Competition and the riskiness of banks' loan portfolios[*]

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Abstract

How does competition in the banking market affect the risk-exposure of the banks' loan portfolios? From a theoretical model we predict that dampened competition may give the banks incentives to accept more borrowers and thereby to take a larger risk on its portfolio. Using a panel of accounting data for Norwegian banks over the last 20 years, the relationship between the rate of non-performing loans and different measures of competition is analysed. We find a U-shaped relationship between concentration and non-performing loan rates (decreasing and then increasing). The findings suggest that a continued increasing trend in concentration contributes to higher non-performing loan rates. Similar results are found when using interest margin as the measure of the toughness of competition.

Keywords: stability, competition, concentration, risk-taking
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1. Introduction

Banks serve an important role in the economy. They are intermediaries of transactions, offer credit to borrowers and they accept and manage deposits for the public. Financial crises often spread out to other industries in the economy via the banking system. Ensuring a stable banking system is therefore crucial for financial stability. An important question is whether competition between banks will lead to more or less stability. This article contributes to both the theoretical and empirical literature on this issue. It is shown theoretically that higher margins can lead to more risk taking by the banks on the borrower side, and from data for the Norwegian bank industry it is found empirically that less competition has a non-monotonic effect on non-performing loan rates.

The relationship between competition and stability in the banking industry has been discussed for several decades in the economic literature.[1] On the one hand, it is found theoretically that competition can lead to less stability. The perhaps main mechanism is explained in the 'franchise value' hypothesis. With tougher competition the bank will have lower margins and thereby lower discounted net value (called franchised value). With lower value, the bank is willing to take more risk and thereby to make the banking industry less stable. On the other hand, it is found theoretically that competition can lead to more stability. One of the main mechanisms is that tougher competition and thereby lower margin will lead to less risk taking by the borrowers. Higher margins leads to a lower franchise value for the borrowers and thereby more risk taking by them.

In this article, a simple theoretical model is applied to analyse how higher margins may affect the risk taking of a bank. This adds to the existing literature, in particular Boyd and De

[1] For details concerning the existing literature, see the next section.

Nicolo (2005), in which the borrowers' rather than the banks' risk taking is analysed. In our model each borrower's risk taking is exogenous, while the banks' overall risk taking on the borrower side is endogenous. It is assumed that the bank must set not only the price the borrowers have to pay, but also the number of borrowers it decides to serve. Since the bank by assumption first serve the low-risk borrowers, the number of borrowers the bank serves will determine its exposure for risk. It is then shown that with a higher margin on lending, the bank will – all else equal – serve a larger number of borrowers. The intuition is simple. A higher margin will give incentives to serve one more borrower, even though this borrower has a higher risk than the last one served so far. Dampened price competition, *i.e.* higher margins, will therefore lead to more risk taking by the banks. In that respect dampened competition leads to more risk-taking and thereby a less stable banking industry.

To make predictions, we combine our theoretical results with results from the existing literature. In particular, it is of interest to take into account that higher margins also lead to more profits for the banks. This will according to 'franchise value' hypothesis make them less willing to take risk. Then there are two opposing effects on the relationship between competition and the risk profile of banks. On one hand, lower competition allows banks to operate with higher margins. This makes banks take less risk in order to protect their earnings. On the other hand, when interest rates become too high, loan customers are more likely to default on their payment obligations. This indicates a non-monotonic relationship between competition and stability: With tough competition initially a dampening of competition is expected to lead to less risk taking, while with soft competition initially a further dampening of competition is expected to lead to more risk taking.

Second, in this article our theoretical prediction is taken to data. In line with the theoretical model, it is focused on the borrower side and in particular on the risk-exposure of banks' loan portfolios. It is analysed empirically how the risk-taking of banks is affected by changes in competition. A panel of quarterly accounting data for all Norwegian banks over the last two decades are used. Using accounting data for Norwegian banks over the last 20 years, the relationship between the rate of non-performing loans and different measures of competition is investigated. Competition measures include concentration indexes and interest rate margin. The empirical findings indicate a non-linear, *U*-shaped, relationship between market concentration and loan risk. For low levels of concentration, increased concentration reduces non-performing loan rates. Past a certain level of concentration, this relationship is reversed. Using the interest rate margin we find similar results. With a low margin initially, an increased margin leads to higher non-performing loan rates, while with a high margin initially the opposite is true.

Our findings help us to better understand the mixed results in the literature concerning the relationship between competition and risk-taking in the banking industry. According to our empirical study, it is crucial to consider whether competition is dampened or not initially. If it is dampened initially, then there is more likely that a further dampening of competition can be harmful to stability in the banking industry. In such a situation there is no trade-off between competition and stability, since tougher competition leads to more stability. Only in those cases where there is tough competition initially, there will be a trade-off between dampening of competition and more stability.

The rest of this paper is organized as follows: Section 2 is a survey of the existing literature, while in Section 3 the theory model and the theoretical predictions are explained. Section 4 presents the general econometric model used for our analysis. In Section 5, we present our data, explain how variables are defined, and provide some descriptive statistics. Section 6 presents the results from the analysis. Finally, Section 7 gives some concluding remarks.

2. The existing literature

2.1 Theoretical literature

For several decades, economic literature has investigated a possible link between the degree of competition in the banking market and the incentives for banks to take risk. The main motivation is that excessive competition between banks has been blamed for past financial crises. However, competition in banking markets is generally thought to be positive for consumers, ensuring greater variety in financial products and wider access to credit. Allen and Gale (2003) argue that while costs of financial instability are large and apparent, efficiency gains of competition are harder to measure and are born continuously. As a result, the common perception that increased competition may hurt financial stability can lead policymakers to favour concentration over competition in banking markets. Differing views on the effects of competition in banking markets has created the foundation for an ongoing debate about whether competition contributes positively or negatively to financial stability. The literature has divided itself into two main paradigms: Competition-fragility and competition-stability.

The competition-fragility paradigm has a strong standing within banking literature, and has been supported over time both theoretically and empirically. This is the view that competition hurts financial stability by increasing banks' risk exposure. Keeley (1990) started this strand of literature by introducing the "franchise value" hypothesis. He claims that the sharp increase in bank failures during the 1980s could be attributed to financial deregulation in the preceding decades intensified the competition between banking organizations. According to Keeley, the increased competition had a negative effect on the banks' profit margins. This, in turn, decreased the franchise value of the banks, defined as the market value beyond the banks' book values. Keeley found this reduction in franchise value to have caused an increase in banks' risk taking. Hellmann *et al*. (2000) contributed to the franchise value hypothesis by stating that competition in the deposit market increases the moral hazard incentives of banks. According to the authors, the franchise value can only be captured if the bank remains in business and therefore represents the opportunity cost for the bank of going bankrupt. They argue that increased competition for deposits diminishes the profitability of banks and reduces franchise values. As a result, competition gives banks an incentive to increase their risk exposure and gamble with the depositors' money. In another paper, Matutes and Vives (2000) also argue that high levels of competition in the deposit market leads to excessive risk taking by banks.

Increased competition between banks may also have a negative effect on the credit-worthiness of the banks' loan applicants. This is due to an *adverse selection* problem in the loans market (Broecker, 1990; Shaffer, 1990). In a market with many banks, a rejected loan applicant is able to re-apply for a loan at competing banks. If the banks' credit screenings are independent of each other and the judgment errors being made differ across banks, the amount of loan applicants being approved by at least one bank will increase with the number of banks (Broecker, 1990). This implies that the average creditworthiness of the pool of applicants is a decreasing function of the number of banks. Allen and Gale (2000) discuss the effects of increased competition on the risk of contagion in the financial system. In the case of a small aggregate shock in demand for liquidity, perfect competition in the interbank market can lead to systemic risk. When each bank is small compared to the whole market, it will act as a price taker and have no incentive to provide liquidity to another troubled bank, thereby causing contagion to spread. Under these assumptions, it may therefore be optimal with an imperfectly competitive interbank market.

The competition-stability view promotes competition between banks in order to achieve a stable banking system. Boyd and De Nicolo (BDN, 2005) criticize the proponents of the franchise value perspective for assuming exogenous distribution of return on the bank's investments. Investments risk and return may in fact be endogenous and depend on the amount of competition in the market. This makes competition an important determinant of risk in both the loan and deposit market.

By assuming that increased competition lowers interest rates, BDN establish a relationship between competition and risk called the *risk shifting*-effect. This is the argument that while higher interest rates increase the franchise value of the banks, the franchise values of the borrowers' projects decrease. Low levels of banking competition therefore increase the riskiness of the borrowers. They argue that this is in essence a principal-agent relationship that exists in both the loan and deposit market. In the deposit market, the bank will be the one taking less risk with depositors' money if the deposit interest rates are low. When margins are higher, banks take less risk. Evidently, competition in the deposit and loan markets has opposite effects on bank risk. The authors conclude that a bank's risk profile will be unaffected by changes in competition when the banks compete in both markets.

The "too big to fail"-hypothesis (Mishkin, 1999) is another argument that competition may have positive effects on financial stability. Due to implicit guarantees by the government, banks above a certain size believe that they will always be saved through public bailouts. This is because the social cost of failure succeeds the private cost when the banks are large enough to have systemic importance. This stimulates these banks will be more risk seeking, knowing that negative consequences will be covered by the government. In a more fragmented banking market, the problem of excessive risk taking due to banks being "too big to fail" will be reduced.

Berger *et al*. (2008) point out that the lack of consensus in the literature may be explained by the need to distinguish between loan portfolio risk and overall bank risk. The competition-fragility view tends to focus on the positive effects of market power on the incentives for banks to reduce their overall risk of bankruptcy. On the other hand, literature within the competition-stability view puts emphasis on the negative effects of market power on loan portfolio risk. Even if market power in the loan market does in fact increase loan portfolio risk, higher interest rates should also contribute to increased franchise values. In order to protect their gain in franchise value, banks may offset the higher loan risk by mitigating other sources of risk, thereby reducing overall bank risk (Berger *et al*., 2008).

Martinez-Miera and Repullo (MMR, 2010) build on the model by BDN. They also analyse risk of failure for banks investing in entrepreneurial loans when the probability of the loans defaulting is endogenous and depends on the competition. The important extension in the MMR-model is that it allows for imperfectly correlated loan defaults, meaning that loans do not necessarily default at the same time. The risk of bank default does not necessarily increase with higher interest rates, because performing loans still make payments, now with an even higher margin. This *margin effect* opposes the *risk-shifting* effect from the BDN-model by increasing the buffer to cover loan losses when interest rates rises. The net effect of interest rate changes on risk is ambiguous. MMR go on to evaluate these effects at different levels of competition, finding a nonlinear *U*-shaped relationship, reconciling simple linear effects as suggested by previous theories. They find that the margin effect often dominates the risk-shifting effect, making increased competition lead to higher risk of bank failure. However, with a sufficiently dampened competition initially they find that even more dampening of competition can lead to more risk-taking in the industry.

2.2 The empirical literature

Empirical studies investigating the relationship between competition and stability are performed either for individual countries or over cross-country samples.

Berger *et al*. (2008) test how the empirical relationship between risk and competition is affected by using different measures of banking risk and market power using data for 8235 banks in 23 developed nations. Their findings indicate that while banks enjoying higher market power have less overall risk exposure (measured by *Z-score*), they also have higher loan portfolio risk (measured by *NPLrate*).

Cross country-studies have been performed over the last years due to the new availability of comparable data across countries. Carletti (2010) points out that cross-country studies generally find a positive relationship between competition and stability in the banking sector. These same cross-country studies also find a positive correlation between concentration and stability. This could imply that the benefits from concentration in terms of stability are not a result of lower competition, but through other effects such as diversification.

Tabak *et al*. (2012) perform a cross-country study investigating the relationship between competition and financial stability for 10 Latin American countries in the period 2003-2008. They find a significant non-linear relationship, but unlike other studies the estimated coefficients indicate that both high and low competition increase financial stability.

In a study of the Spanish banking market, Jiménez *et al*. (2013) investigate MMR's theory of a non-linear relationship between banking competition in the loans and deposit markets and risk-taking. Using *NPLrate* as the dependent risk variable, the authors find support of a non-linear relationship when using market concentration indexes in the loans market as competition measures. However, when using Lerner indexes the results for the loans market are more in support of the original franchise value hypothesis.

The empirical literature on banks' risk-taking and the competitive is inconclusive and the results vary with the different measures of competition and risk.

Several other estimation methods have emerged in response to the need for other measures that can describe competitive behaviour. The new empirical industrial organization approach (NEIO) bases competitive measures on microeconomic models, and is more closely related to the price-cost margin. A measure of the price-cost margin would therefore indicate competitiveness. The Lerner index, which equals the difference between the market price and marginal cost divided by the output price, is a measure of the price-cost margin would therefore indicate competitiveness. The challenge with this measure is that it requires access to detailed data on banks' prices and marginal cost. Examples of such measures are proposed by Panzar-Rosse (1987), Bresnahan (1982) and Boone *et al*. (2007).

3. Theory and predictions

3.1 A theoretical model

As described above, BDN has shown that a higher margin can lead to more risk taking by each borrower. Let us now focus on the endogenous risk taking by the lender (the bank).[2] To make it transparent how this will impact the risk taking in the banking industry, we assume that each borrower's risk taking is exogenous. Each borrower has a risky project, since there will always be a chance that the borrower is not able to repay its loan. Let us assume that the risk differs between the borrowers. Let p denote the probability of success for a project the borrower asks the bank to finance, where $0 < p < 1$. Furthermore, let Q denote the number of borrowers. It is assumed that $p(Q)$, and that $p' < 0$. The latter assumption implies that the probability for success for the next borrower that the bank finances is decreasing in the number of borrowers that are

[2] Thus, in contrast to the model by MMR, here the banks' choices concerning adding new risky borrowers are endogenised.

accepted by the bank. This can be interpreted as if the bank accepts first those potential borrowers with a high probability of success.[3]

Without loss of generality, let us assume that all borrowers pay the same price *r* (uniform price), also referred to as loan rate, and that the bank's unit cost is equal to *C*.[4] For the moment, let us consider the loan rate *r* for given. Then the bank must decide how many borrowers it should accept. The bank's decision problem is then the following:

$$\underset{Q}{Max}\,\pi = p\left(Q\right)Qr - QC \qquad (1)$$

As already mentioned, for each new borrower it accepts, the probability of success for the last borrower will decrease (*p* is decreasing in *Q*). Note that each new borrower has a constant effect on the cost side, while the revenue side depends on the probability of success and is therefore decreasing in the number of accepted borrowers. From the first order condition we find the optimal number of borrowers that are served by the bank, *Q**. By rearranging the first order condition, we find the following optimal risk exposure by the bank:

$$p^* = \frac{C - Q^* \cdot r \cdot p'}{r} \quad \left(= \frac{C}{r} - Q^* \cdot p' \right) \qquad (2)$$

[3] That every next borrower has a higher risk is a simple way of including adverse selection in our model. On the other hand, there is no moral hazard. This simplification is done to put focus on the endogenous risk taking by the bank.

[4] Uniform pricing is not crucial for our results. We could have different prices in different segments, for example. Our mechanism, that the bank would have incentives to accepting more loans when the margin is higher, would still be present within each segment.

We see that an increase in the unit cost *C* will lead to higher *p*, *i.e.* higher probability of success for the last borrower. It implies that higher cost will lead to fewer accepted borrowers and therefore less risk on the last borrower being accepted. This is intuitive.

Price–cost margin, *r*/*C*, might be seen as reflecting competition in the banking industry. Let us therefore consider how the margin will affect the risk taking. For a given unit cost *C*, a higher *r* leads to a higher margin. From (2) it can be shown the following relationship:

$$\frac{\partial p^*}{\partial r} = -\frac{C}{r^2} < 0 \qquad (3)$$

From (3) it follows that a higher price paid by the borrowers, *r*, will lead to a lower *p*, *i.e.*, a higher risk on the last borrower being accepted. The bank accepts a larger number of borrowers, because it earns a higher margin on each borrower. Thus, dampened price competition, *i.e.* higher margins, will therefore lead to more risk-taking by the banks and thereby a less stable banking industry.

Admittedly is the fact that banks might compete on loan rates, i.e. prices, not included in our rather simple model. However, when competition is dampened along one dimension, this might lead to tougher competition along other dimensions. It is in line with the mechanisms found in other markets, called semicollusion effect – that firms collude in one (or several) choice variable(s) and compete in other – might justify our model-simplification.[5] One could therefore think that existing banks collude on prices, but at the same time intensify the effort

[5] For a survey of the literature on semicollusion, see for example Steen and Sørgard (2009) and Schmalensee (1994). One example of this mechanism, analogous to the one we have analysed, is when firms can decide on both prices and capacity. It is shown in the existing literature that dampened competition on prices will lead to more investment in capacities.

on attracting borrowers and/or try to reduce the number of sellers. Thus, our simplification should therefore not affect our qualitative finding, that dampened price competition might lead to more risk-taking.

3.2 Predictions from theory

According to our theory, dampened competition on prices can lead to more risk taking by the banks by accepting a larger number of borrowers. As shown in BDN, dampened competition on prices can also give each borrower incentives to take more risk. Both of these two mechanisms will imply that dampened competition on prices will lead to a higher risk-exposure of banks' loan portfolios, and therefore lead to a less stable banking industry.

However, the existing literature shows clearly that there are other mechanisms at play that may lead to lower risk taking in the banking industry following dampened competition. MMR presents a theoretical model that combines both strands of the literature, the competition-fragility as well as the competition-stability view. They refer to the mechanisms in BDN as the risk-shifting effect, and add to that a margin effect (see above). They show theoretically that there will be a non-linear relationship between competition and risk-taking, and that with sufficiently dampened competition initially then a further dampening of competition may lead to more risk-taking in the industry. The latter is due to the fact that for high margins, which follows as a result of dampened competition, there is a high risk associated with accepting one more borrower.

Given our theory and the predictions of MMR, it is natural to test for any non-linear relationship between competition and risk-taking on the borrower side. Could it be that initially less competition leads to less risk-taking, while after a certain threshold level on the toughness of competition (or more precisely lack of toughness) it is found that less competition leads to more risk-taking? This is what we set out to test in our empirical study.

4. Econometric model

The following model is used to investigate the relationship between banks' risk-taking behaviour in the loan market and competition:

$$NPLrate_{i,t} = \beta_0 + \beta_1 Competition_{i,t} + \beta_2 Competition_{i,t}^2 + \sum_{n=1}^{M} \kappa_n \left(Controls_{i,t,n}\right) + \sum_{j=1}^{2} \gamma_j \left(NPLrate_{i,t-j}\right) + \varepsilon_{i,t} \quad (4)$$

where the ratio of non-performing loans to total loans ($NPLrate_{i,t}$) is a proxy for the risk exposure of banks' loan portfolio, while subscript *i* denotes bank and subscript *t* denotes time.

Competition is a variable with different measures of competition chosen on the basis of being both commonly applied in empirical literature, and within the limits of our available data. We include a squared term of the competition variable to take into account that the relationship between competition and risk may be non-linear. One such set of proxies is measures of market concentration. Examples are the Herfindahl-Hirschman index (*HHI*), the number of banks, and measures of the market share of the five largest banks (*C5*). The theoretical basis for using such indices as competition measures is the structure-conduct-performance (SCP) hypothesis, stating that market concentration creates an environment with less competitive behaviour. This would make concentration a suitable inverse measure of competition. We also use the banks' interest rate margin on loans (*IRmargin*) to proxy competition as a high margin indicates dampened competition. This is line, for example, with the view of the Norwegian Competition Authority when they argue that the competition in the Norwegian mortgage market is insufficient on the basis of increasing interest margins (see Norwegian Competition Authority (NCA), 2015).

The vector of control variables, *Controls*, includes both macro trends and bank-specific variables, which may affect the ratio of non-performing loans. The model also includes two lagged terms of the dependent variable, to account for the persistence in non-performing loan rates. Furthermore, yearly and seasonal dummies are included in all regressions to control for macro-shocks and seasonal effects, respectively. Finally, $\varepsilon_{i,t}$ is the model error term which contains both an unobserved bank-specific effect that remains constant over time - such as for instance management style, banking specialization and ownership structure -, as well as a time- and firm varying component: $\varepsilon_{i,t} = a_i + u_{i,t}$. Endogeneity might be an issue as there are unobservables determining banking competition which at the same time might be correlated with the dependent variable *NPLrate*. As already discussed, banks might compete aggressively to attract new borrowers and these last borrowers might have higher risk of default. The inclusion of bank specific observables, together with the unobserved bank-specific effects a_i, should mitigate the potential endogeneity problems of competition given that these unobserved bank-specific effects are constant over time.

5. Data

5.1 Sample description

The sample consists of quarterly data on earnings, costs and balance statements of banks operating in Norway covering the period from the first quarter of 1992, until the end of 2014. Data form the three first available years, 1992-1994, are discarded due the Norwegian banking crises lasting until 1993 (see for instance NOU 1992:30E), to avoid that peculiarities from this period may drive our estimation results. The data is assembled by Statistics Norway through financial statements and contained in a database called ORBOF, to which all banking corporations operating in Norway are required to report on a quarterly basis.[6] All banks operating in Norway are obligated to report financial statements to ORBOF. The banks can be classified as either Norwegian-owned, subsidiaries of foreign banks, as well as branches of foreign-owned banks. Some exceptions apply to Norwegian-registered branches of foreign banks (NUF), which for example are not required to report data on equity ratios. Banks with activity outside of Norway are required to report for their legal entity, which includes its foreign activities. In our sample, this concerns DNB, Santander, Nordea and Eika Kredittbank. These banks therefore report for two separate entities in each period. In our empirical analysis, we make sure to only include one of these entities. The data is reported on a non-consolidated level for the parent bank, excluding activity in subsidiaries.[7] An important issue regarding non-consolidated data is that over the last years, banks have increasingly transferred issued loans to credit institutions. This is a result of new regulation in 2007, which allowed for creation of covered bonds (OMF – obligasjoner med fortrinnsrett (Norw.)). The condition was that the bonds should be issued in separate credit institutions. Since covered bonds are an affordable form of financing for banks, it has become an increasingly important source of funding (Bakke and Rakkestad, 2010).

Banks that have less than or equal to eight consecutive observations (two years or less) of the dependent variable $NPLrate$ in our regressions are omitted.[8] The final dataset includes

[6] See http://www.ssb.no/innrapportering/naeringsliv/orbof (in Norwegian).

[7] This means that we are not able to analyse the spatial dimension of the Norwegian banking industry. For such an analysis, based on Belgium data, see Degryse and Ongena (2005).

[8] Banks with a shorter life span than this add little explanatory power because of the lag structure in our econometric models.

11502 observations spanning 80 quarters from 1995Q1 to 2014Q4. The number of banks varies from 125 to 147 in the sample period.[9]

5.2 Variable construction

Non-performing loan rates is calculated as the ratio of non-performing loans to total loans for each bank:

$$NPLrate_{i,t} = \frac{Non\text{-}\ perfoming\ loans_{i,t}}{Total\ loans_{i,t}} * 100$$

A loan is considered non-performing when interest and principal payments have not been paid on time. At that time, the bank is required to estimate the expected loss on the loan (Berge and Boye, 2007).[10]

The first competition measure is the C5-index, a measure representing the sum of the combined market shares of the five largest banks in loans market.

$$C5_t = \frac{\sum_{i=N-4}^{N} Total\ loans_{i,t}}{\sum_{i=1}^{N} Total\ loans_{i,t}} * 100$$

where N is the total number of banks, sorted by the size of *Total loans*. The second competition measure is the Herfindahl-Hirschman index (*HHI*) calculated as the sum of squared market shares:

[9] A closer look at our data reveals that outliers are mainly associated with entries, or disappearance due to mergers, yielding either very large or very small values. We exclude observations that are 3 standard deviations above or below the median value for each of the included variables.

[10] Since 2007, non-performing loans are reported for the banks' legal entity. This means that for banks with foreign activity (DNB, Nordea, Santander, and Eika Kredittbank), reported numbers of non-performing loans include loans made by the bank abroad. However, the size of the loans made abroad represents only a small fraction of the total loan portfolio. We therefore assume that the *NPLrate* calculated for legal entity can be used as a proxy for the domestic *NPLrate* for these four banks.

$$HHI_t = \sum_{i=1}^{N} Marketshare_{i,t}^2$$

HHI has a range of $\frac{1}{N}$ – all have equal market shares, to 1 – one bank has the entire market. While the *C5* index ignores the market share distribution of banks that are not among the five largest banks, *HHI* includes the market shares of all banks and assigns greater weight to larger banks.[11] The third competition measure is an interest rate margin for loans. Interest incomes from loans represent a significant part of their earnings base. Our dataset contains accounts for each bank's total loans issued to customers and quarterly interest income, which allow us to construct an implicit measure of the average interest rate charged on loans. The difference between this interest rate and the banks' funding cost is a measure of the interest rate margin. The 3-month NIBOR (Norwegian Inter Bank Offer Rate, provided by Oslo Stock Exchange through *Macrobond* and calculated as quarterly averages of daily trading rates on interbank lending) as a proxy for marginal funding cost. Thus, the third competition measure is constructed as follows:

$$IRmargin_{i,t} = (4 \cdot \frac{Interest\ income_{i,t}}{Gross\ total\ loans_{i,t}} - NIBOR_t) * 100$$

where the ratio in the bracket is multiplied by 4, to be able to interpret *IRmargin* in yearly percentages in the analysis.[12]

[11] Since 2007 significant amounts of loans have been transferred from parent banks to subsidiary credit institutions. Based on comparisons of our estimates with reported consolidated market shares (see https://www.fno.no/statistikk/bank) our calculated market shares for the five largest banks range between 0.5-4 percent above consolidated numbers.

[12] With the existing data funding costs for new loans are not available, only total costs on all deposits of the bank. Since NIBOR reflects market conditions and is the main component of the banks' marginal funding costs (NCA, 2015), our measure of *IRmargin* should reflect the interest rate margin on the marginal loan quite well.

In eq. (4), the following bank-specific effects and macro trends are included as control variables; quarterly GDP growth (*GDPgrowth*) controls for the impact of business cycles on banks' non-performing loan rates. The series is calculated from value-change in GDP from one quarter to the next for mainland Norway. The data is provided and seasonally adjusted by Statistics Norway (SSB 2015). The variable *GDPgrowth* is multiplied by 4 to be able to interpret the estimated coefficients as yearly growth-percentages. Return on Assets (*ROA*) measures the profitability of the bank. Market share (*Marketshare*) is the bank's market share in the loans market. Equity ratio (*Equityratio*) is calculated as equity over total assets. Finally, we include four lagged dependent variables to account for the potential persistency of the *NPLrate* since non-performing loans may remain on banks' balance sheets for several quarters.

5.3 Descriptive statistics

Table 1 provides summary statistics of the variables included in our econometric model.[13]

[Table 1: … about here]

The *NPLrate* varies from rates close to zero to more than 25 percent. Looking at the min-max values of the three competition measures, *C5*, *HHI*, and *IRmargin* we see quite large variation. For the latter variable this is also clear looking at the ratio between mean and st.dev.

[Figure 1: NPLrate … about here]

[13] The dataset is trimmed wrt. outliers. Especially for the *IRmargin* are extreme values found. Closer study reveals that many of these observations are related to banks' starting period, as well as prior to bank closure. A large portion can also be accredited to a small group of banks. This could be due to the fact that some banks specialize within risky segments of the loan market, and therefore consistently operate with high levels of non-performing loans.

Figure 1 shows the aggregate non-performing loans rate. The *NPLrate* was at a historic low before the financial crisis in 2008. This development has mainly been due to strong economic performance of the economy over the last two decades, as well as high debt growth in both the household and enterprise sectors (Berge and Boye, 2007).

[Figure 2: C5 and HHI … about here]

To get a clear picture of how market concentration has developed over the sample period, we provide a graph of *C5* and *HHI* indices for the loans market in Figure 2. The combined market shares of the 5 largest banks (*C5*) range between 55 and 65 percent over the sample period. Both measures show that concentration has increased since the beginning of the last decade. An event that made a large impact on market concentration was the 2003 merger between DnB and Gjensidige NOR, which at the time were the two largest banks operating in Norway. The market share of total loans for the new bank, DNB Bank ASA, was 38 percent after the merger. The event is visible from the spike in *HHI*. This measure puts greater emphasis on larger banks, since it is calculated as the sum of squared market shares.[14] The increase is not as visible from the plot of the *C5*-index, since the merger only increased this measure by the market share of the 6th largest bank moving up to 5th place.

[Figure 3: IRmargin … about here]

[14] The peak seen in 1999, is due to the merger between Postbanken and DnB Bank ASA.

The yearly averages of the interest rate margin, *IRmargin*, in Figure 3 reveals that the variable is subject to considerable variation, even after being trimmed for outliers. Even though this graph aggregates the interest rate margin over all banks and within each year, it illustrates that the measure is sensitive to market fluctuations. In their 2015 study, the NCA argued that the average interest rate margin has been increasing in recent years. They use a sample period from 2007-2015 to make this point. This trend is also evident in our graph. However, when viewed in a larger historical context, interest rate margins for recent years lie close to the average.

6. Empirical results

In our regression results tables, we list the results from estimating our model using both within group (WG), instrumental variable regression (IV), and generalized method of moments (GMM). It is well known that the WG estimator produces biased estimates of coefficients of the lagged dependent variable, and therefore also the other coefficients in the regression model. On the other hand, the WG estimator has bias of order $1/T$, and the bias therefore becomes smaller as T increases. One would therefore think that when the mode of the serial length of bank observation series is 80, the bias should be reduced towards an acceptable level. In our IV-regression, we first remove the fixed effect by taking the first difference, and then following the suggestion of Anderson and Hsiao (1982), using the second lag in levels $NPLrate_{i,t-2}$ as instrument for the first differenced lagged dependent variable. For the GMM we use a one-step estimation in normal first differences, with Windmeijer correction (see Windmejer, 2005) and robust standard errors clustered in banks.[15] We use lags t-2 of the *NPLrate* as instruments for

[15] Discussion of one-step vs. two-step GMM estimation is provided in Bond (2002).

the lagged dependent variable in addition to the other regressors also present as instruments.[16] For all IV and GMM-specifications we report the Arellano-Bond-test (Arellano and Bond, 1991) for first- and second order autocorrelation labelled *m1* and *m2*, respectively. We also report test statistics from the Hansen-tests for overidentifying restrictions for the GMM regressions, and Wald-tests for joint significance of the coefficients for all models.

[Table 2: C5 … about here]

Table 2 shows regression results of the relationship between our dependent variable, *NPLrate*, and the *C5* concentration index. We include results from using WG and IV estimators in Columns (1)-(2), while the results from using our preferred estimator, GMM, are listed in Column (3). Before looking at the coefficient estimates, it is worth noting that the *m2* test indicates that we can reject the null hypothesis of second order autocorrelation in both Columns (2) and (3). Admittedly, the Hansen overidentification test clearly states rejection of the validity of the orthogonality conditions. This problem is probably related to the many orthogonality conditions induced by the length of the sample including in total 80 periods. We furthermore see that the estimated coefficients on the lags of the dependent variable are all significant and positive. The coefficient on the first lag is in Column (3) is 0.44, confirming that the level of non-performing loans that banks hold in their balance is persistent. Focusing on the results in Column (3), the negative signs on the *GDPgrowth* variables confirm that increased economic

[16] Since we are able to use lagged values of already existing variables as instruments, we have also considered including more lags of the instruments. If extra instruments add more information, including them will improve the efficiency of the model. However, for every lag we include as instruments we reduce the sample size by one time period. One way to bypass this trade-off between model efficiency and sample size is the use of the Arellano-Bond (1991) procedure. This is implemented in STATA as xtabond2.

growth in previous quarters decreases the rate of non-performing loans. Our bank-specific control variables *ROA*, *Marketshare* and *Equityratio* turn out insignificant in explaining non-performing loan rates. This may indicate that the majority of differences between banks are controlled for when removing fixed effects.

However, our main relationship of interest is of how concentration affects the riskiness of the banks' loan portfolios. The GMM estimates show a significant non-linear relationship between the *C5* concentration index and non-performing loan rates. The estimated linear coefficient is negative while the coefficient on the squared term is positive, both significant on the 1% level. The turning point is 62.2, which lies within the range of observed values for the *C5* concentration index.

[Table 3: HHI … about here]

We find similar results between competition and the riskiness of banks' loan portfolios when using the *HHI* concentration index as a proxy for competition. Results for these regressions are summarized in Table 3. Both the linear term and the squared term are significantly positive at the 1% level. The turning point is 0.15. The model diagnostics and the significance of control variables remain the same when we use a different concentration index (the C5 and HHI). The findings in both Table 2 and Table 3 support a *U*-shaped relationship between concentration and the riskiness of the banks' loan portfolios. For low levels of market concentration, an increase in concentration has a negative effect on non-performing loan rates. Past the turning point, this relationship is reversed; higher market concentration increases non-performing loan rates.

[Figure 4: C5 based on GMM … about here]

[Figure 5: HHI based on GMM … about here]

Figure 4 and Figure 5 illustrate the estimated relationships between non-performing loan rates and concentration measures *C5* and *HHI*. The horizontal axis plots values of the relevant concentration index. Movement to the right along the horizontal axis implies increased concentration. The vertical grey lines mark the lower and upper levels of observed concentration values in our sample. We use the vertical axis to plot predicted values of *NPLrate* in order to illustrate how a change in concentration will affect levels of non-performing loan rates. The left vertical axis shows the short run effect of concentration changes on non-performing loan rates. The right vertical axis plots values corresponding to the long run effect.[17] The *U*-shaped relationship illustrated in these figures supports the theoretical model proposed by MMR suggesting that only in markets with low levels of competition will increased competition reduce the riskiness of banks. The intuition is that two opposing effects impact the relationship between competition and the risk profile of banks. On one hand, lower competition allows banks to operate with higher margins. This makes banks take less risk in order to protect their earnings. On the other hand, when interest rates become too high, loan customers are more likely to default on their payment obligations. This is referred to as the risk-shifting effect. Within our sample range of *C5*, the effect of concentration on non-performing loan rates is mostly negative. The mean observation value for *C5* is 59.5. For this concentration level, a percentage-point increase in the combined market share for the 5 largest banks reduces the

[17] Constant terms and firm specific effects are removed with GMM estimation. Therefore, the levels of the vertical axes in our graphs are normalized so that the average of the predicted values within the sample equals the *NPLrate* variable average.

NPLrate by 0.04 percentage points in the short run. The long-run effect is a decrease of 0.09 percentage points. The *HHI* variable has a mean value of 0.115, which is also below the turning point. At this concentration level, the short-run effect of an increase of 0.01 in *HHI* is a 0.08 percentage point reduction in *NPLrate*. The long-run effect at this point is a decrease in *NPLrate* of 0.18 percentage points. The estimated turning points for both *C5* and *HHI* are relatively high compared to observed values over the sample period. This could imply that increases in concentration have for the most part contributed to reductions in non-performing loan rates for Norwegian banks. However, the level of concentration as measured by both *C5* and *HHI* has exhibited a positive trend for the last 5 years (see Figure 2). In fact, the concentration level in the last period of our sample (2014, Q4) is among the highest observed values of concentration for the last 20 years. While the last observed *HHI* is still below the turning point, the *C5* index in this quarter is close to the turning point of 61.3. Our regression results therefore indicate that a continued positive trend in bank concentration will increase non-performing loan rates.

[Table 4: IRmargin … about here]

Table 4 reports the regression results using interest rate margins as the measure of competition. *IRmargin* is calculated as of the difference between the average interest rate on loans and the 3-month NIBOR rate. Again the effect of GDP growth is negative in all periods. Model diagnostics show that the both GMM and IV-reg estimations are free from autocorrelation. In the same way as seen in Tables 2 and 3, columns (3) the overidentification tests state rejection of the validity of the instrument (see also discussion in FN 16). As a robustness check, we see that the results from IV-reg in Column (2) and GMM in Column (3) are very similar.

[Figure 6: IRmargin … about here]

Figure 6 graphs the predicted values for $NPLrate$ at different levels of $IRmargin$. The left vertical axis plots the impact on $NPLrate$ in the short run, while the right vertical axis plots the long-run effect. The grey vertical lines represent the maximum and minimum values of $IRmargin$ observed in our sample. Using the interest rate margin as the competition variable, we find the same U-shaped relationship between competition and the bank's non-performing loan rates as for concentration indexes. These findings provide further support of the theoretical model proposed by MMR, and also point to competition having opposing effects on non-performing loan rates. For this variable, the turning point is found to be an interest rate margin of 3.5 percentage points.

The turning point is higher than the sample mean of 2.63 percentage points, but below the average values observed in the last years of the sample. In fact, since the third quarter of 2011, the average interest rate margin of all Norwegian banks has been higher than 3.5 percentage points in every quarter except for Q2:2012. This might indicate that the Norwegian banking market is already sufficiently collusive, so that increased competition will contribute to reductions in non-performing loan rates. However, the average level of $IRmargin$ in each quarter reflects differences among the banks, which compete amongst different market segments. Closer investigation reveals that when weighted according to the total number of outstanding loans, since 2011 average values of $IRmargin$ range between 2.3 and 3.2 since 2011, considerably below the turning point. As a result, these findings do not provide evidence to suggest that reducing competitiveness of the Norwegian banking market will increase the riskiness of the bank's loan portfolios on an aggregate level.

We have addressed the potential endogeneity problems caused by the existence of unobservables determining banking competition which at the same time are correlated with the dependent variable *NPLrate* by the inclusion of the unobserved bank-specific effects. Admittedly is such a control heavily based on the assumption that these bank-specific effects are constant over time. One could of course have addressed this further if good instruments for competition would exists in the dataset. Furthermore, a diff-in-diff analysis related to the mergers in the Norwegian banking industry in 1999 and 2003 might also have been used. However, one could always question whether mergers are really exogenous shocks and whether there is no existence of a gun jumping effects, i.e. that the merging parties are able and willing to coordinate their behaviour a significant period before the announcement of the merger. Such pre-event effects might also make it hard to use lagged values of competition as potential instruments for competition. Finally, as already mentioned, the use of lagged dependent variables and the many orthogonality conditions due to the sample length, makes it hard to address the potential endogeneity problems of competition further (and also the potential endogeneity of the controls), since more instruments necessarily requires more orthogonality conditions.[18]

7. Concluding remarks

According to theory, it can be a non-linear relationship between market concentration and banks' rates of non-performing loans. Using Norwegian data we find support for our theoretical

[18] Another issue which might violate the empirical findings is selection bias due to banks' entry and exit. The number of banks during the sample period has been slightly decreasing mainly because of mergers between smaller banks, while some international banks have entered the Norwegian banking industry. There have been no bankruptcies. The stability makes it hard to really address the bias caused by entry and exit using the Norwegian data used here. Furthermore, a full econometric analysis of entries, potential entry barriers, and exits is beyond the scope of this paper.

prediction. For low levels of concentration in the banking market, increased concentration contributes to reduce non-performing loan rates. Past a certain level of concentration, this relationship is reversed.

Our findings therefore imply that in order to minimize non-performing loan rates, there is an optimal level of market concentration. Regression results using both *HHI* and *C5* indexes conclude that the Norwegian banking market today is close to this optimal level. Our findings suggest a continued increasing trend in concentration will contribute to higher non-performing loan rates. Using the interest rate margin as a competitive measure, we also find a *U*-shaped pattern between the interest rate margin and our risk measure. Higher interest rate margins are found to reduce the rates of non-performing loans as long as the interest margin is less than 3.5 percent. After this point, a further increase in the interest margin leads to an increase in the rates of non-performing loans. Provided that the interest rate margin measures competitive behaviour, these results are consistent with the findings using concentration as proxies for competition; there is a non-linear relationship between competition and risk-taking in the banking industry.

The empirical findings are consistent with already existing findings in the literature, which have shown both positive and negative relationships between competition and stability in the banking industry. In addition, we have applied a simple theoretical model to show that dampened competition can give banks incentives to accept more borrowers and thereby take more risk. This mechanism has so far not been addressed in the literature, and therefore adds to the existing theoretical literature on risk taking and competition. Thus, this article contributes to both the theoretical and empirical literature on the question whether increased competition in the banking sector will lead to more or less financial stability, an issue of high interest of researchers, policy makers and regulators.

References

Allen, F., and Gale, D. M. (2000). Financial Contagion. *Journal of Political Economy*, pp. 1-33.

Allen, F., and Gale, D. M. (2003). Competition and Financial Stability. *NYU Working Paper No. S-FI-03-06*.

Anderson, T., and Hsiao, C. (1982). Formulation and estimation of dynamic models using panel data. *Journal of Econometrics*, 18(1), pp. 47–82.

Arellano, M., and Bond, S. (1991). Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations. *The Review of Economic Studies, 58*(2), pp. 277-297.

Bakke, B., and Rakkestad, K. (2010). Obligasjoner med fortrinnsrett - et marked i sterk vekst. *Penger og Kreditt, 38*(1), pp. 4-19.

Berge, T., and Boye, K. G. (2007). *An analysis of banks' problem loans.* Norges Bank, Financial Markets Department. Economic Bulletin.

Berger, A. N., Klapper, L. F., and Turk-Ariss, R. (2008). Bank Competition and Financial Stability. *Journal of Financial Service Research,* 35, pp. 99-118.

Berger, A. N.-K. (2004). Bank concentration and competition: An evolution in the making. *Journal of Money, Credit and Banking*, pp. 433-451.

Bikker, J. A., and Haaf, K. (2002). Competition, concentration and their relationship: An empirical analysis of the banking industry. *Journal of Banking and Finance*, pp. 2191-2214.

Bikker, J. A., Shaffer, S., and Spierdijk, L. (2012). Assessing Competition With The Panzar-Rosse Model: The Role of Scale, Costs and Equilibrium. *The Review of Economics and Statistics* , pp. 1025–1044.

Bikker, J. A., and Spierdijk, L. (2008). How Banking Competition Changed over Time. *Discussion Paper Series nr: 08-04*.

Bikker, J. A., and Spierdijk, L. (2010). Measuring and explaining competition in the financial sector. *Journal of Applied Business and Economics* (11), pp. 11-42.

Bond, S. R. (2002). Dynamic panel data models: a guide to micor data methods and practice. *Portugese Economic Journal*, pp. 141-162.

Boone, J., van der Wiel, H., and van Ours, J. (2007). How (not) to measure competition. *CPB Discussion Paper*.

Boyd, J. H., and De Nicolò, G. (2005). The Theory of Bank Risk Taking and Competition Revisited. *The Journal of Finance,* 60(3), pp. 1329-43.

Bresnahan, T. F. (1982). The Oligopoly Solution Concept is Identified. *Economics Letters*, 10, pp. 87-92.

Breusch, T., and Pagan, A. (1979). A Simple Test for Heteroskedasticity and Random Coefficient Variation. *Econometrica, 47*, pp. 1287-1294.

Broecker, T. (1990). Credit-Worthiness Tests and Interbank Competition. *Econometrica, 58*(2), pp. 429-452.

Carletti, E. (2008). Competition and regulation in banking. In A. Thakor, and A. Boots, *Handbook of Financial Intermediation and Banking* (pp. 449-482). Elsevier.

Carletti, E. (2010). Competition, concentration and stability in the banking sector. *OECD Competition Committee Roundtable. 9*, pp. 13-37. Paris: DAF/COMP.

Degryse, H. and S. Ongena (2005). Distance, Lending Relationships, and Competition, *Journal of Finance* 60(1), pp. 231–266.

Gram, T. (2011). Når staten tar kontroll - Bankkrisen fra 1991-1993. *Staff memo*(18).
Hellmann, T. F., Murdock, K. C., and Stiglitz, J. E. (2000). Liberalization, Moral hazard in Banking, and Prudential Regulation: Are Capital Requirements Enough? *The American Economic Review, 90*(1), pp. 147-165.
Hoff, E. (2011). *The composition of Norwegian banks' funding and the effect of risk premiums on bank lending rates.* Liquidity Surveillance Department. Norges Bank.
Jiménez, G., Lopez, J. A., and Saurina, J. (2013). How does competition affect bank risk-taking? *Journal of Financial Stability,* 9, pp. 185-195.
Keeley, M. C. (1990). Deposit Insurance, Risk, and market Power in Banking. *The American Economic Review, 80*(5), pp. 1183-1200.
Martinez-Miera, D., and Repullo, R. (2010). Does Competition Reduce the Risk of Bank Failure? *The Review of Financial Studies*, 23(10), pp. 3638-64.
Matutes, C., and Vives, X. (2000). Imperfect competition, risk taking, and regulation in banking. *European Economic Review,* 44, pp. 1-34.
Mishkin, F. S. (1999). Financial consolidation: Dangers and opportunities. *Journal of Banking and Finance*, 23, pp. 675-91.
NCA. (2015). *Konkurransen i boliglånsmarkedet.* Konkurransetilsynet.
NOU - Norwegian Official Reports (1992). Report by the Commision on the Banking Crisis. NOU 1992: 30E, Royal Ministry of Finance and Customs, Oslo
Norges Bank (2014). *2014 Financial Stability Report.* Oslo: Norges Bank.
Panzar, J. C. (1987). Testing for 'Monopoly' Equilibrium. *Journal of Industrial Economics*, 35(4), pp. 443-56.
Roodman, D. (2009). How to do xtabond2: An introduction to difference and system GMM in Stata. *The Stata Journal, 9*(1), pp. 86-136.
Schmalensee, R. (1994): 'Sunk costs and market structure: A review article', *Journal of Industrial Economics*, 40, pp. 125-134.
Shaffer, S. (1990). The Winner's Curse in Banking. *Journal of Financial Intermediation*, pp. 359-392.
Sparebankforeningen. (n.d.). *Antall sparebanker*. Retrieved from http://www.sparebankforeningen.no/id/16941
Spierdijk, L., and Shaffer, S. (2015). The Panzar-Rosse Revenue Test and Market Power in Banking. *Social Science Research Network (SSRN).*
Statistics Norway (SSB). (2015, Febuary 11). *Statistics Norway.* Retrieved March 1, 2015, from Kvartalsvis nasjonalregnskap: https://www.ssb.no/knr
Steen, F., and Sørgard, L. (2009): 'Semicollusion', *Foundations and Trends in Microeconomics*, 5, pp. 153-228.
Stiglitz, J. E., and Weiss, A. (1981, June). Credit Rationing in Markets with Imperfect Information. *The American Economic Review*, 71(3), pp. 393-410.
Tabak, B. M., Fazio, D. M., and Cajueiro, D. O. (2012). The relationship between banking market competition and risk-taking: Do size and capitalization matter?. *Journal of Banking and Finance* 36, pp. 3366-3381.
Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step GMM estimators. *Journal of Econometrics,* 126, pp. 25-51.

Table 1: Descriptive Statistics

	Mean	Observations	Median	Min	Max	St. dev
Dependent variable						
NPLrate	2.057	11502	1.44	0.00027	25.5	2.089
Competition variables						
C5	59.54	11502	60.06	54.5	64.3	2.554
HHI	0.115	11502	0.11	0.082	0.17	0.025
IRmargin	2.631	11502	2.50	-3.45	17.3	1.635
Control variables						
GDPgrowth	0.726	11502	0.61	-2.28	4.23	0.989
ROA	0.297	11502	0.29	-4.66	6.09	0.294
Marketshare	0.695	11502	0.09	0.0022	36.9	2.721
Equityratio	10.38	11502	9.81	-11.8	64.1	3.997

Notes: The statistics are based on observations in the sample from regressions in Tables 2-4.

Table 2 - Regression with *C5* as competition proxy

Variables	(1) WG	(2) IV-reg	(3) GMM
C5	-1.4504***	-0.8925***	-1.2318***
	(0.2840)	(0.3164)	(0.3303)
C5-squared	0.0116***	0.0070***	0.0099***
	(0.0023)	(0.0026)	(0.0027)
L1.NPLrate	0.5267***	0.5259***	0.4446***
	(0.0274)	(0.0426)	(0.0344)
L2.NPLrate	0.2231***	0.1613***	0.1195***
	(0.0216)	(0.0298)	(0.0263)
L1.GDPgrowth	-0.0309***	-0.0249**	-0.0204*
	(0.0116)	(0.0121)	(0.0112)
ROA	-0.1830**	-0.0696	-0.0676
	(0.0733)	(0.0816)	(0.0802)
Marketshare	0.0179	0.0331	0.0370
	(0.0217)	(0.0785)	(0.0819)
Equityratio	-0.0120	-0.0058	-0.0201
	(0.0112)	(0.0440)	(0.0392)
Observations	11502	11502	11502
Sum L.R.	0.7498	0.6871	0.5641
Seasonal dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
1st order AC - m1		-7.648	-7.822
2nd order AC - m2		-1.918	0.188
Wald test	0.000	0.000	0.000
Hansen test			0.000

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: Dependent variable; NPLrate. *C5* is a market concentration index - market shares in the loans market for the 5 largest banks. m_1 and m_2 are the Arellano-Bond tests for first- and second order autocorrelation. The reported p-values of the Wald-test, which tests for joint significance of the estimated coefficients. The Hansen test tests the model for overidentification. Clustered standard errors in parentheses.

Table 3 - Regression with *HHI* as competition proxy

Variables	(1) WG	(2) IV-reg	(3) GMM
HHI	-63.7934***	-33.0254*	-54.7451***
	(11.5668)	(16.8640)	(14.3000)
HHI-squared	212.7231***	103.3730	184.2357***
	(42.4364)	(65.2239)	(51.4429)
L.NPLrate	0.5262***	0.5173***	0.4405***
	(0.0273)	(0.0551)	(0.0340)
L2.NPLrate	0.2230***	0.1578***	0.1170***
	(0.0215)	(0.0215)	(0.0265)
L.GDPgrowth	-0.0329***	-0.0258***	-0.0214*
	(0.0114)	(0.0091)	(0.0110)
ROA	-0.1821**	-0.0710*	-0.0693
	(0.0733)	(0.0399)	(0.0801)
Marketshare	0.0182	0.0312	0.0390
	(0.0214)	(0.1125)	(0.0793)
Equityratio	-0.0118	-0.0038	-0.0174
	(0.0112)	(0.0228)	(0.0394)
Observations	11502	11502	11502
Sum L.R.	0.7492	0.6751	0.5575
Seasonal dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
1st order AC - m1		-16.563	-7.785
2nd order AC - m2		-3.022	0.264
Wald test	0.000	.	0.000
Hansen test			0.001

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Notes: See notes to Table 2

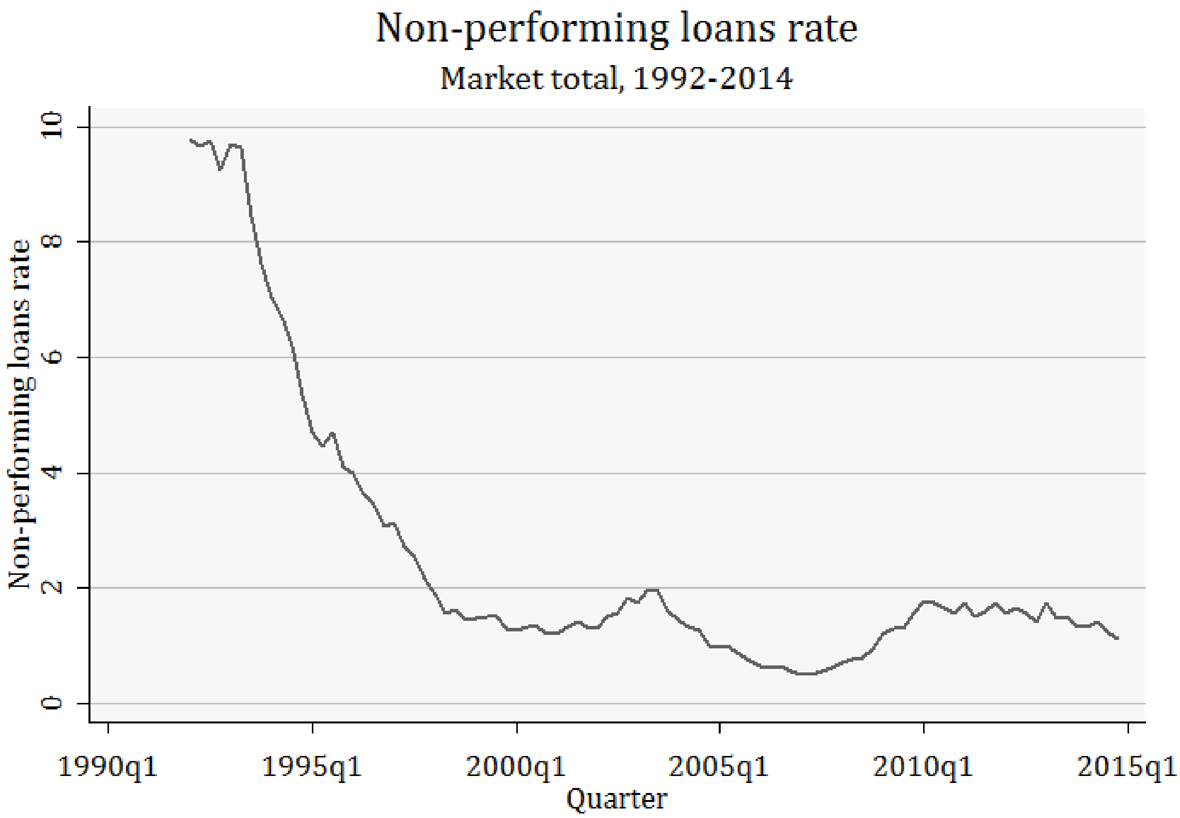
Table 4 - Regression with *IRmargin* as competition proxy

Variables	(1) WG	(2) IV-reg	(3) GMM
IRmargin	-0.0359*	-0.0597**	-0.0575*
	(0.0183)	(0.0299)	(0.0308)
IRmargin squared	0.0059***	0.0071**	0.0078**
	(0.0017)	(0.0033)	(0.0034)
L1.NPLrate	0.5248***	0.5162***	0.4384***
	(0.0271)	(0.0404)	(0.0323)
L2.NPLrate	0.2213***	0.1586***	0.1164***
	(0.0216)	(0.0306)	(0.0271)
L.GDPgrowth	-0.0430***	-0.0308***	-0.0313***
	(0.0110)	(0.0119)	(0.0104)
ROA	-0.1975***	-0.0661	-0.0694
	(0.0733)	(0.0805)	(0.0802)
Marketshare	0.0249	0.0304	0.0290
	(0.0214)	(0.0733)	(0.0745)
Equityratio	-0.0116	-0.0058	-0.0165
	(0.0113)	(0.0440)	(0.0398)
Observations	11502	11502	11502
Sum L.R.	0.7461	0.6749	0.5548
Seasonal dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes
1st order AC - m1		-7.536	-7.743
2nd order AC - m2		-1.916	0.221
Wald test	0.000	0.000	0.000
Hansen test			0.001

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

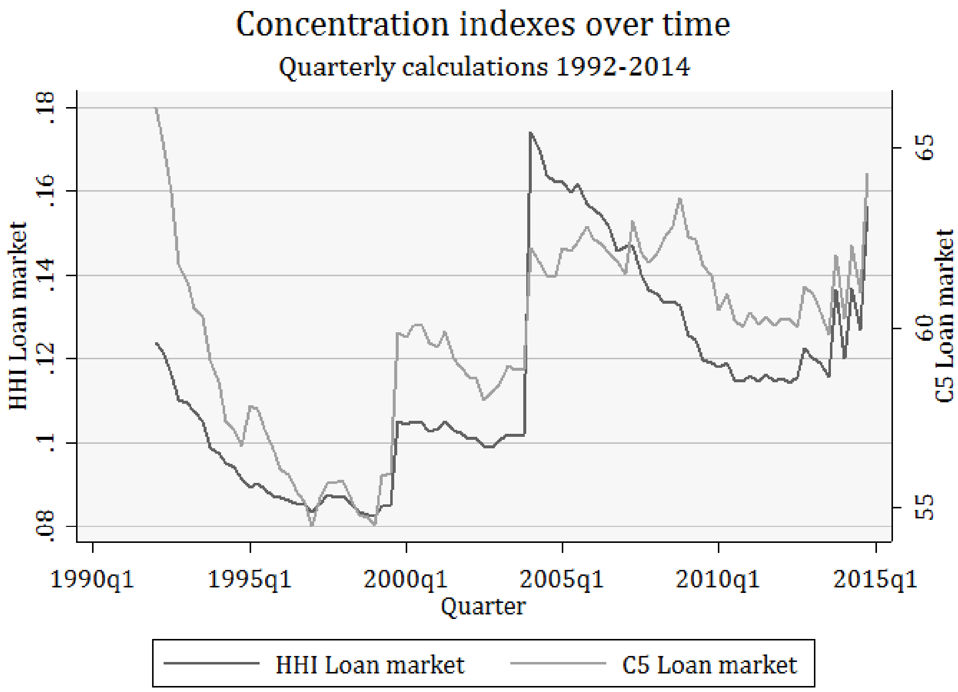
Notes: See notes to Table 2.

Figure 1



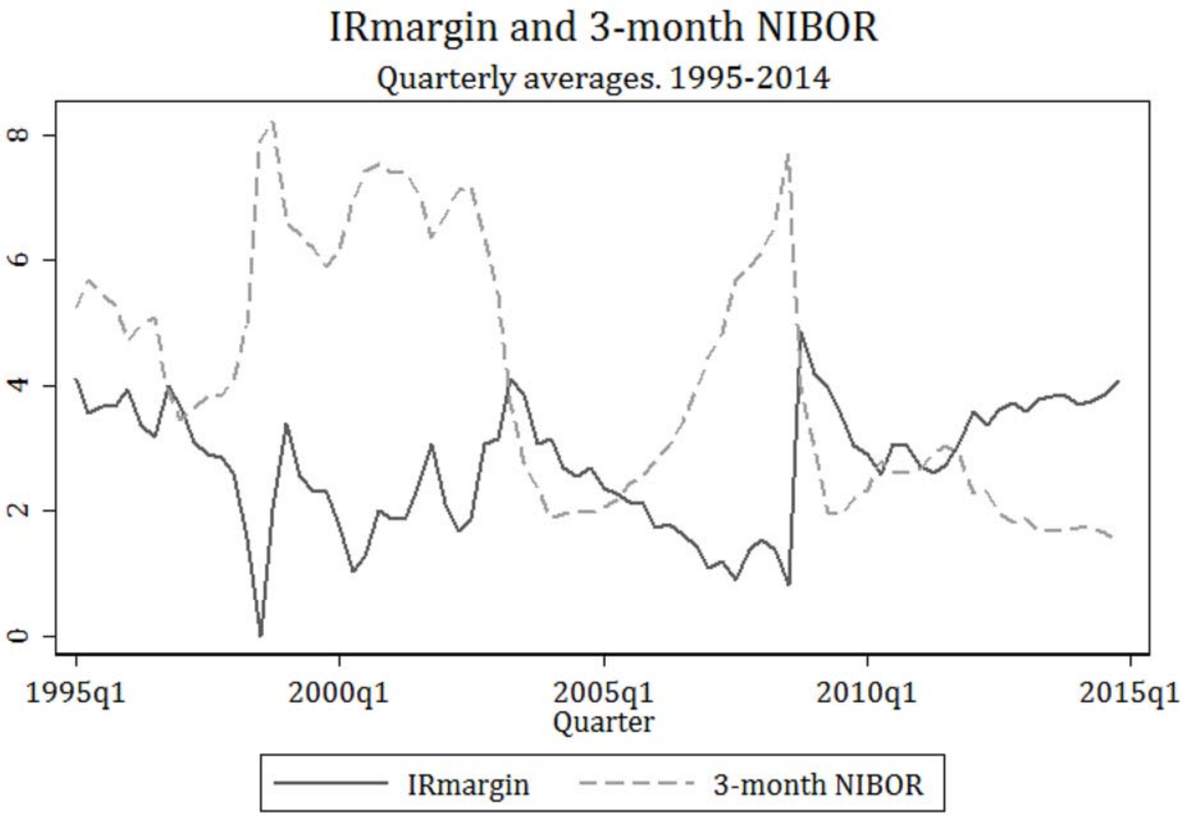
Note: Source: ORBOF database (Statistics Norway)

Figure 2



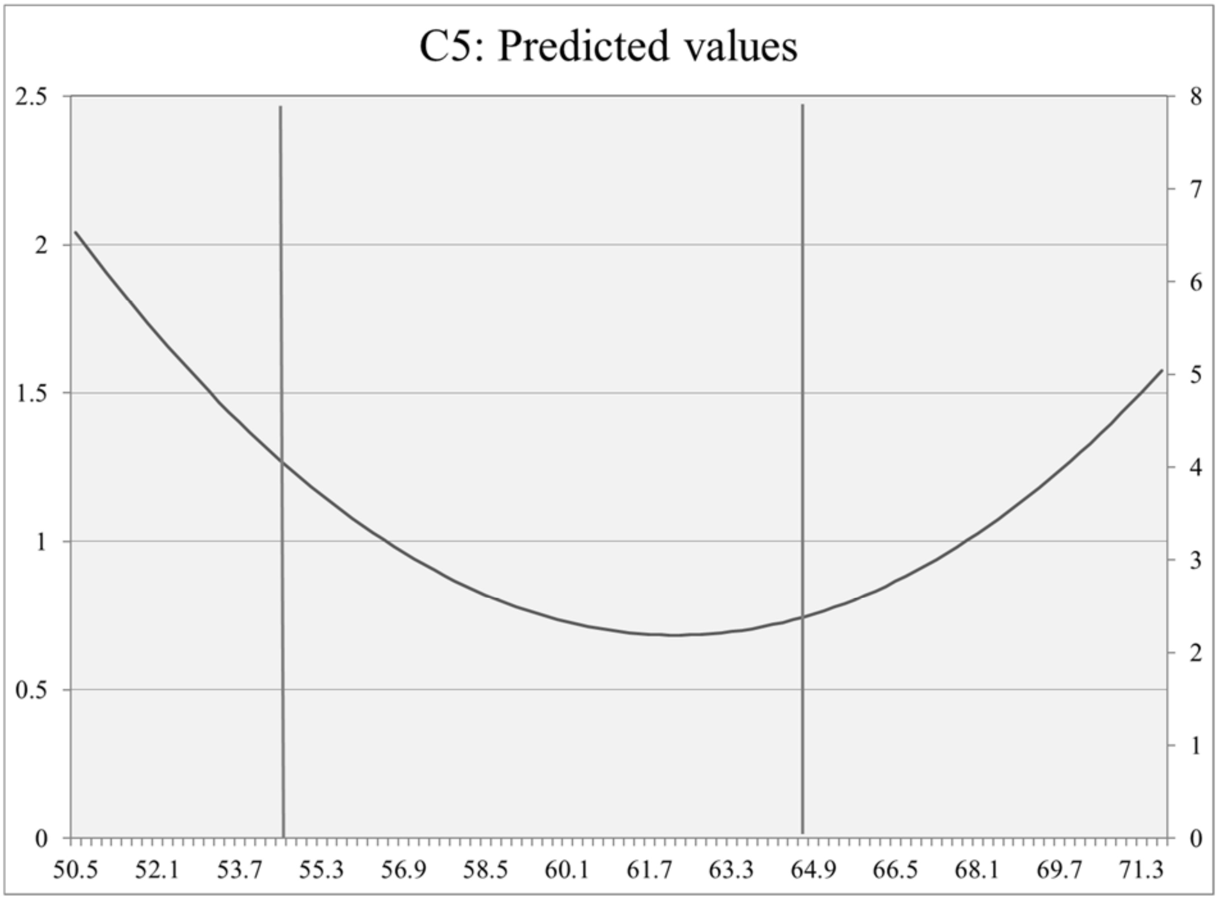
Note: Source: ORBOF database (Statistics Norway)

Figure 3



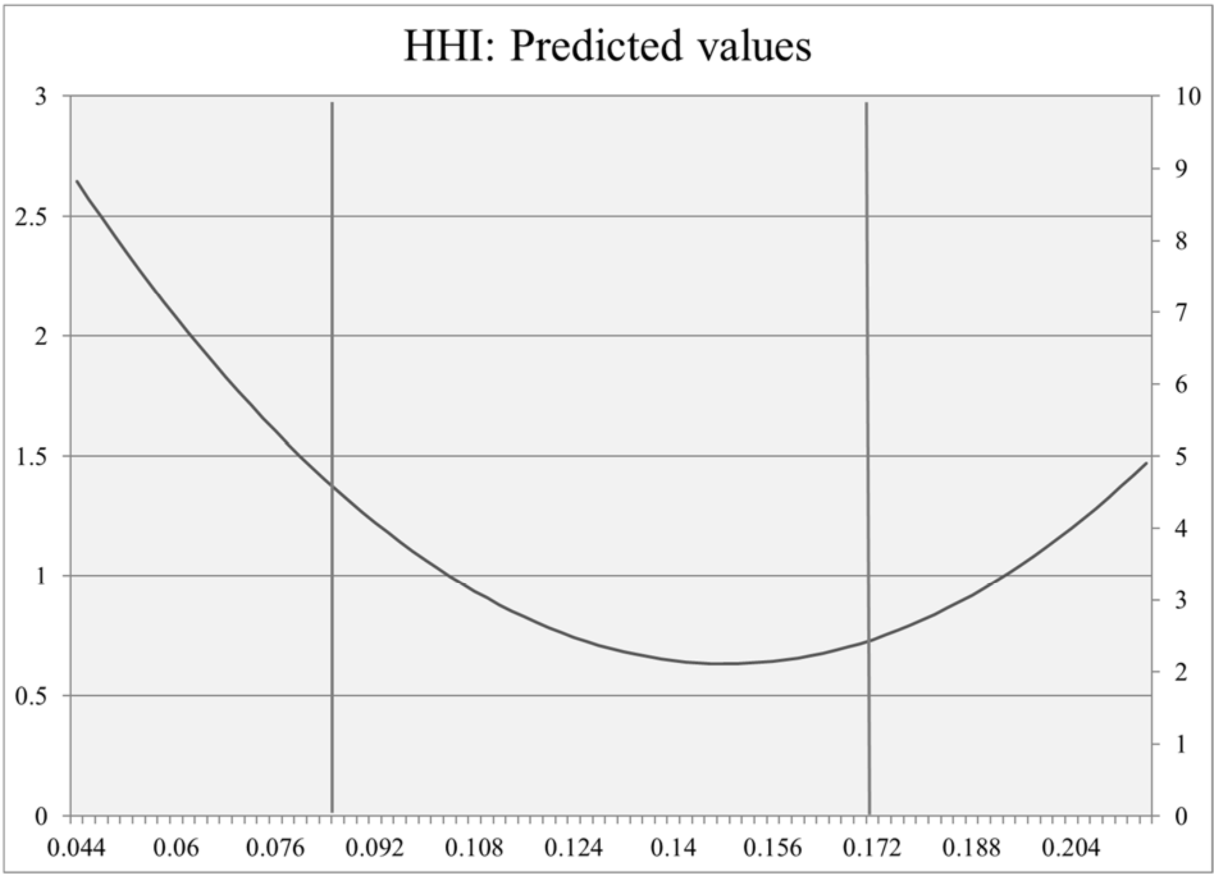
Note: Source: ORBOF database (Statistics Norway)

Figure 4



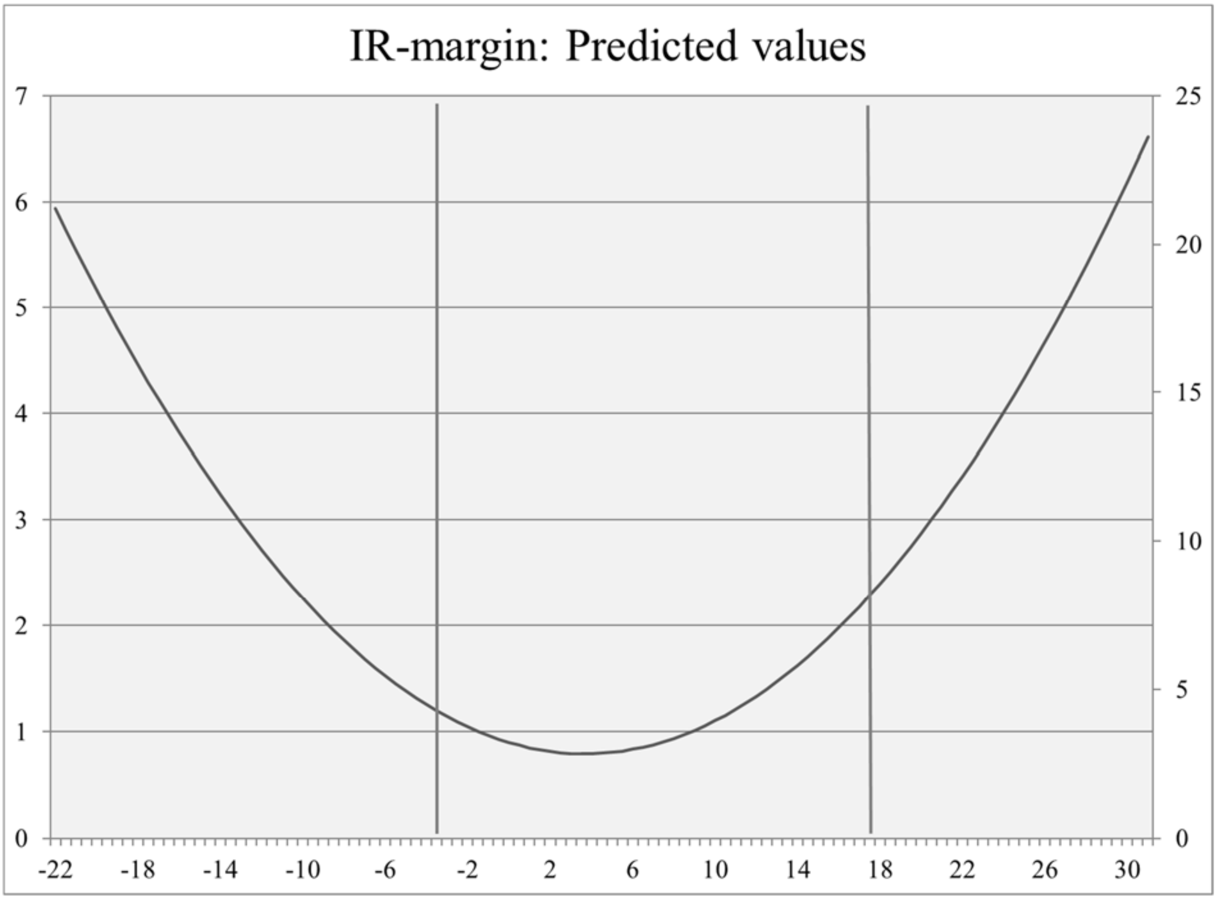
Note: Predicted values are based on estimations from regression (4) in Table 2. The vertical lines mark the minimum and maximum observed values of C5 within the sample used in estimation (54.5, 64.3, min. and max. respectively).

Figure 5



Note: Predicted values are based on estimations from regression (4) in Table 3. The vertical lines mark the minimum and maximum observed values of HHI within the sample used in estimation (0.08, 0.17, min. and max. respectively).

Figure 6



Note: Predicted values are based on estimations from regression (4) in Table 4. The vertical lines mark the minimum and maximum observed values of IRmargin within the sample used in estimation (-3,45, 17.3, min. and max. respectively).