment. In 2002 the strict regulations of ownership and external

[7]For a more detailed description, as well as an analysis of the market evolutions, see Norges Bank, (2017)

[8]For more information about the Norwegian Finanacial System, see the reports published yearly by the Norwegian central bank: https://www.norges-bank.no/Publisert/Publikasjoner/det-norske-finansielle-systemet/.

capital raising of savings banks was removed, which has made the distinction between commercial and saving banks is not very clear. Over the past decades, there has been a considerable decrease in the number of banks in Norway, especially among savings banks. An important development feature during the 1990s was the prominence of alliances between smaller savings banks.

There has been a significant number of bank branch closures in Norway over the last thirty years. Since the peak in 1987, with 2,177 bank branches, the number of bank branches has decreased by more than 1,000, a trend that most likely will continue (Aamo 2016, p. 80-81, and www.finansnorge.no).

(Figure 1: Households and Corporate Market about here)

Figure 1 reports the evolution of banks' loans to private household and to firms over time.[9] We see that both measures have increased steadily over the last 15 years. We also see that banks are highly exposed to the household and mortgage market, which amounts to somewhat more than 50% of total loans over the sample periode. In the same figure we see that losses (as share of loans) are small in general, but larger for loans to firms.[10]

4.2 Data sources

The main data are based on information from the Norwegian Tax Administration. The dataset includes information on Norwegian firms and their loans.[11] For each loan we know the size of the loan on December 31 and the interest payments during the year, in addition to the name (and an identifier) of the bank/loan supplier. The sample period includes the years 1997-2013.[12] An advantage of these data are that they are collected for public registers and have universal coverage. Furthermore, they are scrutinised by

[9]Source: https://www.ssb.no/statbank/table/10769/

[10]Source: https://www.finanstilsynet.no/publikasjoner-og-analyser/finansielt-utsyn/

[11]This data is collected by the tax authorithy since interest payments are deductable in Norway.

[12]The database is confidential, but has been made available to us by the Norwegian Tax Directorate (Skattedirektoratet).

auditing firms and the Tax Administration before being made available for aggregate public statistics and research. Hence, the data are in general of a high quality. The dataset consists of approximately 16 million observations, with 5 million unique accounts held by 800,000 customers.

Balance sheet information, addresses, and industry codes for the firms are based on information from a database put together by the Centre for Applied Research (SNF) at the Norwegian School of Economics. The main source of information in this database is based on the compulsory firms' annual financial accounts. Also these data are collected for public registering and have universal coverage. Furthermore, they are also of high quality since they are scrutinised by auditing firms and the Tax Administration before release.

Information about the addresses of the bank branches is based on information from Finans Norge (Finance Norway), the financial sector's industry organization, and collected in the so-called Bank Branch Location Register. The information in this register is based on a questionnaire sent to all banks located in Norway. Responses are voluntarily. For our analysis, missing information in the Bank Branch Location Register is completed with data directly collected from the banks themselves (for instance from Nordea for some of the last sample years), or by manually using address information of the bank branches.

The Financial Supervisory Authority of Norway (Finanstilsynet) collects detailed accounting information from Norwegian banks and other financial institutions in the ORBOF-database, a database administrated by Statistics Norway. We use this database to construct our two risk measures, the nonperforming loans rate (NPLR) and the loss provision rate (LPR). We construct the NPLR of a bank in a given year by dividing the value of loans reported as nonperforming (as mentioned earlier, a loan is considered nonperforming if scheduled payments have not been made for a period of 90 days or more, or if the bank has performed a write-down of the loan based on an individual assessment) by the total amount of loans. Similarly, the LPR is given by the loan loss provisions divided

by the total amount of loans. Since our data from the Norwegian Tax Authority covers corporate loans only, both risk measures are also calculated using only loans to firms.

For estimation of our bank-level models, we include observations for the period 2000-2013 , since this is the period where we have data on NPLR and LPR. Our final sample consists of distinct 159 banks.The number of banks each year varies between 128 in 2013 and 147 in 2002. This gives us 1852 observations in total.

To aid comparisons across our different models, we restrict the sample period to 2000-2013 also when we estimate the firm-level models. We restrict attention to new loans, since we believe that competition first and foremost affects the loan terms of new loans, since e.g., interest rates of already existing loans may be fixed and therefore unaffected by changes in the competitive environment. In the estimation of the models specified in Equations 6 and 7, we have 225,743 observations. When we are estimating the probability of getting a loan (Equation 8), also firms that do not obtain a loan are included. The number of observations then rises to 1,855,042.

4.3 Preliminary results and descriptive statistics

In Figure 2 we present a plot of the cumulative distribution of the distance between the borrowing firm and the closest local branch of the bank supplying the loan (the inside bank). We see that loans tend to be supplied by banks with bank branches close to the borrowing firms. The median distance to the inside bank is 2.3 kilometers while the average distance is 35.6 kilometers. For comparison, the median distance to the closest branch of all banks is 293.5 kilometers, while the mean distance is 337.9 kilometers. This supports our decision to model bank competition geographically, rather than assuming that competition occurs at the national level.

(Figure 2: Distribution of the distance about here)

In Figure 3 we plot our two risk measures, non-performing loan rates (NPLR) and and loan loss provision rates (LPR), over time. The correlation between the two measures of losses, NPLR and LPR, is 0.70 (t= 41.33).

(Figure 3: Loss measures over time about here)

In Figure 4 we plot the average interest rate and total loan volume over time.

(Figure 4: Interest rate and loan volume about here)

Figure 5 compares the kernel density of the bank-level HHI calculated using actual firm choices with the kernel density of the bank-level HHI calculated using the choice probabilities predicted by the model specified in Equation 1. To account for potential differences in the effect of distances across regions and time we estimate the conditional logit model separately for each year-region combination.[13] For each loan, the choice set includes all banks active in Norway in that year. In order to focus on bank choices for any given loan, we focus on loans negotiated in each given year, dropping outstanding loans in the years subsequent to negotiation.[14]

(Figure 5: Density plots of HHI about here)

The correlation coefficient between the two competition/concentration measures is

[13]We use regions defined by Statistics Norway: The Oslo capital area and surroundings, East-Norway, South-Norway, South-West-Norway, West-Norway, Mid-Norway, and two regions for the northern part of Norway where the most northern one corresponds more or less to the county Finnmark. The regions nest the areas defining our local bank markets. The eight regions vary both in size, industry composition, and centrality.

[14]In our application of the restricted cubic spline function, we use nots at 5, 10, 50, 100 and 200 kilometres. Simpler functional forms, notably the quadratic and cubic polynomials, have also been tested. The correlation between the actual HHI and the adjusted ones was highest for the restricted cubic spline function. The knots used in our cubic spline function are roughly at the 64th, 75th, 89th, 93th, and 95th percentiles, respectively.

equal to 0.35 (t=18.08). The distribution of the adjusted bank-level HHI is shifted to the left compared to the bank-level HHI calculating with actual demands. One explanation for this is that when we estimate choice probabilities, all banks will, conditional on distance, have equal market shares for loans from a given location. Of course, firms' bank choice is not exclusively determined by distance to bank branches, and other observed and unobserved differences between the banks will make the actual market shares (conditional on distance) more unevenly distributed. Since the HHI is the sum of the squared market shares, it follows by construction that the more unevenly distributed actual market shares give rise to a higher HHI than the estimated market shares.

In Figure 6 we plots the two bank-level HHI measures (actual and adjusted) over time.

(Figure 6: HHI by year about here)

Table A1 in the appendix reports additional descriptive statistics of the variables used, both at the bank and at the firm level.[15]

5 Main results

We first study the relationship between risk taking and competition. Table 1 reports the results of the regression with NPLR as the dependent variable, and the adjusted bank-level HHI as the explanatory variable.[16].

(Table 1: Competition and NLPR about here)

[15]Details about the construction of the variables are described throughout the paper. For instance, our two loss measures, HHI, loan size, and the supply of loan, together with the definition of small and new firms, are explained in Section 3. The variable constructions are also given collectively in the note to Table A1.

[16]All the reported standard errors are clustered at the bank level, making them asymtotically robust to both heteroskedasticity and serial correlation. Comparing the robust standard errors with normal standard errors, we find the former ones much larger than the latter ones.

The baseline specification in Column (1) shows that there is a negative relationship betweeen NPLR and the adjusted HHI. More concentration (i.e. reduced compeition) reduces the non-perfoming loan rate. The adjusted HHI range from 0.03 to 0.44. For the average bank (adjusted HHI=0.10), a one standard deviation (0.05) increase in the adjusted HHI corresponds to a decrease in the non-performing loans rate of 1 percentage point. Column (2) shows the relation beween risk taking and the one-year lagged adjusted HHI. The idea behind using lags is that competition affecting lending behavior, which in turn affects the performance of loans only after some time. There is again a negative relationship, and a non-linearity is present. Column (3) reports a regression where we include contemporaneous and lagged values of the adjusted HHI.

Table 2 also reports results of a regression of Equation 4 but now with LPR as the explanatory variable. While we do not find any significant relation between LPR and contemporaneous or lagged concentration measures (Columns (1) and (2)), we find significant parameters for the lagged HHI in the specification including both contemporaneous and lagged HHI (Column (3)). Again, we find a negative relationship between the one-year lagged concentration measure and LPR, with a non-linearity suggesting a U-shaped relationship.

(Table 2: Competition and LPR about here)

To fully grasp the importance of the non-linearity, we plot the relationship between our loss measures and HHI together with the 95% confidence interval in Figures 7 and 8. On the horizontal axis, we report the adjusted HHI values in the interval 0-0.20. We use the estimates from Column (3) imposing that the contemporaneous and one-year lagged HHI are the same. Thus the plotted curves represent long run effects of concentration on risk taking.[17] Comparing Figure 7 and Figure 8, we note the similar shape of the

[17]For the NPLR, the sum of the HHI coefficients is significant at the 5% level (F=3.97), and the sum of the HHI squared coefficients is significant at the 10% level (F=3.68).

estimated relationship between competition and risk taking. The U-shape is apparent in both panels. While the estimated turning points differ somewhat, a glimpse into Figure 5 reveals that almost the entire distribution of the adjusted HHI falls in the region where there is a negative relationship between competition and non-performing loans, regardless of which loss measure we are considering.[18] Our findings thus indicate that more intense competition leads to more risk exposure. However, we provide evidence that banks in more concentrated markets have lower loan loss provision rates, so that the impact of competition on stability may be (at least partially) neutralized by loan loss provisions.

(Figure 7 and 8: Predicted NPLR/LPR as function of adjusted HHI about here)

Our concentration indexes are based on estimated market shares rather than actual market shares. To illustrate that this distinction may be important, we have also estimated a "naive" model where we use bank-level HHIs based on actual market shares as the explanatory variable. The results from this regression is reported in Table A2 in the Appendix. Measured by actual market shares, competition has no significant effect on our measures of risk. As mentioned above, these estimates may be biased. If larger banks also have a riskier portfolio, we would expect this bias to imply an overestimate of the effect of concentration on risk taking. The opposite would be true if larger banks were more cautions, which would imply a negative correlation between concentration and risk taking.

Let us now turn to the effect of competition on loan supply. Column (1) of Table 3 reports the results of an estimation of Equation 6, which models the effect of competition on the interest rate of loans.

[18]Both the predicted NPLR and the predicted LPR are minimized when the adjusted HHI is equal to 0.17, which is the 92nd percentile of the adjusted HHI.

(Table 3: Competition and Loan supply about here)

We note first that competition has significant impact on the interest rate only for firms that are small, newly established, or both. A reason for this may be that large and established firms find it easier to negotiate with banks outside their local market and are thus less affected by the local competition than small and newly established firms. For small and newly established firms, a change in the firm-level HHI equal to one standard deviation (0.11) gives a predicted change in the interest rate of about 0.08 percentage points (8 basis points). Since we include local market-, sector-, and bank- fixed effects, our results are driven by variation within, and not between, these dimensions. This, in addition to the fact that our competitive measure is based only on distances between firms and banks, gives support to a causal interpretation of our results.

Column (2) of Table 3 reports the results of an estimation of Equation 7, which models the effect of competition on the (log-transformed) size of loans (amount in million of NOK).[19] We see that loan size is increasing in competition. Again, the the most significant effect (economically and statistically) is for firms that are small, newly established, or both. This seems reasonable, since the results in Column (1) indicate that competition mainly reduces the cost of borrowing for these firms. For a small and newly established firm, the effect of competition is substantial: A one standard deviation increase in the firm-level HHI (0.11) is predicted to lead to a reduction in the loan size of about 9.5 percent.

Finally, Column (3) of Table 3 reports the results of an estimation of Equation 8, which models the effect of competition on the probability that a firms takes out a loan in a given year or not. Since the sample in this regression includes firms that do not take out a loan in a given year, we cannot include bank fixed effects in this model. Apart from this, the same fixed effects are included in this model as in the two other models.[20]

[19] 9 NOK $\approx$ 1 EURO over the analysed period.

[20] We have also estimated a logit model with the same dependent and independent variables. Qualitatively, the results are completely parallel to the ones reported in Column (3).

More competition reduces the probability that a firm takes out a loan. While this holds for all firms, the effect is stronger for small and newly established firms. For such firms, a change in the firm-level HHI equal to one standard deviation (0.10 in this sample), increases the predicted probability of taking out a loan with 1.64 percentage points.

These results on the take up probability are consistent with the idea that banks in more competitive environment may use credit rationing as an alternative to costly monitoring, particularly for small and newly established firms (see Carminal and Matutes, 2002). However, the drop in interest rates and the increase in loan volumes associated with fiercer competition do not support this view. Competition may also reduce the scope for relationship lending, as suggested for instance by Braggion and Ongena (2017).[21] This theory could explain our finding that competition increases risk taking. However, the literature also predicts that less relationship landing should be correlated with higher interest rates. This is in contrast with our evidence that competition reduces interest rates. Further investigation would be needed to shed some light on the economic mechanism behind our findings.

We conclude this section with a brief comparison with some of the empirical findings in the literature. Beck et al. 2006 cross-country study indicates that limited competition is associated with greater banking system fragility. Similarly, Keeley 1990 finds that banks with more market power have a lower default risk. Conversely, Schaeck et al. 2009, also using cross-country data, find that more competitive banking systems are less prone to experience a systemic crisis. Jimenez eta al. (2013) find that there is a U-shaped relationship between competition and stability, which explain the mixed empirical findings about the association between competition and stability. Concerning competition and lending behavior, Dick (2006) finds that the costs (interest rates) are more or less unchanged following the Riegle-Neal U.S branching deregulation in the banking industry in the 1990s. We exploit a uniquely rich and high-quality dataset that allows us to control for endogeneity of competition, and profide new evidence lending partial support

[21] For a meta analysis of the existing evidence on relationship landing, see Kysucky and Norden (2016).

the empirical findings in the literature. However, the comparison between our results and the existing findings is complicated by the fact that the institutional settings may vary quite substantially.

6 Concluding remarks

Banks serve several important roles in the economy. They first of all offer credit to borrowers and they accept and manage deposits for the public. In addition, they are intermediaries of transactions. Thus, there is a very strong link between the financial system and the real economy. Furthermore, as financial crises often spread out to other industries in the economy via the banking system, it is crucial to ensure a stable banking system is crucial. This is done through capital requirements, but also via regulation of competition in the sector. However, there has long been a concern that competition may make banking markets less stable. On the other hand, competitive banking markets may be beneficial to society in other ways, e.g., by reducing the cost and increasing the availability of funding for firms and households.

In this paper we have used a unique data set with the population of Norwegian banks and firms to empirically investigated the possible trade-off between risk and competition. We find that more competition leads to more risk exposure, measured by the banks non-performing loans rate and loss provision rates. We also find that, when facing more intense competition, banks increase their loan loss provision rates, which could partially compensate for the increase in risk taking.

With regards to the potential benefits of competition, our results are mixed. Our results indicate that competition in local banking markets first and foremost affect small and newly established firms. For these firms, more competition reduces the interest rate and increases the size of the loans, but on the other hand makes it more difficult to obtain a loan. This may suggest that banks in more competitive markets ration credit at the extensive margin, while lower interest rates and higher funding to firms obtaining a loan.

All in all, our results substantiate the concern that intense competition can lead to increased risk exposure in the banking sector, while also highlighting the complexity of the relationship between bank competition and availability of funding.

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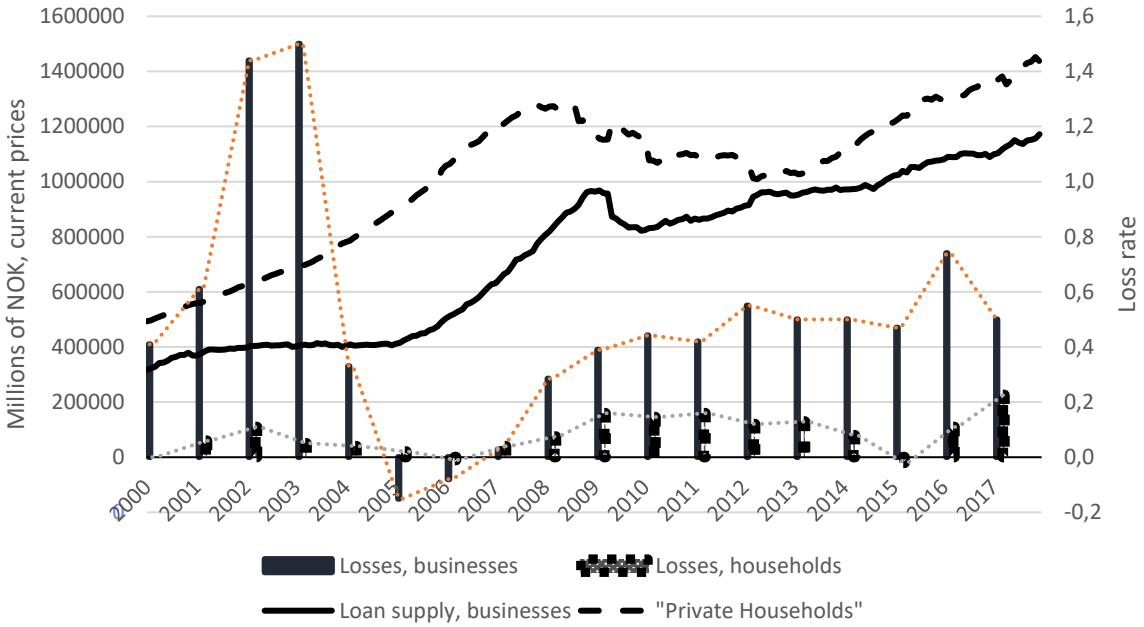
Figures and Tables

Figure 1: Households and Corporate Market: Total loans and losses (NOK)



Notes: The reported loss-numbers are, according to the rules, expected losses divided by total loans. It may happen that the actual losses are smaller than initially expected, and the banks then take negative losses. When these negative losses exceed new posted losses, net losses will be negative.

Figure 2: Distribution of the distance between firm and closest branch of inside bank

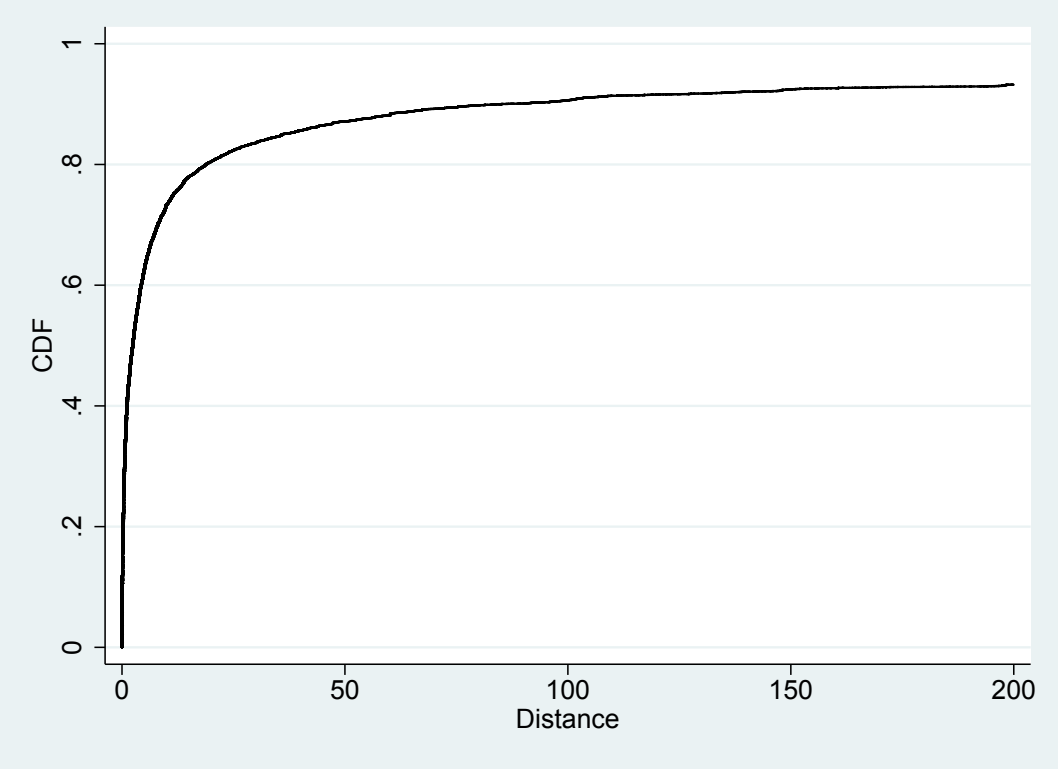
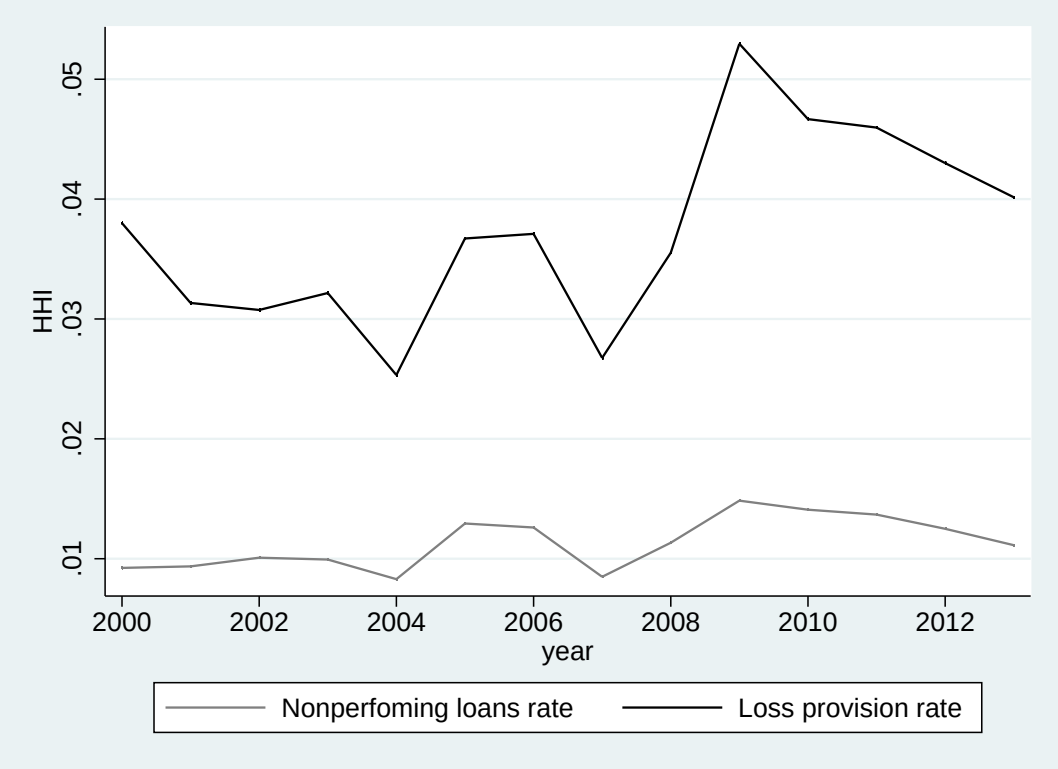
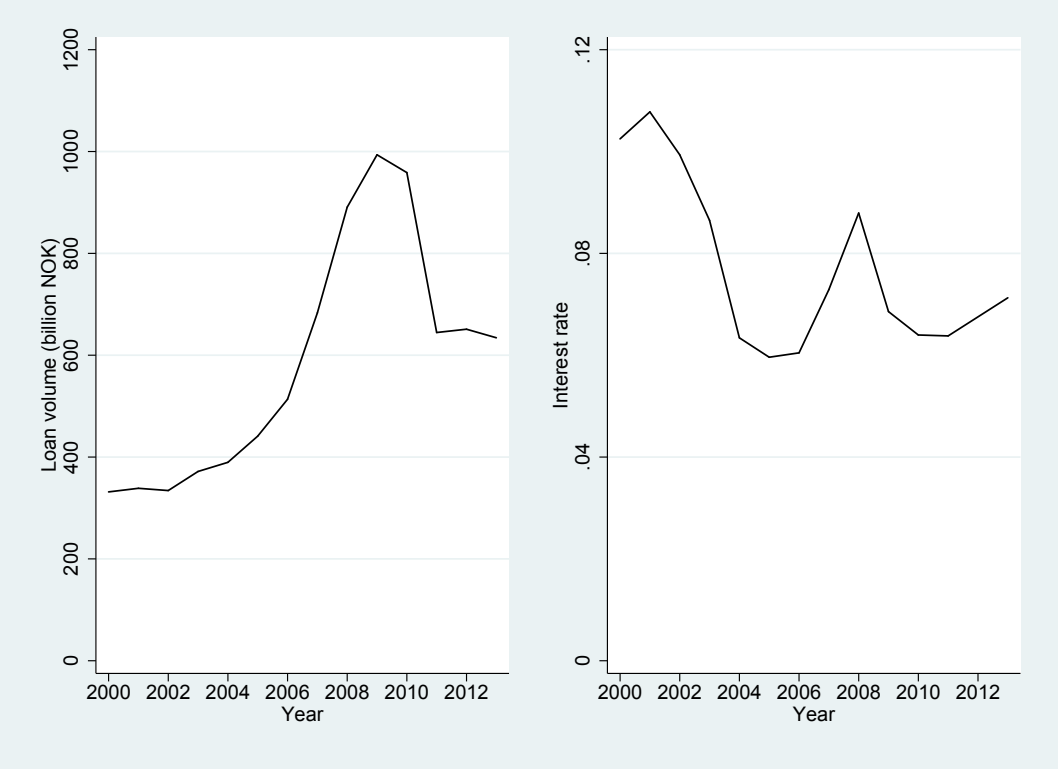


Figure 3: Non-performing loans rate and Loss provision rates in the period 2000-2013



Notes: Non-performing loans rate and loss provision rate are yearly averages across all banks in our sample.

Figure 4: Interest rate and loan volume



Notes: Loan volume is total outstanding loans from banks to firms in a given year. Interest rate is the average yearly interest rate, where each loan is given equal weight.

Figure 5: Kernel density of actual and adjustedl bank-level HHI

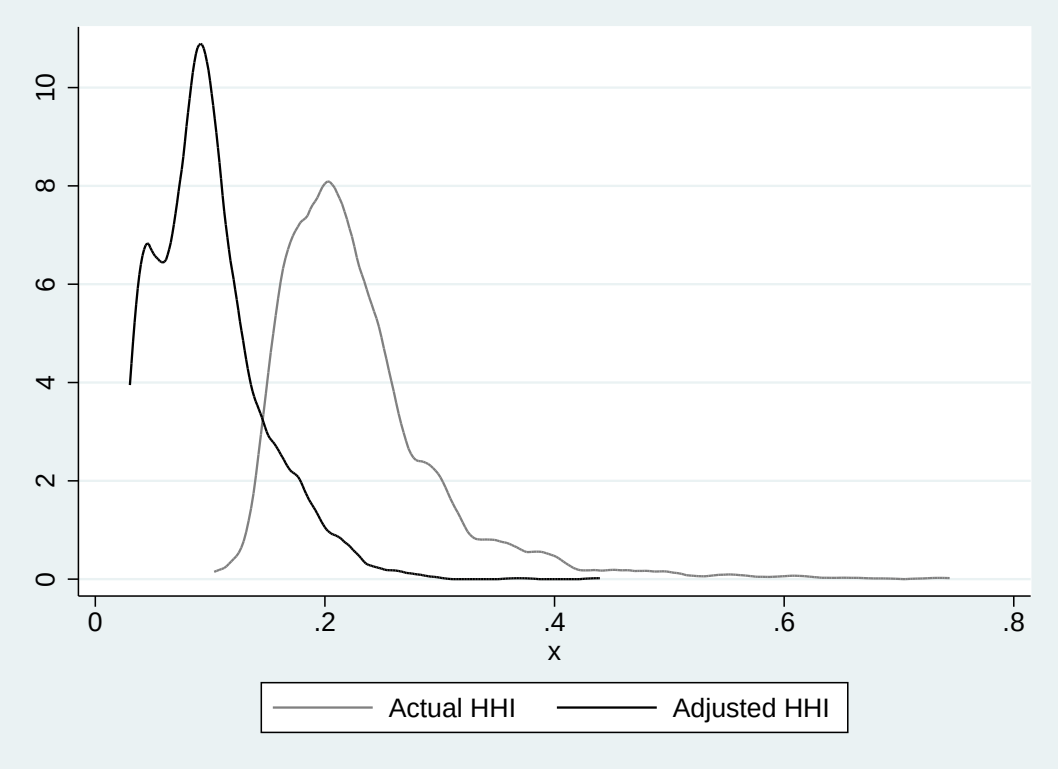
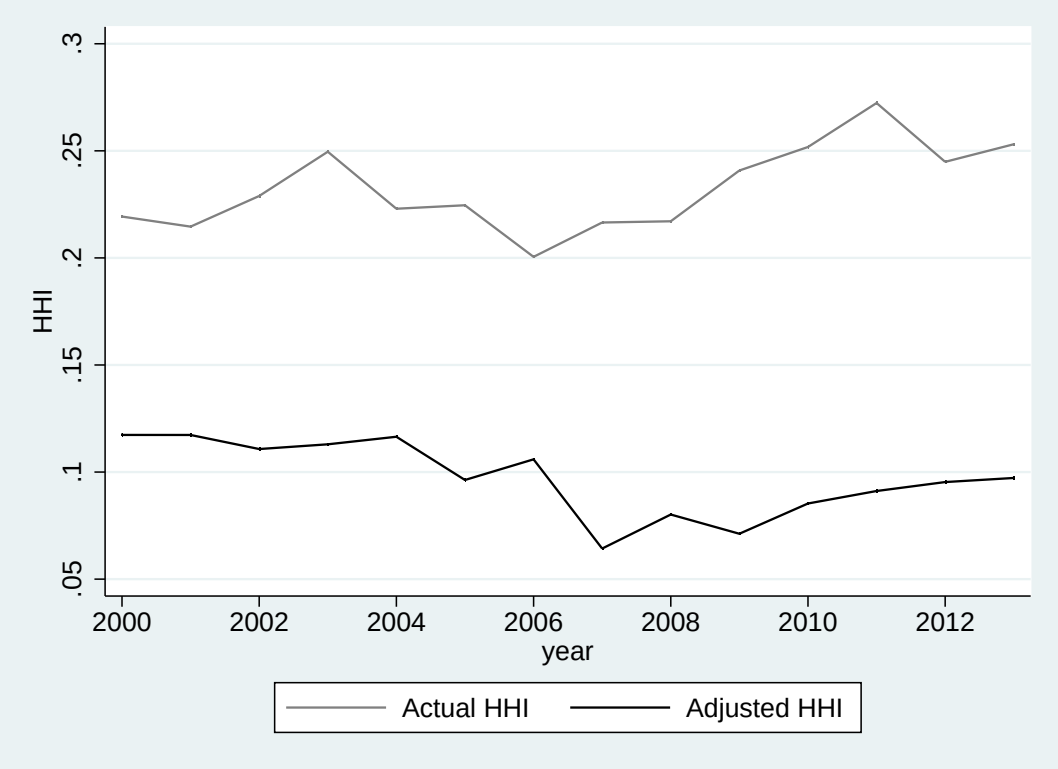
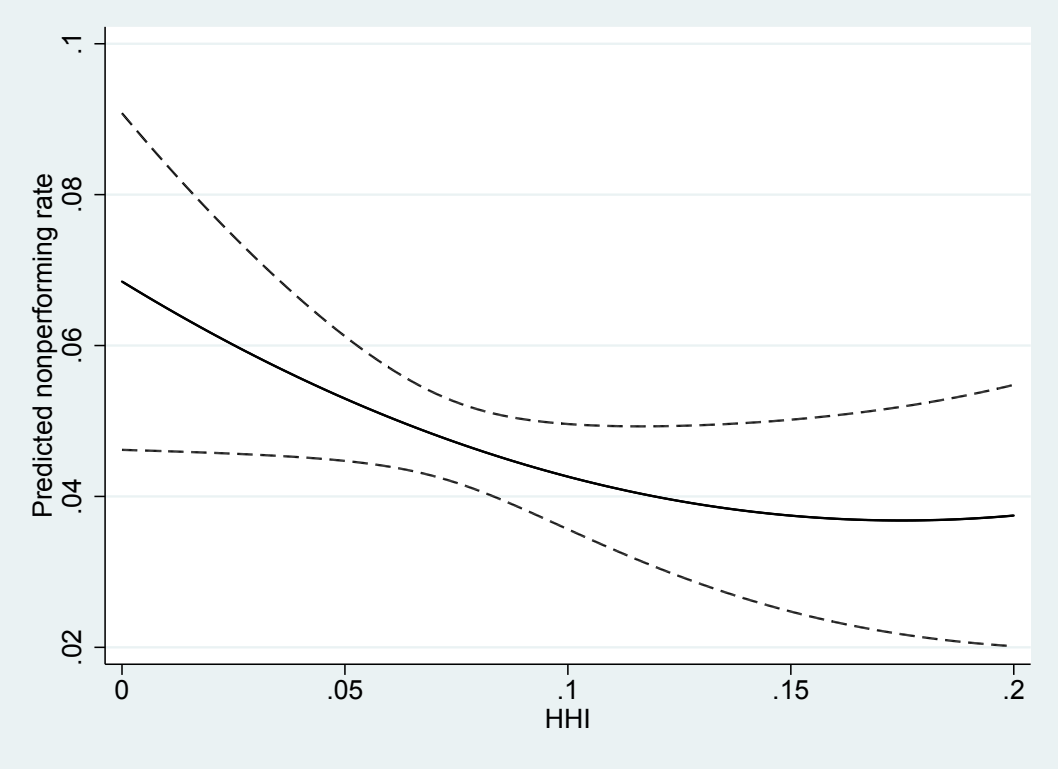


Figure 6: Actual and adjusted bank-level HHI in the period 2000-2013



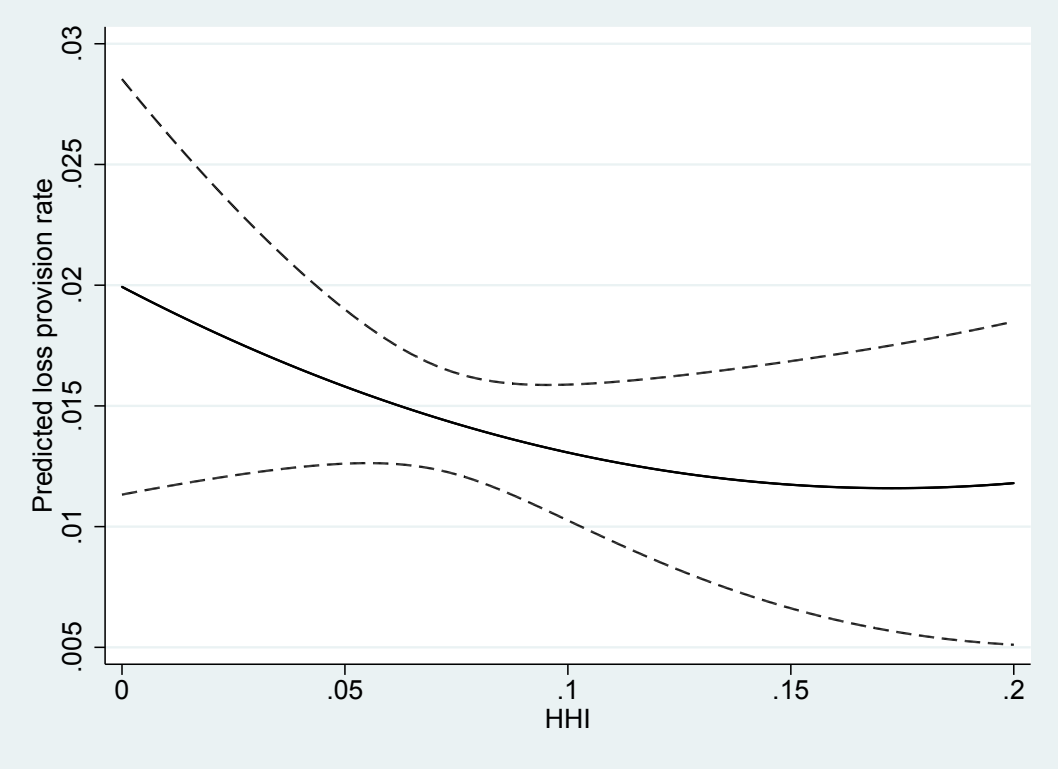
Notes: Actual and adjusted bank-level HHI are yearly averages across the banks in our samples.

Figure 7: Estimated values of nonperforming loan rate as a function of the adjusted HHI.



Notes: The estimates are obtained using the specification of Column (3) of Table 1. Dashed lines represent 95 % confidence interval.

Figure 8: Estimated values of loss provision rate as a function of the adjusted HHI.



Notes: The estimates are obtained using the specification of Column (3) of Table 2. Dashed lines represents 95 % confidence interval.

Table 1: Competition and NPLR

	(1) NPR	(2) NPR	(3) NPR
Adjusted HHI	−0.212*		−0.180*
	(0.120)		(0.108)
Adjusted HHI^2	0.541		0.468
	(0.328)		(0.293)
Adjusted HHI, one-year lag		−0.237*	−0.182*
		(0.120)	(0.099)
Adjusted HHI^2, one-year lag		0.680**	0.568**
		(0.335)	(0.282)
Observations	1852	1827	1827
Number of banks	160	157	157
Year fixed effects	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes

Notes: Column (1)-(3) report results of a fixed effect regression of the model specified in Equation 4. In all columns, the sample period is 2000-2013. NPLR is the non-performing loan rate, calculated as the proportion of loans whose interest and principal payments have not been paid on time. A loan is considered non-performing if scheduled payments have not been made for a period of 90 days or more, or if the bank has performed an write-down of the loan based on an individual assessment. The bank-level HHI is defined in Equation 3. The standard errors reported in parentheses are clustered at bank level.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: Competition and LPR

	(1) LPR	(2) LPR	(3) LPR
Adjusted HHI	−0.051		−0.028
	(0.045)		(0.039)
Adjusted HHI^2	0.150		0.102
	(0.117)		(0.099)
L.Adjusted HHI, one-year lag		−0.073	−0.068*
		(0.045)	(0.036)
L.Adjusted HHI^2, one-year lag		0.188	0.178*
		(0.118)	(0.097)
Observations	1852	1827	1827
Number of banks	160	157	157
Year fixed effects	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes

Notes: Column (1)-(3) report results of a fixed effect regression of the model specified in Equation 4. In all columns, the sample period is 2000-2013. LPR are loss provision rates. Loss provisions are allowances set aside to cover expected losses on loans considered to be at risk of not being repaid in full. A bank's LPR is the loss provisions divided by the value of the bank's loans. The bank-level HHI is defined in Equation 3. The standard errors reported in parentheses are clustered at bank level.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: Competiton and loan supply

	(1) Interest rate	(2) Loan size	(3) Loan take-up
Firm level HHI	0.123	−0.139*	0.045***
	(0.175)	(0.085)	(0.006)
Firm level HHI × Small	0.290*	−0.444***	0.066***
	(0.166)	(0.081)	(0.005)
Firm level HHI × New	0.306**	−0.251***	0.053***
	(0.151)	(0.069)	(0.005)
Small	0.310***	−0.295***	−0.028***
	(0.035)	(0.017)	(0.001)
New	0.483***	−0.134***	−0.003***
	(0.031)	(0.014)	(0.001)
Size of loan (million NOK)	−0.003***		
	(0.001)		
Constant	8.466***	0.993***	0.131***
	(0.088)	(0.047)	(0.003)
Observations	225743	225743	1855042
Year FE	Yes	Yes	Yes
Bank FE	Yes	Yes	No
Firm market FE	Yes	Yes	Yes
Industry sector FE	Yes	Yes	Yes

Notes: Column (1) reports results of an OLS regression of the model specified in Equation 6. Interest rate is calculated in the first full year the loan is observed. Only new loans are used in the estimation. Column (2) reports results of an OLS regression of the model specified in Equation 7. The dependent variable is the natural logarithm of the loan amount of new loans (in million NOK). The loan amount is measured at the end of the year the loan is taken up. Only new loans are used in the estimation. Column (3) reports results of an OLS regression of the model specified in Equation 8. The dependent variable equals one if the firm took out a loan in the year in question, zero otherwise. The firm-level HHI is defined in Equation 5. In all columns, the sample period is 2000-2013. Robust standard errors are reported in parenthesis.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Appendix

Table A1: Summary statistics

	Average	Median	St. Dev.	Observations
Bank level				
Actual HHI	.232	.216	.073	1852
Adjusted HHI	.098	.092	.045	1852
Non-performing loans rate	.037	.025	.042	1852
Loss provision rate	.011	.007	.013	1852
Firm level				
Interest rate (percentage points)	6.89	6.25	4.36	225743
Size of loan (million NOK)	6.87	0.97	54.5	225743
Small	.722	1	.448	225743
New	.359	0	.480	225743
Prob. of loan	.106	0	.308	1855042

Table A2: Naive regression

	(1) NPR	(2) NPR	(3) NPR
Acctual HHI	0.043		0.023
	(0.070)		(0.066)
Actual HHI^2	−0.070		−0.042
	(0.112)		(0.103)
L.Actual HHI, one-year lag		0.082	0.080
		(0.068)	(0.067)
L.Actual HHI^2, one-year lag		−0.119	−0.114
		(0.112)	(0.106)
Observations	1852	1827	1827
Number of banks	160	157	157
Year fixed effects	Yes	Yes	Yes
Bank fixed effects	Yes	Yes	Yes

Notes: Column (1)-(3) report results of a fixed effect regression of the model specified in Equation 4. In all columns, the sample period is 2000-2013. NPLR is the non-performing loan rate, calculated as the proportion of loans whose interest and principal payments have not been paid on time. A loan is considered non-performing if scheduled payments have not been made for a period of 90 days or more, or if the bank has performed an write-down of the loan based on an individual assessment. The bank-level HHI is the actual one, computed using actual demand flows. The standard errors reported in parentheses are clustered at bank level.

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.