



The Effect of Credit Portfolio Diversification and Ownership on Banks' Risk Exposure

A case study of the Norwegian banking market

Mathilde Ragnhildstveit & Caroline Silver

Supervisor: Professor Øivind Anti Nilsen

Master thesis, MSc in Economics and Business Administration,
Finance

NORWEGIAN SCHOOL OF ECONOMICS

This thesis was written as a part of the Master of Science in Economics and Business Administration at NHH. Please note that neither the institution nor the examiners are responsible – through the approval of this thesis – for the theories and methods used, or results and conclusions drawn in this work.

Acknowledgements

This thesis is written as a part of our Master's degree in Economics and Business Administration at the Norwegian school of Economics (NHH). We feel fortunate to have been able to study a topic of our own choice and within our area of interest, which is also meaningful in a societal context.

We would like to thank our supervisor Øivind Anti Nilsen for giving us advice on the choice of a feasible topic and for valuable input and feedback on our work. We also wish to thank Steffen Juranek for helpful insight and feedback throughout the research process.

Further, we would like to thank the Institute for Research in Economics and Business Administration (SNF) at NHH and The Norwegian Tax Administration for entrusting us with access to relevant data. Without these data sources, it would not have been possible to carry out our master thesis.

Abstract

In this thesis, we attempt to provide evidence on the effect of credit portfolio diversification in two dimensions, industrial and geographical diversification. Further, we analyze whether differences in banks' risk exposure are related to different ownership structures. We use an empirical approach and comprehensive data from the Norwegian banking market, containing annual information on 142 banks over the period 2005-2013. We measure the impact on two different variables reflecting risk in different ways; risk of insolvency by using the Z-score and banks' credit portfolio risk using the loan loss ratio. Our findings suggest that banks' choice of diversification strategy has a significant impact on banks' risk exposure. We find that increased industrial diversification reduces Norwegian banks' risk. Moreover, our findings indicate that increased geographical diversification increases banks' risk of insolvency. We do however not find conclusive evidence suggesting that bank ownership is relevant when explaining banks' risk exposure in the Norwegian banking market.

Table of contents

ACKNOWLEDGEMENTS.....	2
ABSTRACT.....	3
1. INTRODUCTION	6
1.1 MOTIVATION AND PURPOSE	6
1.2 RESEARCH QUESTION	8
1.3 OUTLINE.....	9
2. BACKGROUND	10
2.1 OVERVIEW OF NORWEGIAN BANKS.....	10
2.2 MARKET CHARACTERISTICS	10
2.3 NORWEGIAN BANKS' RISK	12
3. RELATED LITERATURE	16
3.1 THEORETICAL LITERATURE	16
3.2 EMPIRICAL LITERATURE.....	20
3.2.1 <i>The effect of diversification on banks' risk exposure</i>	20
3.2.2 <i>The effect of bank ownership on banks' risk exposure</i>	22
3.3 SUMMARY	23
4. ECONOMETRIC MODEL.....	24
5. DATA AND CONSTRUCTION OF VARIABLES.....	26
5.1 DATA SOURCES AND TREATMENT OF THE DATASET	26
5.2 CONSTRUCTION OF VARIABLES.....	30
5.2.1 <i>Dependent variables</i>	30
5.2.2 <i>Concentration variables HHI indices</i>	32
5.2.3 <i>Ownership variable</i>	33
5.2.4 <i>Control variables</i>	34
5.3 SUMMARY STATISTICS	37
6. DESCRIPTIVE STATISTICS.....	40
6.1 BANKS' RISK	40
6.1.1 <i>Banks' default risk</i>	40
6.1.2 <i>Banks' credit portfolio risk</i>	41
6.2 BANKS' CREDIT PORTFOLIO DIVERSIFICATION AND COMPOSITION	44
6.2.1 <i>Industrial diversification</i>	44
6.2.2 <i>Geographical diversification</i>	49

7. METHODOLOGY AND THE CHOICE OF ESTIMATION METHOD	52
7.1 THE CHOICE OF ESTIMATION METHOD	52
7.1.1 <i>Fixed effects estimation</i>	53
7.1.2 <i>Fixed effects variance decomposition</i>	53
7.1.3 <i>Random effects estimation</i>	54
7.1.4 <i>Choosing estimation method</i>	54
7.2 MODEL DIAGNOSTICS.....	55
7.2.1 <i>Testing and correcting for serial correlation and heteroskedasticity</i>	55
7.2.2 <i>A robust Hausman test</i>	55
8. RESULTS	56
8.1 USING Z-SCORE AS A PROXY FOR RISK.....	56
8.1.1 <i>The effect of credit portfolio diversification and bank ownership on risk: dummy approach</i>	57
8.1.2 <i>The effect of credit portfolio diversification and bank ownership on risk: using interaction terms</i>	59
8.2 USING THE LOAN LOSS RATIO AS A PROXY FOR RISK	62
8.2.1 <i>The effect of credit portfolio diversification and bank ownership on risk: dummy approach</i>	63
8.2.2 <i>The effect of credit portfolio diversification and bank ownership on risk: using interaction terms</i>	66
8.3 SUMMARY	68
8.4 SOURCES OF DIVERGENCE	70
9. CONCLUDING REMARKS.....	75
APPENDIX.....	77
REFERENCES	80

1. Introduction

1.1 Motivation and purpose

In today's economy and financial system, banks are considered to play an important role. By providing specialized financial services, banks are able to reduce the cost of obtaining information. As a consequence, banks make the overall economy more efficient. Due to the maturity mismatch between a bank's assets and liabilities, banks are subject to the possibility of runs and systematic risk (Berger, Molyneux, & Wilson, 2015). Thus, making bank stability critical to the financial system.

The importance of bank stability has become evident due to several financial crises over the past century. The banking system, and especially the risk-taking behavior of banks, have an important impact on the financial stability of the economy. If banks systematically take on too much risk, it may result in severe financial crises. Ten years ago, the global financial crisis hit the world economy causing a great number of banks going bankrupt. The crisis was followed by a global recession, and a debt crisis in the banking system of European countries using the euro. Although the Norwegian banks suffered from an increase in loan losses, not a single bank became insolvent following the crisis. This can be explained by the experiences from the Norwegian banking crisis that lasted from 1988 to 1993. The crisis had its peak when the second and fourth largest bank in Norway, with a joint market share of 24%, lost their capital (Moe, Solheim, & Vale, 2004). The crisis was caused by financial deregulation resulting in a bank lending boom. Following the crisis, several policy changes were made. The focus on financial stability and systematic risk was increased, both in terms of monetary and fiscal policy (Aamo, 2016). Additionally, in order to avoid excessive risk-taking and to strengthen banks' capability of absorbing losses, the capital requirements became stricter. As a consequence, the Norwegian banks were solid enough to withstand the recession and debt crisis following the global financial crisis.

Furthermore, Norwegian banks experienced rising losses and write-downs on loans made to oil-related enterprises in 2016 due to decreasing oil prices. The losses declined through 2017, but there may however still be a risk related to banks' exposure to oil-related industries (Norges Bank, 2018b). In addition, the historical losses on commercial real estate loans have accounted for the highest share of overall bank losses during crises. Norwegian banks have substantial

exposures to the commercial real estate market. In the event of a pronounced downturn in the Norwegian economy, the profitability and debt-servicing capacity of commercial real estate companies would likely be reduced. If commercial property prices were to fall, banks' losses could increase substantially. Accordingly, we aim to investigate Norwegian banks' exposure to different industries, and thus whether industrial diversification increases or decreases banks' risk exposure.

Additionally, The Financial Supervisory Authority of Norway (Finanstilsynet) recently announced a recommendation of increasing the capital buffer requirement for systematically important banks to also include banks with a market share of at least 10 % of corporate lending in different regions.¹ This may lead to several regional banks being subject to the proposed regulation, and an increase in the number of banks being classified as systematically important. Consequently, making it interesting to look at the effect of geographical diversification on banks' risk exposure.

According to Winton (1990), the riskiness of banks depend on monitoring incentives as well as diversification. Thus, indicating that diversification alone will not guarantee reduced risk of failure. Consequently, we are also interested in investigating the effect of bank ownership on risk. The Norwegian banking market consists of three bank types. Firstly, the pure savings with ownerless capital and thus no residual claimants. Secondly, the savings banks that have issued equity certificates (EC-banks) and lastly, listed commercial banks.² The three forms of bank ownership are subject to the same regulations and accounting standards in reporting losses, as well as macroeconomic conditions.³ Thus, the potential differences in risk taking could be a result of behavior induced by ownership and governance. To exemplify, it could be the case that a local representative convinces the managers of a local savings bank to finance high-risk projects, or grant credit with favourable conditions to small firms, with the argument of promoting local development. Contrarily, theoretical literature argues that savings banks ability to monitor borrowers leads to lower risk (Ghatak, 2000; Liikanen et al., 2012).

¹ Banks classified as systematically important by The Financial Supervisory Authority of Norway are subject to an additional capital requirement. Today, the capital buffer for systematically important banks applies to DNB and Kommunalbanken.

² Savings banks may also be joint-stock banks. Only Sparebanken 1 SR-Bank and Bien Sparebank are joint-stock banks during our sample period. We classify these banks as EC-banks as these banks will have similar induced behavior.

³ Norwegian banks may prepare financial statements based on IFRS or Norwegian GAAP (NGAAP). In reporting losses (net impairment losses on loans and write-downs) banks' follow IAS 39 and *Utlånsforskriften*.

In this master thesis we aim to investigate the effect of credit portfolio diversification and bank ownership on Norwegian banks' risk exposure. We will do this by using annual panel data consisting of 142 banks operating in Norway in the period 2005 to 2013. Our analysis is similar to previous studies, such as the ones conducted by García-Marco and Robles-Fernández (2008), Berger, Hasan and Zhou (2010) and Jahn, Memmel and Pfingsten (2013). To our knowledge, this specific topic has not previously been studied for the Norwegian banking market.

1.2 Research question

This master thesis aims to investigate how the risk exposure of Norwegian banks is affected by credit portfolio diversification and bank ownership. We therefore propose the following research question:

How does credit portfolio diversification and ownership affect the risk exposure of Norwegian banks?

We attempt to answer this question by regressing measures of diversification as well as bank ownership on two different risk measures taking into account banks' default risk as well as credit risk.

1.3 Outline

This master thesis will be organized as follows: **In Section 2** we will present an overview of the Norwegian banking market. **In Section 3** we review relevant theoretical and empirical literature investigating the relationship between credit portfolio diversification, bank ownership and risk. **Section 4** presents our general econometric models, which later will be estimated using different measures of risk. **Section 5** consists of data treatment and explanations on how the variables in our model have been computed. In **Section 6** we will present descriptive statistics in order to describe trends in the Norwegian banking market over the sample period. **Section 7** provides the discussion and choice of estimation methods, while **Section 8** consists of results and potential sources of divergence. Finally, in **Section 9** we will present our concluding remarks.

2. Background

2.1 Overview of Norwegian banks

Norwegian banks are categorized as either savings banks or commercial banks. In 2017, the Norwegian banking market consisted of 124 banks of which 100 were registered as savings banks, and 24 as commercial banks including subsidiaries of foreign-owned commercial banks (Norges Bank, 2018a; Sparebankforeningen, 2018a). Norwegian savings banks have traditionally been organized as self-governing foundations whose equity has largely consisted of previous years' retained profits, and have thus no residual claimants. However, 38 savings banks have issued equity-certificates of which 20 are listed on the Oslo Stock Exchange in 2017.⁴

The equity certificates are similar to regular shares, but the control rights are limited to the equity certificate capital of the banks' joint equity capital. This is due to the primary capital owned by the savings bank's foundation, often referred to as the ownerless capital of savings banks. Hence, the shareholders of an EC-bank will have a limited influence on decision making compared to the influence shareholders of commercial banks can obtain. Compared to a limited company where losses directly hit shareholders' equity, the losses of EC-banks are first absorbed by the primary capital, hence the ownerless capital (Sparebankforeningen, 2015). The equity certificate capital is only at risk if the primary capital is exhausted. Further, the governing bodies of savings banks are more widely represented by for instance including representatives from the local authorities, employees and depositors. Savings banks are expected to, but not legally obligated to support the local community by offering bank services and reinvesting parts of the profits to support local development. This due to the capital owned by the savings banks' foundations.

2.2 Market characteristics

The number of savings banks in Norway has declined substantially the last decades, from 600 savings banks in 1960 to 100 in 2017 (Sparebankforeningen, 2018a). The consolidation process has largely been due to mergers and acquisitions, as well as a natural development from demographic patterns, industrial settlement and structure.

⁴ When referring to savings banks, we collectively refer to both pure savings banks and EC-banks.

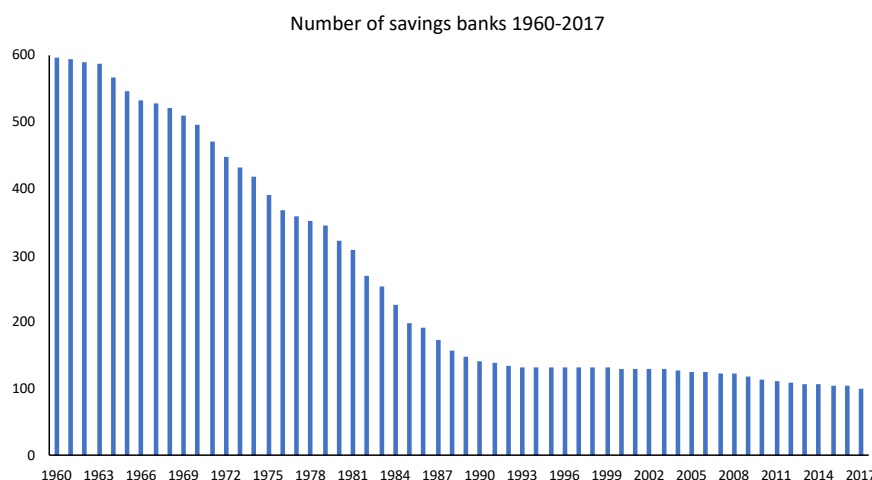


Figure 2.1: The number of savings banks from 1960 to 2017.
Source: Sparebankforeningen (2018).

In addition, competition has incentivized banks to be more cost efficient and to offer a wider range of banking services. The increase in regulation in the financial sector in Norway over the past 10-20 years has made it more difficult for small sized banks to offer satisfactory products to customers while satisfying government requirements. Consequently, alliances in the savings banks market emerged in the 1990s. The alliances are strategic and operatic collaborations motivated by economies of scale, collective products, shared R&D and shared technology (Norges Bank, 2018a). Thus, alliances enable smaller banks to compete with full-service banks. Today, 14 savings banks, such as Sparebank 1 SR-Bank and Sparebank 1 Østlandet, are affiliated with the Sparebank 1 alliance, while 69 savings banks, such as Aurland Sparebank and Hønefoss Sparebank, are affiliated with the Eika alliance. Banks affiliated with the Eika alliance are typically small and local savings banks, whereas banks affiliated with the Sparebank 1 alliance are typically savings banks with high market shares in their core regional areas.

Furthermore, digitalized customer relationships have disrupted the market structure the past decade (Kreutzer, 2015). Digitalization within the banking sector has made banks more accessible for a wider customer base, since customer relationships to a larger extent can endure on digital platforms. This has enabled banks to expand geographically by reaching customers in new areas. Commercial banks can more easily reach customers in districts as they operate nationwide, and savings banks can offer banking services in geographical areas outside their local markets. Hence, the relative importance of individual bank's customer base diminishes, and the accessibility of the customer base and account data will increase. The Norwegian

banking market is nonetheless characterized by having a large number of banks, but is considered to be relatively highly concentrated. The 15 largest savings banks account for more than 75 percent of the total assets in the Norwegian savings banks market (Sparebankforeningen, 2017).

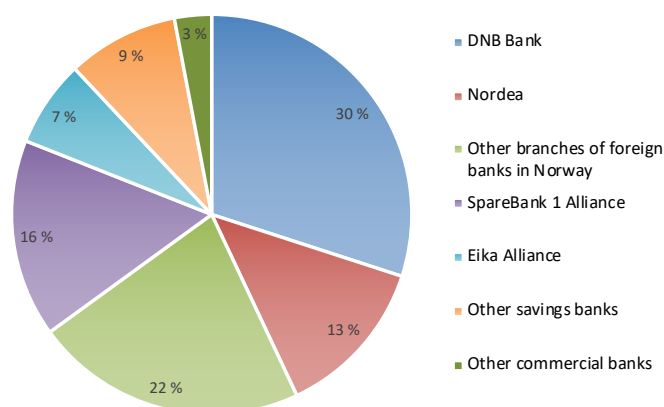


Figure 2.2: Corporate lending market shares in the Norwegian banking sector at the 30th of June 2018.
Source: Norges Bank (2018).

Furthermore, the banking sector is not considered to be large compared to other developed countries (Norges Bank, 2018a). The sectors total assets amount to 200% of GDP, whereas the total assets in the Swedish banking sector by comparison amount to 300% of GDP. A potential reason is that Norwegian banks mainly lend to domestic customers.

2.3 Norwegian banks' risk

According to Norges Bank (2018b), Norwegian banks aggregated and short-term credit risk is relatively low. Lending to the corporate sector constitutes a large share of Norwegian banks credit portfolio. Historically, losses on loans made to the corporate sector have substantially exceeded losses on household loans, both during crises and in periods without major solvency crises (Hjelseth & Raknerud, 2016). Figure 2.3 reports the evolution of banks' loan losses (as share of loans) to the private sector and to the corporate sector over time. Although the loan losses are relatively low, the losses from the corporate sector have increased steadily over the years in our sample period.

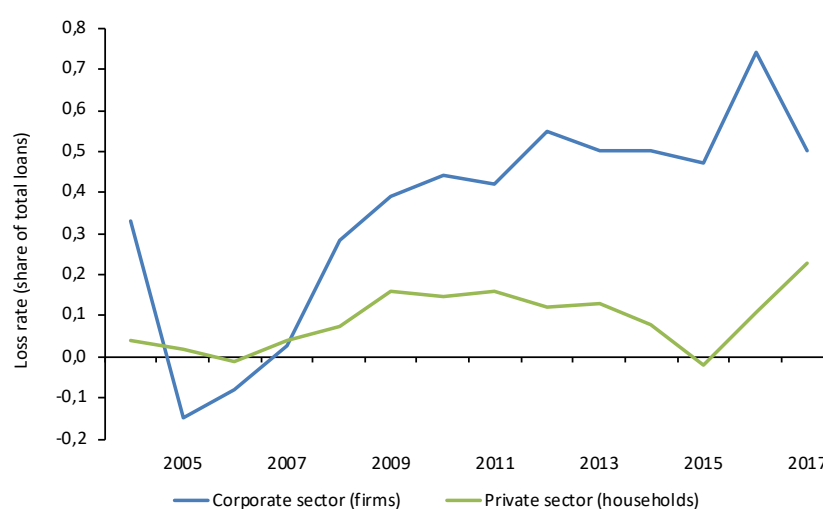


Figure 2.3: The reported loss numbers are expected loan losses divided by total loans. When the actual losses are lower than previously expected, the banks have negative losses. In cases where the negative losses exceed the expected losses of particular years, the net loan loss ratio will be negative.

Source: The Financial Supervisory Authority (2018).

In recent years, loan losses from the corporate sector have mainly been attributed to loans made to oil-related industries (Norges Bank, 2018b). However, in the long term, loans made to the commercial real estate sector may pose as a threat to the financial system. Over the past 20 years, Norwegian real estate prices have increased substantially. Additionally, the credit portfolios of Norwegian banks are relatively concentrated due to large exposures to the commercial real estate sector. This might represent a concentration risk for Norwegian banks and increases the vulnerability of the Norwegian financial system. Historically, the commercial real estate sector has suffered from large losses during times of crisis. Furthermore, experiences from banking crises' in Norway and abroad have shown that losses on commercial property loans can contribute to solvency problems in the banking sector.

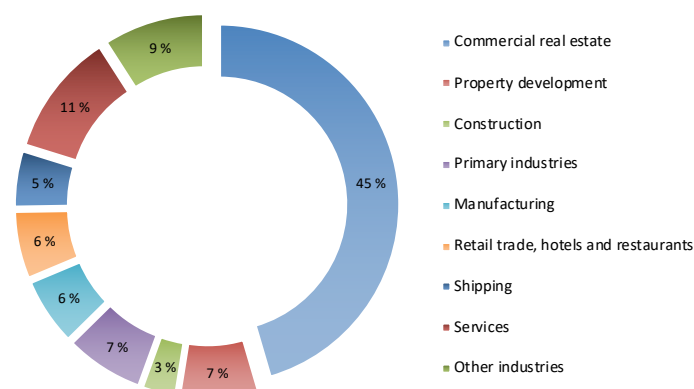


Figure 2.4: The share of lending to different industries by all banks and mortgage companies at the 30th of June 2018.

Source: Norges Bank (2018).

Another source of risk can be attributed to the underestimation of credit risk during the expansion phase of the business cycle (Norges Bank, 2018b). Setbacks due to high losses on commercial real estate emerges rarely during the expansion phase. Further, banks do not consider the risk of losses occurring simultaneous in the banking sector, which has the potential to intensify a crisis. As a consequence, loans made to the commercial real estate sector might be incorrectly priced due to the possibility that prices do not reflect the aggregated credit risk the loans represent. However, The Financial Supervisory Authority of Norway require banks to use credit risk models taking into account the experience from the banking crisis as well as uncertainty in the dataset. When calculating the risk-weights for commercial real estate loans, banks that use internal rating-based models (IRB), are required to give substantial weight to the loss experience from crises.

Furthermore, decreasing real estate prices can have repercussions for the real estate development sector, to which Norwegian banks are greatly exposed to (Norges Bank, 2018b). Compared to the commercial real estate sector, the real estate development sector is associated with relatively high bankruptcy risk as well as greater variance over the business cycle. The sector-specific risk is especially associated with the degree of pre-sales and settlement risk. Moreover, the credit risk in the real estate development sector has been low in recent years. However, the risk of losses will have considerable consequences if the real estate prices were to fall.

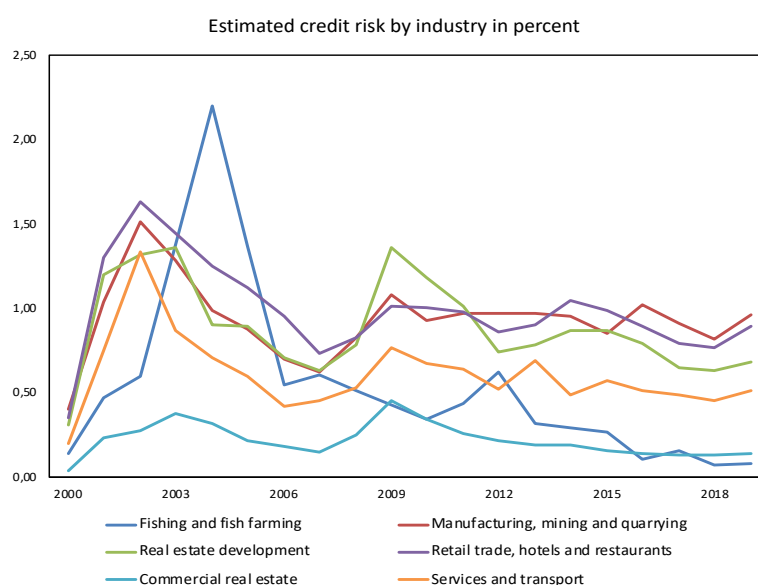


Figure 2.5: Estimated bankruptcy-exposed bank debt per industry as a share of total bank debt in the industry. Numbers for 2018 and 2019 are based on model predictions.
Source: Norges Bank (2018).

Historically, commercial property prices tend to rise considerably before a substantial fall (Norges Bank, 2018b). In the event of a pronounced increase in prices combined with an increase in banks' loan exposures to commercial real estate, the credit risk of banks would likely increase. Moreover, the debt-servicing capability of commercial real estate companies is determined by the rental market. Further, the rental market is determined by the supply and demand for office spaces, which historically has largely varied with GDP growth. Due to the fact that the commercial real estate sector is capital intensive, increases in the interest rate may lead to significant increases in interest expenses and thus weakened earnings. According to Norges Bank (2018c), the key policy rate will increase the upcoming years. Consequently, we can expect weakened earnings due to increased interest expenses. Additionally, the commercial real estate market signals high risk according to Norges Bank's heatmap for assessing systematic risk in the Norwegian financial system.

3. Related literature

The effect of credit portfolio diversification and bank ownership on risk has been thoroughly researched in both theoretical and empirical literature over the past decades. Theoretical literature provides valuable insight on whether diversification is beneficial for banks and financial intermediaries. Further, we will present theoretical literature suggesting that bank ownership is likely to have an influence on the risk exposure of banks. Lastly, we will look at empirical literature that investigates the relationship between diversification and risk as well as literature studying the effect of bank ownership on risk. The empirical studies will serve as an inspiration when we later choose appropriate measures for risk as well as control variables for our empirical model.

3.1 Theoretical literature

In the theoretical literature, there is no clear consensus on whether banks should diversify or specialize their credit portfolios. From a traditional portfolio and banking perspective diversification is considered to be the preferred investment strategy. The prominent economist and Nobel Prize winner Harry Markowitz (1952) argued that diversification is “the only free lunch in finance”. Contrarily, the opposing view is found in corporate finance theory where the literature suggests that financial intermediaries should specialize their portfolios (Denis, Denis & Sarin, 1997; Lang & Stulz, 1994). Furthermore, the theoretical literature suggests that bank ownership affects banks’ risk exposure. The common view is that banks controlled by shareholders, hence commercial banks and partly savings banks with equity certificates, are exposed to greater risk (Black & Scholes, 1973; Saunders, Strock & Travlos, 1990). In addition, the literature emphasises the ability to monitor customers, hence the proximity between the local community and savings banks (Ghatak, 2000; Liikanen et al., 2012). In the following, we will present literature focusing on advantages and disadvantages of diversification as well as literature investigating the relationship between bank ownership and risk.

In a paper written by Diamond (1984), a theory on financial intermediation is developed. The theory is based on financial intermediaries' capability to minimize the costs related to monitoring information in order to resolve incentive problems between lenders and borrowers. The risk neutral financial intermediators receive funds from depositors to lend to entrepreneurs. Therefore, the financial intermediators are delegated the task of monitoring entrepreneurs'

projects on behalf of depositors. Further, the intermediary bears all penalties in case of any short-fall of payments to depositors. The result of the study indicates that as the number of depositors and loans made to entrepreneurs grows to infinity, the monitoring costs will approach zero. As a consequence, the financial intermediators have the incentive to diversify their loan portfolios by lending to as many entrepreneurs as possible. By doing this, financial intermediaries will be able to reduce their risk.

A coherent article written by Ramakrishnan and Thakor (1984) finds similar results by developing a model showing that the emergence of financial intermediaries is based on their ability to lower information production costs. If each investor were to monitor each firm, there would be a great amount of information duplication. To avoid this, firms can assign an information producer to certify the economic worth of borrowers. By forming coalitions of information producers, there will be a reduction in the cost of information production. The coalition of information producers will thereby operate as a diversified financial intermediary. Further, the paper enhances that the exogenous risk for each member in the coalition cannot be removed unless the intermediary's total reward from borrowers is non-random. According to the authors, the intermediary can achieve this by becoming infinitely large and thus capable of diversifying away the risk associated with each borrower. However, Lang and Stulz (1994) find evidence suggesting that highly diversified firms are consistently lower valued than specialized firms. Thus, indicating the existence of a diversification discount. Hence, the evidence supports the view that diversification is not a successful path to higher performance.

In order to explain the diversification discount, Denis et al. (1997) develop the agency cost hypothesis. According to the hypothesis, diversification reduces firm value because of agency problems between the management and ownership in firms. Managers may pursue a diversification strategy because of the power and prestige of managing a large firm. In addition, compensation is often related to the size of the firm. The authors find evidence supporting the hypothesis that agency problems are responsible for firms preserving diversification strategies that are value-reducing for shareholders.

According to Winton (1990), regulators must be careful when recommending banks and financial intermediaries to diversify. The study finds that credit risk depends on monitoring incentives as well as diversification. Thus, diversification alone is no guarantee for reduced risk of failure. Further, credit risk is considered to be endogenous because it is affected by the bank's

effectiveness and investment in loan monitoring. Compared to diversification, monitoring ability is difficult to observe, therefore risk-shifting caused by underinvestment in monitoring may be a problem for regulators.

On the other hand, one can argue that monitoring ability can be observed by examining bank ownership. A common point in explaining the difference in performance between savings banks and commercial banks have been attributed to the difference in screening and monitoring competences. According to Liikanen et al. (2012), savings banks with strong regional or local presence will have a lower transaction cost when screening and monitoring customers due to the proximity between the local community and the savings banks. This is supported in a paper by Ghatak (2000), which emphasize that credit market failures caused by asymmetric information can be alleviated by the existence of relationships within the local community and local information. Consequently, one can argue that savings banks with local presence will be exposed to lower credit risk. Further, this is consistent with Winton (1999)'s findings that banks' risk doesn't solely depend on diversification, but also loan monitoring.

In addition, differences in bank ownership may give rise to the importance of profit maximization, since savings banks pursue multiple goals relative to commercial banks. According to García-Cestona and Surroca (2008) one such goal is the savings banks aim at contributing to the regional development and generating social externalities in the regions where they are present. Thus, savings banks are more prone and better positioned to lend funds to smaller entrepreneurs and corporations in local communities, as the banks might be influenced by the goal of fostering development in regions where they belong. However, one could argue that this will have the potential to increase the riskiness of the credit portfolios of savings banks, due to the possibility of local savings banks being more prone to grant loans based on subjective criteria rather than profit maximization.

Tirole (2001) supports the view of García-Cestona and Surroca (2008), and takes the agency model one step further by allowing for multiple stakeholders. The control rights do not only reside with owners and managers, but also with depositors, employees, politicians, and society at large. Hence, the firm's objective function reflects the preferences of several stakeholder types. In such a context, maximizing returns to capital invested may no longer be the dominating concern, and monitoring by owners may be a less critical governance mechanism.

Furthermore, Saunders et al. (1990) studies the effect of bank ownership structure on risk-taking. According to the paper, banks controlled by stockholders have incentives to take greater risk compared to banks controlled by managers. This can be explained by the conflicting risk preferences of bank managers and stockholders. While stockholders wish to increase the value of their equity by increasing the bank's risk, the risk-taking incentives of bank managers will depend on whether their interests are tied to value-maximizing activities. For instance, the interests of bank managers may be aligned with those of the stockholders if the managers are offered stock options.

The risk argument proposed by Saunders et al. (1990) is supported by the option pricing model developed by Black and Scholes (1973). According to the option pricing model, equity is considered to be a call option on the underlying assets in a leveraged firm. Hence, high asset volatility will increase the value of equity at the expense of other stakeholders of the firm. As a consequence, commercial banks are likely to increase the cash flow volatility in order to maximize the value of its owners' equity. In contrast, a savings bank will likely not exhibit such behavior due to the ownerless capital.

Contrarily, Allen, Carletti and Marquez (2009) argues that firms may choose to be controlled by stakeholders because it increases firm value. The authors develop a model where firms with stakeholder governance put weight on the effect of bankruptcy on stakeholders rather than shareholders. If a firm goes bankrupt, stakeholders are faced with costs as they have to search for new opportunities. However, if the firm survives, the stakeholders can collect rents and benefits. Consequently, it will be beneficial to take on less risk and reduce the probability of bankruptcy. Concerns for stakeholders can therefore benefit shareholders, both in terms of lower probability of bankruptcy as well as increased firm value.

3.2 Empirical literature

In the empirical literature investigating the relationship between credit portfolio diversification and risk, the common view supports the theoretical literature from corporate finance. Hence, that diversified banks are exposed to greater risk compared to specialized banks. However, we will also present empirical literature suggesting that diversification reduces banks' risk. Lastly, we will look at studies investigating the effect of bank ownership on banks' risk where the common view is that commercial banks are exposed to greater risk (Bøhren & Josefsen, 2013; García-Marco & Robles-Fernández, 2008).

3.2.1 The effect of diversification on banks' risk exposure

Acharya, Hasan and Saunders (2006) performed a study investigating the effect of loan portfolio specialization versus diversification on the return and risk of Italian banks. Their data consisted of 105 banks over the period 1993-1999. The authors examine how the entry of banks via lending into new sectors, hence increased diversification, affects their credit risk. In order to measure diversification, the authors employ the Hirschman Herfindahl Index (HHI). The authors construct different variables such as doubtful and non-performing loans to assets as well as the ratio of loan loss provisions to assets as proxies for risk, taking into account the ex-ante level of expected losses. In order to obtain robustness, the authors also construct measures of unexpected losses such as the sample standard deviation of doubtful and non-performing loans, the monthly stock return volatility of publicly traded banks, as well as a measure of the idiosyncratic risk component. The authors find evidence suggesting that the quality of monitoring by banks is poorer in newer industries and that banks seem to face greater adverse selection when they choose to expand into industries previously entered by competitors. The most important finding is that sectoral loan diversification produces riskier loans for high-risk banks while also reducing bank return. Furthermore, sectoral loan diversification produces either an inefficient risk-return trade-off or produce only a marginal improvement for low-risk banks.

In a coherent study, Berger et al. (2010) investigate whether banks should specialize their credit portfolio in different products and geographic regions, or diversify, using a sample of 88 Chinese banks during the period 1996-2006. Their measures of diversification are four different focus indices employed by HHI measures, one focus index for each dimension of diversification. Hence, the study captures diversification in four dimensions: loans, deposits,

assets, and geography. The authors find that the dimensions of diversifications all lead to higher costs and reduced profits. In addition, the study examines the effect of ownership on diseconomies of diversification by including ownership variables (i.e., state ownership, domestic private ownership, foreign ownership). They find that Chinese banks with foreign ownership suffer less increase in cost when they diversify and observe that specialized banks with private ownership on average have higher levels of return on assets. Furthermore, they find evidence that specialized banks are associated with lower risk and that the negative effect of diversification on banks' risk is mitigated by foreign ownership and conglomerate affiliation. Thus, indicating that ownership and diversification affects banks' risk.

In a discussion paper from Deutsche Bundesbank, Jahn et al. (2013) study the sector specific loan exposures to the real economy and examines the effect of loan portfolio concentration on credit risk. The data consists of German banks for the period 2003-2011. The paper uses the standard deviation of historic and realized loan losses to approximate the credit risk of banks. This in order to avoid the subjective judgement of bank management and accounting standards. Risk measures such as loan loss provision, non-performing loan rates and their respective standard deviations are therefore considered to be biased proxies for risk. Further, the analysis considers industry-specific effects as well as regional differences. The authors perform regressions on samples including all banks, nationwide banks and regional banks. The HHI measure is employed in order to measure concentration. The paper finds evidence suggesting that concentrated banks have less unexpected credit risk, as the standard deviation of their loss rate is lower. This suggests that specialized German banks are able to acquire selection and monitoring abilities that reduces the loan portfolios credit risk. Thus, supporting the findings of Acharya et al. (2006) and Berger et al. (2010). Lastly, the authors conclude that by allowing banks to specialize, the credit allocation is likely to be more efficient, which further can lead to enhancement of financial stability.

Chen, Wei and Zhang (2013) examine the effect of sectoral composition in banks' credit portfolio on risk of 16 Chinese banks in the period 2007-2011. They use non-performing loans as a risk measure and employ a risk-adjusted HHI as a new measure of sectoral concentration. The study is interesting as it does not only consider sectoral concentration, but takes account of the systematic risk of the sectors themselves by risk-weighting different sectors with their betas when constructing the HHI measure. Thus, the study investigates the effect on risk of sectors that are more volatile and closely related with economic upturns and downturns. They find

evidence of a positive relationship between portfolio concentration and banks' risk, and that banks with concentrated credit portfolios are vulnerable to economic downturns since they have a greater exposure to a few sectors. Their main finding is that there is higher risk associated with sectoral concentration, which can be explained by the fact that diversification to some extent offset the specific risk and thus achieve lower risk. By supporting the view that diversification reduces risk, their findings differ from the results in the empirical studies mentioned above.

3.2.2 The effect of bank ownership on banks' risk exposure

Bøhren and Josefsen (2013) investigate the relationship between bank ownership and economic performance. The sample used in the study consists of Norwegian commercial banks that are listed and owned by shareholders, pure savings banks and lastly EC-banks that can be considered to be partly owned and partly ownerless. By investigating the balance sheet structure of the different bank types, the authors find that pure savings banks are typically smaller and less exposed to risk compared to banks where stockholders are in full or partially control. The result is consistent with existing theory, for instance the findings of Allen et al. (2009). In addition, the authors find that the monitoring function of stockholders may be substituted by other mechanisms such as competition. Thus, indicating that bank managers may be efficiently disciplined by substitutes for the role of bank ownership.

Furthermore, García-Marco and Robles-Fernández (2008) performed a study on Spanish financial intermediaries in order to investigate whether differences in risk behavior are related to different ownership structures or to other factors such as the size of the intermediary. The paper defines Spanish savings banks as non-profit organisations, due to their profits being either retained or distributed to community programs. The control rights are distributed between interest groups such as local and regional governments, employees and depositors. Thus, the ownership structure and governance is similar to the pure savings banks in Norway. Contrarily, Spanish commercial banks are defined as firms under strong shareholder control. Ownership is measured by means of three variables: a dummy variable for bank type, a HHI measure for ownership concentration and a dummy variable for public control. The authors employ the Z-score as a measure of banks' risk of failure. The Z-score is a widely used measure in literature investigating the riskiness of banks, it is for instance used by Nicolò and Loukoianova (2007) and Beltratti and Stulz (2012) in order to measure banks' default risk. The paper finds significant differences in the patterns and determinants of risk-taking behavior between savings

banks and commercial banks as well as size. The results suggest that Spanish commercial banks exhibit greater risk-taking behavior. Additionally, smaller institutions appear to be less risky, thus they find that size is relevant when explaining risk-taking.

In a coherent study conducted by Salas and Saurina (2002) the determinants of problem loans of Spanish commercial and savings banks are investigated. Problem loans are defined as loans with very low recovery probability in addition to loans that are not accumulating any interest or principal payments. The authors account for both macroeconomic and individual bank level variables. Thus, explaining credit risk by using variables such as the GDP growth rate, portfolio composition, size and market power. In order to check for differences between the bank types, the authors regress their empirical model on two different samples, one for commercial banks and one for savings banks. According to the paper, there are significant differences between commercial banks and savings banks. The different determinants of commercial and savings banks problem loans are attributed to the historical differences between the customers as well as geographical presence of commercial banks and savings banks. Hence, confirming that the institutional form is relevant in regards to the management of credit risk in the Spanish banking sector.

3.3 Summary

To sum up, there is no clear consensus on whether banks should diversify or specialize their credit portfolio in the theoretical literature. However, according to the common view in the empirical literature, diversified banks tend to be exposed to greater risk compared to specialized banks. Furthermore, the theoretical literature enhances that banks' risk doesn't solely depend on diversification strategy, but could also be related to bank ownership. The common view in the empirical literature investigating the effect of bank ownership on risk, is that commercial banks tend to be riskier than savings banks. In our thesis we aim to investigate whether similar dynamics exist in the Norwegian banking market.

4. Econometric model

In this paper we aim to investigate the relationship between diversification, bank ownership and risk. Evidence from previous related empirical work and theoretical literature suggests that such a relationship exists.

We attempt to estimate our model using HHI as a measure of credit portfolio concentration in two dimensions: industry and geography. Diversification variables are chosen on the basis of being widely used in related empirical banking literature as well as within the limits of our available data. To address the effect of diversification on banks' risk, we propose the following general model to measure the impact of diversification with regards to industries and geography:

$$(1) \text{ risk}_{it} = \beta_0 + \beta_1 \text{div}_{it}^{ind} + \beta_2 \text{div}_{it}^{geo} + \sum_{n=3}^M \beta_n X_{nit} + \delta_t + \lambda_i + \varepsilon_{it}$$

Where risk_{it} is one of our dependent variables for bank i in a given year t . div_{it}^{ind} is diversification in terms of industries and div_{it}^{geo} is geographical diversification. X_{nit} is a vector containing bank-specific control variables obtained from banks' financial accounts, such as return on assets, size measured by total assets and equity ratio. δ_t is a set of year dummies that aims at capturing a common year effect for all banks and firms in banks' loan portfolio. This is included in order to control for the impact of business cycles on banks' risk. λ_i represents bank specific time-constant effects. Lastly, ε_{it} captures the unobserved and bank-specific effects that vary over time.

The general model measures the effect of diversification on banks' risk for the full sample, but we also aim to measure the effect of bank ownership on risk. Our study aims to investigate whether there are potential differences in banks' risk exposure that could be a result of behavior induced by ownership and governance. To achieve this, we extend our general model:

$$(2) \text{ risk}_{it} = \beta_0 + \beta_1 \text{div}_{it}^{ind} + \beta_2 \text{div}_{it}^{geo} + \beta_3 D_i^{ownership} + \sum_{n=4}^M \beta_n X_{nit} + \delta_t + \lambda_i + \varepsilon_{it}$$

The model is based on the general model in (1), but introduces a dummy variable, $D_i^{ownership}$, for bank i . $D_i^{ownership}$ can be either a savings bank or a commercial bank.

We also aim to investigate whether there exists differences in the effect of diversification on risk between savings banks and commercial banks. We therefore extend our model further to include interactions between the diversification measures and bank ownership dummy. The model is based on the extended general model in (2):

$$(3) \text{ risk}_{it} = \beta_0 + \beta_1 \text{div}_{it}^{ind} + \beta_2 \text{div}_{it}^{geo} + \beta_3 D_i^{ownership} + \beta_4 \text{div}_{it}^{ind} D_i^{ownership} + \beta_5 \text{div}_{it}^{geo} D_i^{ownership} + \sum_{n=6}^M \beta_n X_{nit} + \delta_t + \lambda_i + \varepsilon_{it}$$

$$\text{div}_{it}^{ind} D_i^{ownership}$$

The interaction $\text{div}_{it}^{ind} D_i^{ownership}$ allows us to compare the effect of industrial diversification on savings banks compared to commercial banks.

$$\text{div}_{it}^{geo} D_i^{ownership}$$

The interaction $\text{div}_{it}^{geo} D_i^{ownership}$ allows us to compare the effect of geographical diversification on savings banks compared to commercial banks.

5. Data and construction of variables

5.1 Data sources and treatment of the dataset

The data used to conduct this study originates from several sources. A unique dataset provided by the Norwegian Tax Administration (Skatteetaten) contains detailed information on loans made to the corporate sector by banks operating in the Norwegian banking market. The dataset provides insight into just below 9.5 million loan observations made to corporate customers in the period 2005-2013.

Data concerning firm-specific information is retrieved from a database assembled by the Institute for Research in Economics and Business Administration (SNF). The dataset contains detailed firm-specific information about firms' location and industry codes, among other information. This enables us to connect firm-specific information about corporate customers to bank-borrower relationships, and to construct the industrial and geographical composition of each bank's loan portfolio for banks operating in the Norwegian banking market. In addition, the SNF database contains information concerning individual firm's credit rating, which is obtained from Bisnode, and will be used to reflect the quality of banks' credit portfolios.

Lastly, information about banks' financial performance and loan losses, is provided by Finance Norway (Finans Norge), The Financial Supervisory Authority of Norway and The Norwegian Banks' Guarantee Fund. The dataset contains yearly bank-specific information on banks' financial accounts and balance-sheet information on every bank operating in Norway (reported on a non-consolidated level). Furthermore, the database contains information on loan losses which is to be used for risk analysis. An important notion is that the datasets contain information concerning Norwegian banks, subsidiaries of foreign banks as well as branches of foreign-owned banks. Data on loans are only reported on firms that are registered in Norway. In addition, information concerning classification of different bank types are based on data retrieved from Finance Norway.

In the case of merger activities during the sample period, we keep the merged banks prior to the merger, with their respective organizational numbers, as separate entities. In handling mergers and acquisitions, we apply a common procedure, similar to Jahn et al. (2013). In cases where a third bank is constructed, our sample will artificially exceed the number of existing

banks at the time of the merger. We do not omit the pre-merger banks since we assume that a bank-borrower relationship does not necessarily cease to exist after a merger, as the relationship can be extended in the merged entity. Hence, this will allow us to follow the entire bank-borrower relationship. In order to keep as many observations as possible, we include banks even though they are established late in the sample period.

The banks in the data assembled by Finance Norway are not listed with an organization number, therefore we have to retrieve it from the data provided by The Norwegian Tax Administration. Furthermore, we observe that there are several banks that change their organizational number during the sample period. In order to keep the bank-borrower relationship over the entire sample period, we change the organizational number to that of the latter organizational number. The organizational number is the key identifier of a bank in the dataset. Thus, the organizational number needs to be consistent during the sample period in order to connect a bank to its respective loans.

In order to link each bank to the bank's total loan exposure, we merge the banks from the Finance Norway dataset with the data provided by The Norwegian Tax Administration, using banks' respective organizational numbers. In cases where both the loan amount and interest payment on the loan is zero or missing, we omit the observations. Further, we exclude deposits from our sample. We choose to keep observations where the loan amount is zero but the interest payment has a positive value. Furthermore, we omit observations in the cases where the only variable with non-missing value is either the customer's organisational number or the bank's organisational number. Thus, we remove observations where there is no connection between a bank and a customer.

To gain insight into the industrial composition of banks' credit portfolios and to connect individual bank's loans to its corporate borrowers and their industry codes, we merge the dataset from The Norwegian Tax Administration with data from the database provided by SNF. This allows us to decompose each bank's credit exposure into separate industries using the 14 different industry categorisations.

The dataset from SNF contains two different industry code systems. The industry codes are based on the industry classification following the Standard Industrial Classification (NACE)-system that was first introduced in 2008. In cases where firms prevail after the year 2008, the

new industry code is applied both in years before and after the reform in industry codes. However, in cases where a firm ceases to exist before 2008, the firm is not given a new industry code. Thus, several observations have missing values. It is also an issue that many firms do not have consistency in non-value and industry codes. Thus, the industry code is missing in some years. In order to avoid losing observations, we aim to assign industry codes to as many firms as possible. In years where the industry code is missing, we assign a firm with the industry code from the year before or the year after in cases where the industry code was reported in previous or preceding years.

To deal with firms that do not have information regarding industry classification of the NACE-system, but do have an industry code from the previous industry coding system, we replace the missing values of the new system with the corresponding industry codes of the outdated industry code system. This only in cases where the two industry code standards coincide.

Lastly, we omit observations that do not have an industry code in cases where we do not find corresponding industry codes and industry group descriptions in the two industry code systems, and there is no efficient method of assigning correct industry code. By omitting the observations without an industry code, the number of observations is reduced and we may have excluded loans and customers that could have been meaningful for our results. Even though we lose approximately 13% of our observations by omitting observations with missing industry code, we still have more than two million loan observations. The industry classification set by Statistics Norway (SSB) is as follows:

(1) Primary Industries, (2) Oil, Gas, Mining, (3) Manufacturing Industries, (4) Energy, Sewage, Utilization, (5) Construction, (6) Trade (Retail), (7) Shipping, (8) Transport and Tourism, (9) Telecom, IT, Media, (10) Finance and Insurance, (11) Commercial Real Estate, Services, (12) General Services, (13) Research and Development, (14) Public Sector and Culture.

The SNF database contains information on firms' location, concerning firms' postal codes, municipality and county. The variable county consists of 21 different geographical areas and states the name of the county in which the firms in banks' credit portfolios are located. This allows us to investigate whether banks are geographically diversified or have a high concentration of their loans in certain counties. In years where the county information is missing, we assign a firm with the county from the year before or the year after in cases where

the firm's location was reported in previous or preceding years. We omit observations that do not have an associated county reported in the dataset, which constitutes 0.47% of our total sample.

The inclusion of industry codes and firms' county location in the dataset enables us to calculate a yearly industrial and geographical concentration measure of individual bank's loan portfolio in the corporate sector in the period 2005-2013. Lastly, when having constructed the industrial and geographical concentration measures, we merge the sorted dataset with a dataset containing constructed variables based on banks' financial figures and loss information from the data provided by Finance Norway, using banks' organizational number and year as a composite unique identifier.

We transform the merged and cleaned dataset to panel data by only keeping aggregated variables concerning annual total loan exposure of each bank, control variables and measures of banks' risk. Finally, the data is gathered in one panel data ranging from 2005-2013.

Our final sample consist of 1,213 observations. The total number of banks across bank types ranges from 142 to 123 from 2005 to 2013. The number of pure savings banks in our sample diminishes from a total of 125 in 2005 to 106 pure savings banks in 2013. Commercial banks on the other hand varies greatly during our sample period, from 17 commercial banks in 2005, to 22 in 2010 and lastly 17 commercial banks in 2013. One potential reason for this may be due to the varying accessibility of equity reporting and information regarding financial figures and loan losses from subsidiaries and branches of foreign banks operating in Norway.

5.2 Construction of variables

5.2.1 Dependent variables

In order to measure banks' overall risk and banks' credit portfolio risk, we use two measures of bank risk-taking. Both risk measures used as dependent variables, the Z-score and the loan loss ratio, are based on yearly bank-specific accounting information. The Z-score relates to each individual bank's overall risk exposure, whereas the loan loss ratio reflects each bank's overall credit portfolio risk. The risk variables are calculated using yearly bank-specific data provided by Finance Norway. Risk measures that are based on balance sheet information are preferable since our sample includes non-listed banks.

Z-score

Z-score is a widely used composite risk measure of banks' stability in related empirical banking literature. It is used to assess individual bank risk by reflecting banks' distance to insolvency and relates each bank's variability in returns to its equity base (Vives, 2016). The Z-score of each bank equals the return on assets (ROA) plus the equity-to-assets ratio divided by the standard deviation of the ratio of return on assets. A higher Z-score indicates lower risk of the bank and that the bank is more stable. Hence, a high Z-score indicates that the number of standard deviations below the mean by which return on assets can drop and still be absorbed by the bank's capital base, is large (De Nicolò, Jalal, & Boyd, 2006). The variability of a bank's return is measured by the standard deviation of ROA calculated over the full sample. The Z-score for bank i at time t is defined as:

$$Z-score_{it} = \frac{Equity-ratio_{it} + ROA_{it}}{\bar{\sigma}_{ROA_i}}$$

Following De Nicolò et al. (2006) there has been an increase in implementing the Z-score as a time-varying risk measure in panel studies (Lepetit & Strobel, 2013). The advantage of using a time-varying measure of bank-risk is to take account of the fact that a bank's risk profile might change over time due to changes in a bank's capital structure and lending behavior. There are differing views on the optimal construction of time-varying Z-score and no consensus in the empirical banking literature.

We construct the time-varying Z-score by using current period values of equity ratio and moving mean of return on assets over 3 years that is calculated for each period, combined with standard deviation estimates that are calculated over the full sample. In line with related literature by De Nicolò et al. (2006), we apply a window with of 3 years ($t-1$ and $t-2$) due to our data availability, as our sample is an unbalanced panel data that only consist of 8 years of data. This measure requires that some of the initial observations are dropped by construction.

Loan loss ratio

In order to measure banks realized losses in any given period, we use the bank's annual net loan losses, provided by Finance Norway. The available data on reported loan losses are retrieved from the bank's balance sheet. Thus, the reported losses constitutes of both losses on loans made to private households and the corporate sector.⁵

A risk measure should take account of the unexpected part of losses in order to capture banks' risk-taking. Risk measures that take account of expected losses, such as loan loss provisions and non-performing loan rates, may be subject to bias if an expected loan loss is a result of a subjective decision or by accounting practices.

Banks may write down debt if there is objective evidence such as the development of probability for default, if a firm goes bankrupt or becomes insolvent, or there are other significant financial difficulties that should entail a reduction in future cash flow for an individual loan commitment (Hjelseth & Raknerud, 2016). The calculation of per period loan losses is based on changes in individual (specified) write-downs and group write-downs (unspecified) on loans, realized losses on commitments previously written down, realized losses on commitments not previously written down, change in losses on repossessed assets in the period, amortized loans, recoveries on loans and guarantees previously written down. Thus, the reported net impairment losses on loans in Norwegian banks' profit and loss account capture both the expected and unexpected parts of credit risk in banks' loan portfolios. Furthermore,

⁵ We have examined several annual reports for different years of selected banks within our sample in order to investigate whether reported loan losses are calculated from both the private and corporate sector. Further, we aimed at investigating if there is a large discrepancy in reported losses in the corporate sector in their annual reports and the reported losses from the financial figures in the data provided by Finance Norway. We did not find large discrepancies. The reported impairment losses from the corporate sector accounts for a substantial share of the total loan losses in our sample of banks. However, we do not rule out the possibility that there may be large losses attributed to private households for certain banks, especially commercial banks specializing in consumer lending.

since realized losses that have not previously been written down are not specified in our dataset, we cannot isolate the unexpected part of banks' credit risk. Hence, there is no precise measures of a bank's actual loan losses in any given period.

$$Loan\ loss\ ratio_{it} = \frac{Net\ loan\ losses_{it}}{Total\ loans_{it}}$$

We calculate loan loss rate by losses on loans and guarantees over total loans from each bank's profit and loss account. In order to more accurately capture the bank's unexpected credit risk, we also use the standard deviation of the loan loss ratio following Jahn et al. (2013) and Behr, Kamp, Memmel and Pfingsten (2007). The rationale behind the construction of the volatility measure of the loan loss rate is that loan losses to some extent are expected losses which banks take account of when pricing their loans.

5.2.2 Concentration variables HHI indices

Data retrieved from The Norwegian Tax Administration and the SNF database enables us to decompose individual bank's credit portfolio into separate industries. The industry breakdown is set by Statistics Norway and is in accordance with the standard industrial classification in EU. Furthermore, information provided in the SNF database concerning firms' geographical location enables us to calculate each bank's total loan exposure in a given county, similar to Berger et al. (2010). This allows us to investigate two dimensions of diversification, both industrial diversification and geographical diversification.

The Hirschman-Herfindahl Index is a widely used measure of concentration, often applied in studies related to competition and market concentration. However, the HHI concentration measure is also commonly used to measure the degree of portfolio concentration. We thus follow related empirical banking studies, and use the Hirschman-Herfindahl Index to assess the level of concentration of banks' loan portfolios in terms of industries and geographical areas.

Relative exposure of bank i at time t to each industry y is defined as:

$$x_{ity} = \frac{Nominal\ industrial\ exposure_{ity}}{Total\ exposure_{it}}$$

Relative exposure of bank i at time t to each county c is defined as:

$$x_{itc} = \frac{\text{Nominal geographical exposure}_{itc}}{\text{Total exposure}_{it}}$$

Hence, the HHI-industry and HHI-county of bank i at time t can be written as:

$$\begin{aligned} HHI - \text{industry}_{it} &= \sum_{i=1}^n x_{ity}^2 \\ HHI - \text{county}_{it} &= \sum_{i=1}^n x_{itc}^2 \end{aligned}$$

The constructed Hirschman-Herfindahl Indices is the sum of squares in each category as a fraction of total loan exposure. In our case, we construct two different concentration indices. We calculate the total loan exposure in each of the 14 industry categories, as well as the total loan exposure in each of the 21 counties. The index ranges from $1/n$ to 1, with a higher value of the index indicating a concentrated (less diversified) loan portfolio and a more specialized bank.

5.2.3 Ownership variable

A bank ownership dummy is included in order to control for the variation in ownership structure among bank types in the Norwegian banking market. There are several similarities between pure savings banks and savings banks that have issued equity certificates. For one, the savings bank foundations are owning a substantial portion of the outstanding shares. Secondly, control rights reside with employees, depositors and representatives from the local government. Additionally, pure savings banks and EC-banks have conceding goals in fostering local development rather than just profit maximization. We therefore assume the risk-taking behavior of pure savings banks and EC-banks to be quite similar, and thus define savings banks as a main bank type including both savings banks and EC-banks when conducting our analysis. Consequently, we include a dummy variable for two different bank types; savings banks and commercial banks. The dummy variable, $D_i^{\text{ownership}}$, takes the value 1 if a bank is as a savings bank, and 0 if the bank is a commercial bank.

The classification of bank ownership is based on information retrieved from Finance Norway that follows the definition of bank types in the Act on Financial Undertakings and Financial Groups §2-19, as well as Finanstilsynet's registry regarding the savings banks that have issued equity certificates. In cases of uncertainty regarding bank type, we turn to the bank's annual reports for the years in our sample period.

5.2.4 Control variables

In order to control for the impact of bank-specific effects and macro trends on banks' risk, we include control variables to take account of plausible factors which may affect the bank's loan portfolio risk and the overall riskiness of the banks in our sample. To control for firm-specific variations in our sample, we construct measures of the bank's profitability, capital structure, size and credit rating ratios.

ROA

In order to control for differences in the bank's profitability, we include return on assets (ROA) as a measure of profitability. ROA is the ratio of annual net income to average total assets of a bank for each fiscal year and reflect the efficiency of managers in their utilization of a bank's available resources.

Banks' return on assets is calculated by adding net income to net operating income, subtract net loan loss and lastly dividing the pre-tax operating income for bank i in year t by total average assets. Pre-tax ROA is preferred in order to avoid distortions in banks' profitability that are introduced by differences in financial leverage and changes in the tax laws. A bank's return on assets should reflect its distinctive operations. Hence, write-downs on long-term securities are excluded from the pre-tax ROA calculation. Banks are highly levered, and for that reason achieve a lower ROA compared to non-financial firms and institutions.

$$ROA_{it} = \frac{\text{Pre-tax net operating profit}_{it}}{\text{Average total assets}_{it}}$$

We allow for ROA to have negative values, since the negative observations on return on assets are likely to contain information on individual bank's ability to persist in years after financial turmoil, similar to Berger and Bouwman (2013).

Equity ratio

Furthermore, we include equity ratio in order to control for bank-specific effects such as the capital structure of the banks. In addition, the risk preference of bank managers may be reflected in the amount of equity capital relative to the total assets of the bank. Consequently, we will expect banks to have a high equity ratio if the bank management has a low risk preference. Accordingly, we anticipate equity ratio to have a negative effect on risk.

$$Equity-ratio_{it} = \frac{Equity_{it}}{Total\ assets_{it}}$$

Size

Larger banks have to a larger extent than small institutions the opportunity to diversify their credit risk. A larger customer base implies larger capital funds available for investment and for geographical expansion. In addition, they are likely to have greater expertise in risk management. However, regulators may be unwilling to let large and systematically important banks fail, hence the value of implicit failure guarantees rise with bank size (Saunders et al. 1990). As a consequence, implicit guarantees by the government may stimulate banks large enough to be of systematic importance to be more risk-seeking. In order to control for these effects, we include a variable measuring the size of the banks in terms of the bank's logarithm of total assets for each year of the sample period. Further, we also include a squared term of size in order to capture potential non-linear relationships between the size of a bank and the bank's risk.

$$Size_{it} = \ln (Total\ assets)_{it}$$

Credit rating ratios

We construct a credit rating ratio for each separate rating category, using information about credit ratings retrieved from Bisnode. The credit ratings are based on several financial indicators, such as firms' financial figures and payment history, and reflects the financial health of the firms in each bank's loan portfolio (Hjelseth & Raknerud, 2016). The inclusion of the share of each bank's loan exposure in each credit rating category may provide additional insight into the bank's credit risk associated with loans to the corporate sector and reflect the "quality" of the bank's loan portfolio. The share of each bank's loan exposure in each credit rating category is calculated using Bisnode's internal credit rating system, which consists of 5 rating categories. A credit rating equal to 1 corresponds to firms rated C and credit rating equal to 5

is the highest credit rating a firm can obtain and corresponds to firms rated AAA. The share of the credit portfolio of bank i at time t in each rating category r over total loan exposure is defined as:

$$x_{itr} = \frac{\textit{Nominal exposure}_{itr}}{\textit{Total exposure}_{it}}$$

A separate rating category is created for firms with missing observations of credit rating, which may also contain non-rated firms, as non-rated firms often are newly established firms without previous financial history. Since the non-rated category constitutes a large share of certain bank's gross lending, we do not wish to omit non-rated firms from our sample.

5.3 Summary Statistics

We are left with the following distribution after the construction of our variables and cleaning of the dataset:

Table 5.1: Summary statistics for regression variables.

	Mean	Observations	Median	St.dev	Min	Max
Z-score ⁶	34.144	929	29.850	23.014	0.665	164.996
Loan loss ratio	0.002	1,213	0.001	0.004	-0.011	0.059
Diversification Industry (<i>HHI</i>)	0.283	1,209	0.244	0.144	0.112	1
Diversification geography (<i>HHI</i>)	0.649	1,209	0.661	0.210	0.993	1
ROA	0.009	1,213	0.001	0.007	-0.106	0.060
Size	8.231	1,213	7.853	1.421	4.927	14.417
Size ²	69.33	1,213	61.663	26.278	24.278	207.86
Equity-ratio	0.095	1,213	0.091	0.042	0	0.749
<i>Credit rating ratios</i>						
Rating category: AAA	0.042	1,213	0.035	0.037	0	0.336
Rating category: AA	0.221	1,213	0.221	0.103	0	0.644
Rating category: A	0.224	1,213	0.223	0.099	0	0.836
Rating category: B	0.202	1,213	0.199	0.098	0	0.581
Rating category: C	0.031	1,213	0.020	0.038	0	0.404

In order to consider the overall impact of diversification strategy and ownership structure on banks' risk, we do not omit extreme values of the Z-score and the loan loss ratio. Since our sample includes a period of financial turmoil, and thus both an expansion and a mild contraction in the Norwegian economy, it would not be reasonable to omit extreme values related to risk-taking. Especially considering that smaller banks and firms are more exposed to changes in the business cycle. Thus, following related empirical work, we do not exclude outliers related to risk-taking as we wish to examine the effect of individual bank's concentration and bank ownership on risk over the full sample period.

⁶ We also tried to apply a second approach to construct the Z-score by using the mean and standard deviation estimates of the return on assets calculated over the full sample combined with current values of the equity-to-asset ratio. This approach created more stable Z-score values, and provided Z-scores for longer consecutive periods as we are exempt from dropping the two initial observations per bank. The only variation in this computation would be due to the equity-to-asset ratio. The two measures were highly correlated with close similarities between mean, median and standard deviation values and we receive consistent regression results when applying each of the Z-scores. We only report the Z-score that is computed using a moving mean of ROA and standard deviation over the full sample as it allows for more variation each year, utilizing both variation in ROA and the equity-to-asset ratio.

The extreme values observed in our sample when constructing ROA are caused by new entrants, mergers and bankruptcies. We do not omit negative observations of ROA since a bank's return on assets is unlikely to be negative in consecutive periods.

Further, Handelsbanken and SEB have missing annual bank-specific accounts in several years, which precludes the construction of several control variables over the sample period. We thus omit observations of Handelsbanken and SEB in years with missing values. This reduces our sample of commercial banks, which may affect our results with regards to differences between ownership structure, since Handelsbanken is a bank with a considerable market share in the Norwegian banking market.

Notes on the construction of ownership variable:

DNB is a public limited company during the whole sample period. Thus, shareholders own a share of the entire capital, which is similar to the ownership structure of commercial banks. Whereas an owner of an equity certificate holds a share of the specific portion of the equity capital. Since the ownership structure of DNB differs from savings banks, we categorize DNB as a commercial bank over the entire sample.⁷ Furthermore, the governing bodies of DNB are more similar to those of commercial banks. The Savings Bank Foundation DNB has a low ownership stake of DNB's capital despite being above the 10% ownership-limit in years before 2015. A last point in explaining the classification of DNB as a commercial bank in our sample, is the fact that the foundation does not have a local anchorage. Hence, the effect of the foundation's focus on regional development is less pronounced for DNB, since it donates to charitable causes in Norway at large.

DNB has a market share of approximately 30% both in the private and corporate sector and is thus likely to affect the sample of commercial banks. Even though DNB is likely to affect the sample within its categorization we wish to keep DNB in our sample as it is the largest bank, and has historically incurred large losses.

Sparebank 1 SR-Bank is classified as an EC-bank over the full sample period, even though it restructures into a joint-stock bank in 2012. We keep its classification as an EC-bank due to the

⁷ Requirement of >10% in order to still be a per-definition savings bank from the Act on Financial Undertaking and Financial Groups §2-19. DNB is per definition a savings bank during the sample period and do not classify as a commercial bank until 2015 when The Savings Bank Foundation DNB is owning less than 10% of its outstanding shares.

foundation still owning a substantial amount of the outstanding shares. Taking into account that ownership concentration and more diversified owners is the primary change after the restructuring, the regional interests in the bank's governance structure will still be preserved due to the savings bank foundation still being the largest owner.

6. Descriptive statistics

6.1 Banks' risk

6.1.1 Banks' default risk

The Z-score is a measure of a bank's risk of default. A high Z-score indicates that a bank's risk of insolvency is relatively low, while a low Z-score indicates high risk of insolvency. As observed in figure 6.1, the Z-score decreases in the years leading up to the global financial crisis, and remains low throughout the crisis until 2009. When the return on assets decreases, banks' loan-loss absorbing capacity decreases, which is illustrated by a simultaneous decline in the average Z-score. In the years preceding the financial crisis, the Z-score increases steadily, and on average Norwegian banks experienced improved returns on assets. In the aftermath of the financial crisis, stricter regulatory requirements for the banking sector were proposed and introduced, both common European and distinctively Norwegian regulatory requirements. One of the requirements in the Basel framework was higher capital ratios in order to reduce the cost to society, reduce the risk of a banking crisis and strengthen Norwegian banks' loss-absorbing capacity. Thus, the increase in the Z-score in years following the global financial crisis can additionally be accredited an increase in banks' capital base, which indicates that Norwegian banks have in fact improved their loss-absorbing capacity.

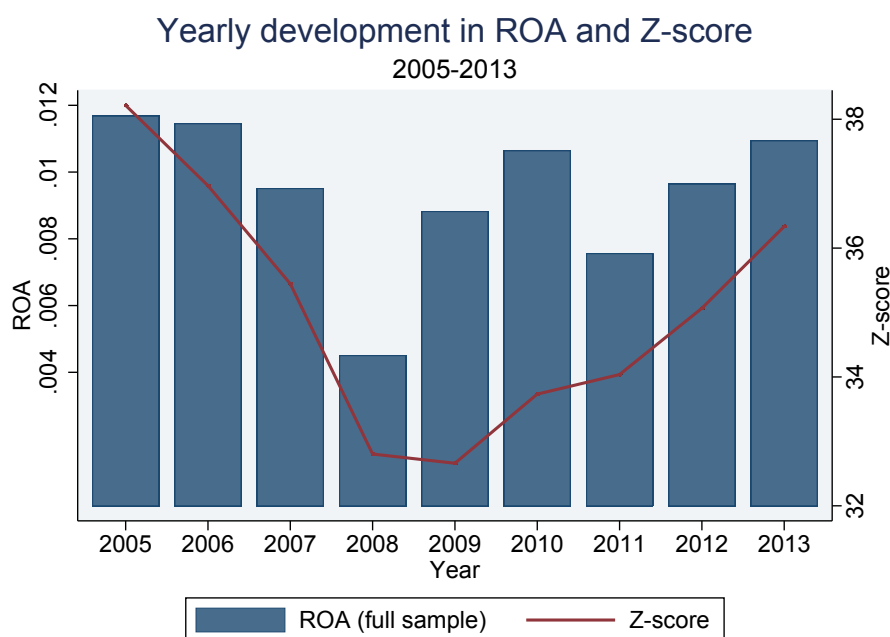


Figure 6.1: Average default risk and ROA for the full sample of banks 2005-2013.

In figure 6.2, there is an observed discrepancy in the average Z-scores for each of the three bank types; pure savings banks, EC-banks and commercial banks. The minimum value of the Z-score of 0.67 belongs to Bank Norwegian. In comparison to the mean value of the sample of 34.14, with considerable variation over the full sample. We observe that commercial banks are overrepresented in the lower end of the Z-score distribution. Especially, commercial banks specialized in consumer lending have low Z-scores throughout the sample period. To exemplify, the commercial bank yA Bank has a Z-score ranging from 4.7 to 5.5, which is well below the mean value. On the other hand, savings banks typically have the higher Z-scores. The average Z-score calculated over the full sample period for pure savings banks is 40.28, whereas the full sample average Z-score for commercial banks is 21.67.

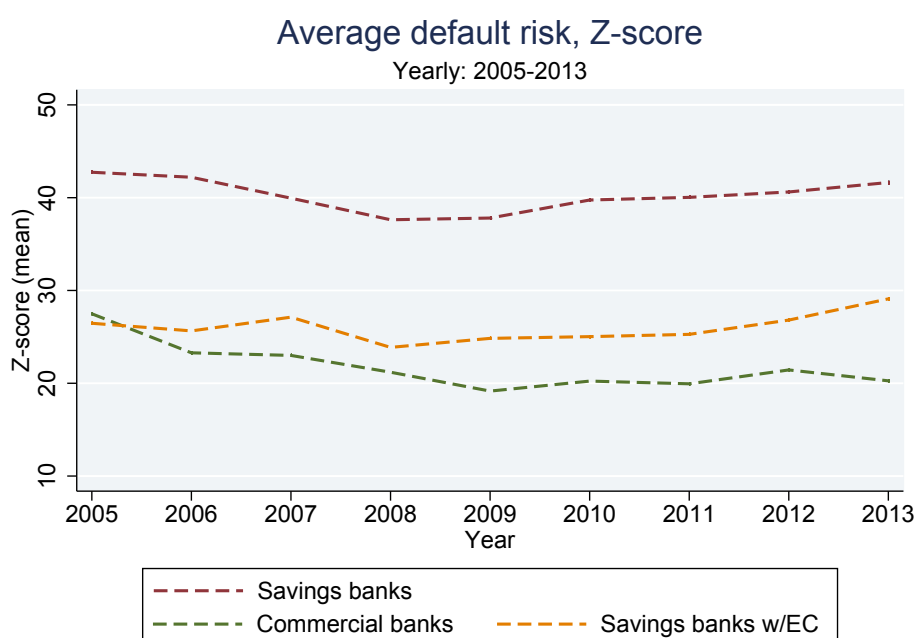


Figure 6.2: Average default risk of the full sample of banks and for each bank type for the period 2005-2013.

We observe that the average Z-score of EC-banks lie between that of the pure savings banks and commercial banks. This is in line with what we expect, since EC-banks can be considered a hybrid form of a savings bank and a commercial bank.

6.1.2 Banks' credit portfolio risk

A bank's credit portfolio risk can be measured by the loan loss ratio. The mean value of the loan loss ratio is 0.22% for the full sample. For pure savings banks the mean value of the loan loss ratio is 0.18%. Commercial banks on the other hand, have an average loan loss ratio of

0.41% over the full sample period. The mean value is lower for pure savings banks than the full sample, supporting the view that savings banks take on less risk. This may however be due to the composition of the loan portfolios of savings banks compared to commercial banks. Savings banks and commercial banks may have different lending exposures in the private household and corporate sector. Historically, savings banks have focused on lending toward their respective local communities, and have a higher share of total lending in the private household sector, whereas commercial banks have typically targeted the corporate sector (Norges bank, 2018b). Thus, the observed discrepancy in the mean value of the different bank types may also be driven by composition effects.

Over our sample period, the loan loss ratio ranges from -1.1% to 5.9%. We observe some negative values of the loan loss ratio for certain banks in our sample, especially during the years 2005 to 2007. A period characterized by high lending growth, reversals of expected losses, low loan losses and changes in accounting practices for loan loss provisions. Reported loan losses are banks' expected and unexpected losses divided by total loans. In periods where the actual losses are smaller than expected losses, the reported loss-numbers can take negative values. Thus, the negative minimum value can be explained by negative losses exceeding new expected losses in the given period.

From figure 6.3, we observe that the loan loss rate increased substantially in 2008. Further, there is an observed tendency that the largest loan losses are found in the years preceding the financial crisis, and are typically related to both smaller savings banks and commercial banks. The decline in economic activity and pessimistic outlooks at the time of financial turmoil might have led banks to increase their write-downs of expected losses. Especially yA Bank experienced large losses in the years 2007-2012. This is consistent with what we observed from the Z-score. We do also find large losses related to banks of a considerable size. For instance, DNB did incur a loss of 0.5% (within the 90th percentile of the loan loss ratio) and Sparebanken Vest incurred a loan loss of 0.38% in 2009 following the global financial crisis.

The graph below, figure 6.3, illustrates the development in the average loan loss ratios for all banks across sub-samples of the different bank types, and compares the development of loan losses to the business cycle over the sample period. The left vertical axis measures the average net loan losses over total loans for pure savings banks, commercial banks and EC-banks in each

year from the period 2005-2013. The right vertical axis measures the inverse of the GDP growth rate of the Norwegian economy over the sample period.

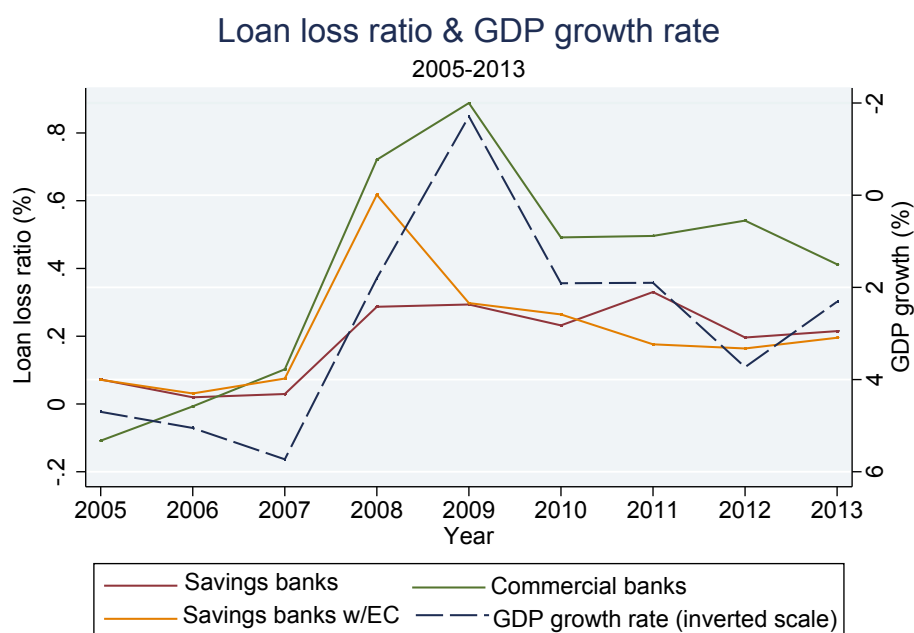


Figure 6.3: Average loan loss ratio (net loan losses over total loans) for all banks in the sample, by bank type and GDP growth rate for the period 2005-2013.

From figure 6.3 we observe a relatively close relation between the GDP growth rate and the loan loss ratio for the three different bank types. This suggests that macroeconomic factors to some extent are relevant when explaining banks' loan losses over our sample period. Especially the loan loss ratio of commercial banks follows the pattern of the development of the GDP growth rate. Thus, indicating that commercial banks especially are sensitive to fluctuations over the business cycle. Whereas the average loan loss ratio for pure savings banks is well below that of commercial banks. The loan loss ratios start to increase before the global financial crisis and reaches its' first peaks just before the year 2008. The average loan loss ratios for pure savings banks and EC-banks flattens out in the following years, whereas the average loan loss ratio of commercial banks continue to increase until 2009 before it decreases. Furthermore, the average loan loss ratio of commercial banks remain at a higher average level than the loan loss ratios of the savings banks.

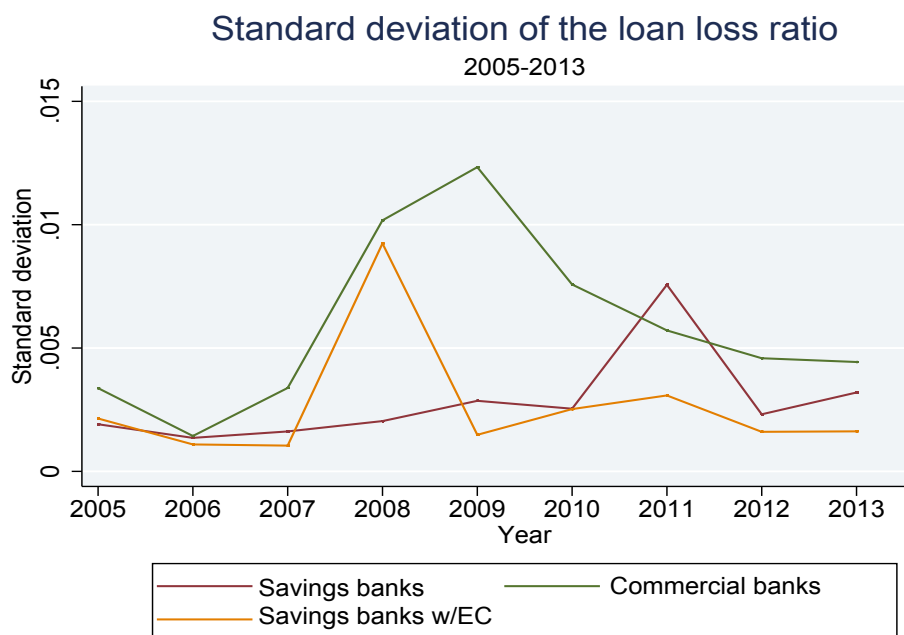


Figure 6.4: Standard deviation of the loan loss ratio for Norwegian pure savings banks, commercial banks and EC-banks in each year for the sample period 2005-2013.

Figure 6.4 shows the development over time of the standard deviation of the loan loss ratio for the three types of bank ownership. The relatively large standard deviations of the loan loss ratio, especially for the commercial banks in our sample, indicate substantial individual variations in the loan loss ratio among the banks in our sample. The savings banks, which is the largest category-base, have a more stable aggregated loan portfolio in terms of loan losses, despite an increase in the standard deviation in the years 2010 to 2011. Indicating that commercial banks have larger within-group variation and more unexpected credit portfolio risk.

6.2 Banks' credit portfolio diversification and composition

6.2.1 Industrial diversification

The mean value of the industrial concentration measure is 0.28 for the full sample. Thus, indicating that most of the banks in our sample do to a large extent diversify their credit portfolios in different industries. Figure 6.5 illustrates the development of average loan portfolio diversification from 2005 to 2013, both for the full sample and decomposed in the different sub-groups.

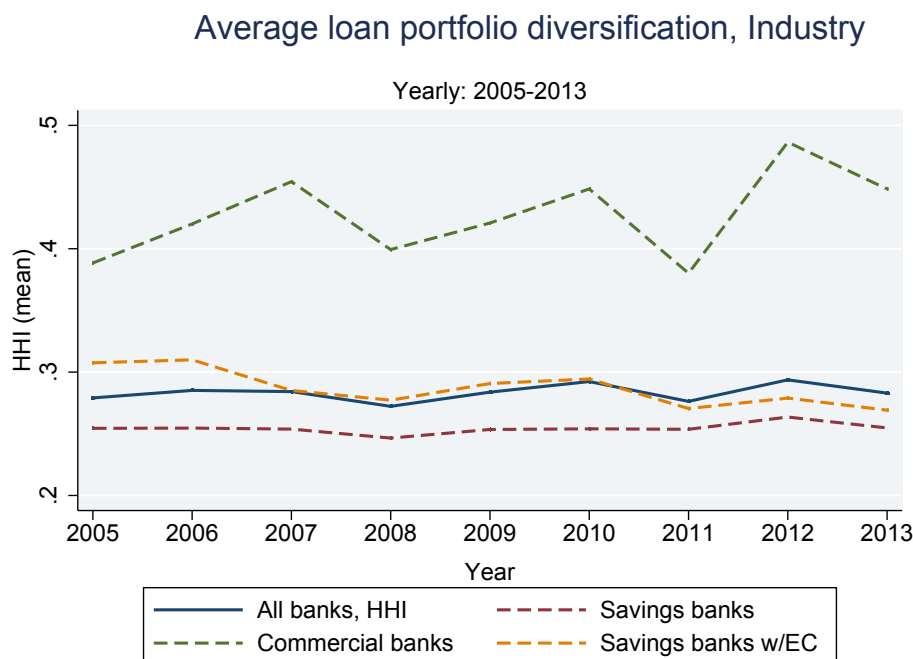


Figure 6.5: Average loan portfolio industry diversification for the full sample of banks, and decomposed for each bank type for each year for the sample period 2005-2013.

The different levels of loan portfolio diversification captured in our sample ranges from 0.11 to 1. Thus, all possible levels of diversification are represented in our sample. For instance, Bank Norwegian has a value of industrial HHI equal to 1 in 2007 and 2008, when all loans are made to the industry categorization finance and insurance. From 2009, Bank Norwegian increases its exposure to primary industries. Similarly, yA Bank has an HHI of 1 in 2006 and 2007. For the remaining years of our sample period the HHI is close to 1, and the bank is to a large extent exposed to the industry finance and insurance. Further, focused banks with highly concentrated loan portfolios are more often commercial banks specialized in consumer lending. Thus, the banks specializing in consumer credit often holds a large portion of their credit portfolio in the finance and insurance category. Banks with a low degree of concentration are typically small savings banks.

Several banks adjust their level of diversification in the credit portfolio over the sample period. For instance, Sparebanken Sør has increased its degree of diversification over the sample period from 0.36 in 2005 to having an HHI of 0.28 in 2013. Sparebanken 1 Nordvest on the other hand, decreases its level of diversification from 0.17 in 2005 to 0.30 in 2013.

Figure 6.6 illustrates the average aggregated loan portfolio composition of the banks in our sample during the years 2005-2013, decomposed in industry categories.

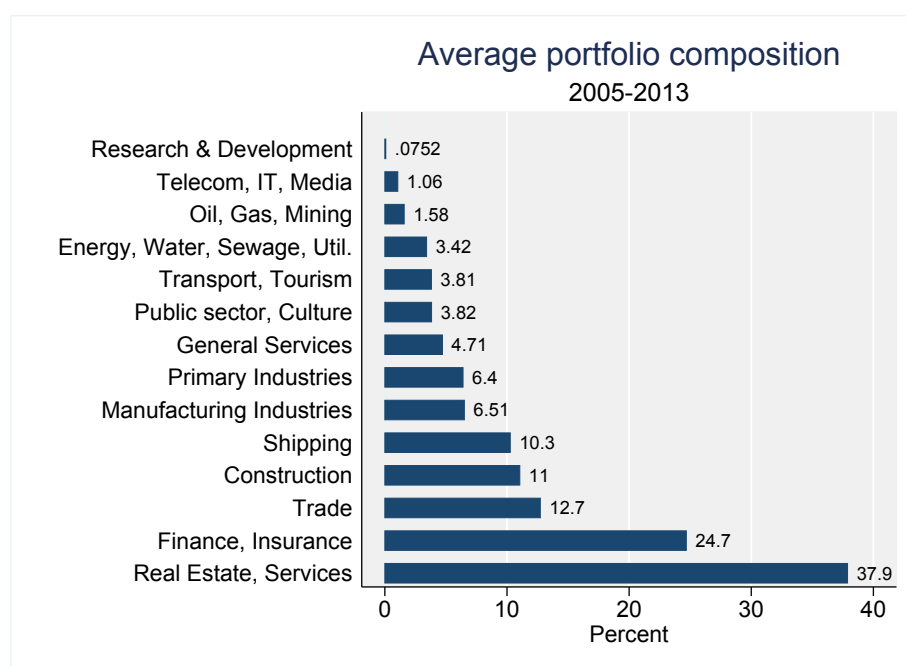


Figure 6.6: Average industrial loan portfolio composition for the full sample of banks, 2005-2013.

The classification in figure 6.6 diverges somewhat from the decomposition of banks' loan portfolio in the background section from chapter 2, due to the fact that Norges Bank apply a different industry classification standard than that of Statistics Norway. Even though there are differences in the classification standards used in the two charts, the general picture of the aggregated decomposition of banks' loan portfolio is consistent.

From figure 6.6, we observe that commercial real estate and finance and insurance on average account for the largest portion of banks' credit portfolio. Whereas the rest of the loan portfolio is relatively evenly distributed among the remaining industries. After the introduction of the Basel II framework in 2007, residential mortgage loans were given lower risk-weights (Andersen, Johansen, & Kolvig, 2012). Thus, banks may have increased their lending towards market segments, such as commercial real estate, associated with higher risk-weights, when the risk-weight of a substantial segment of banks' portfolio was reduced. By doing this, the banks could expand their lending and still be within their required capital ratio. In addition, the commercial real estate industry is capital intensive and is therefore in high demand for financing. As previously mentioned, the dominating position of commercial real estate in

Norwegian banks' credit portfolios may represent a concentration risk. Especially considering commercial real estate's prominent role in contributing to financial distress and historically large loan losses.

Interestingly, the oil and gas industry constitute a relatively low share of the bank's aggregated loan portfolio contrarily to what one may expect considering its prominent position in the Norwegian economy. One potential reason why the oil, gas and mining industry on average constitutes a relatively low share of banks' aggregated credit portfolio, is that there has been a tendency that oil related companies often have loans from several banks, both granted by Norwegian and international banks (Hjelseth, Turtveit & Winje, 2016). In addition, oil related companies extract debt financing from the bond market. One important notion to make, is that we only have reported loans from Norwegian registered firms that are made to banks with license to operate in the Norwegian banking market. Hence, considering that several oil related companies are foreign registered companies, the share of firms in our sample in the oil related industry may be lower than banks' actual credit exposures in the oil related industry.

The finance and insurance industry is the second largest industry in the bank's aggregated credit portfolio. A considerable number of loans within the finance and insurance industry can be attributed to interbank lending, as well as to investment funds and firms classified as holding companies. Further, the retail trade industry makes up a relatively large share of the bank's aggregated credit portfolio. This is typically an industry sensitive to consumer behavior and fluctuations in the business cycle. Additionally, there have historically been substantial losses related to the retail trade industry. Finally, we observe that the loans are fairly distributed among the remaining industries.

Figure 6.5 illustrating the differing degrees of diversification between commercial banks and savings banks, indicated that commercial banks on average are more industrial diversified compared to savings banks. It is therefore interesting to illustrate commercial banks' and savings banks' average portfolio composition separately.

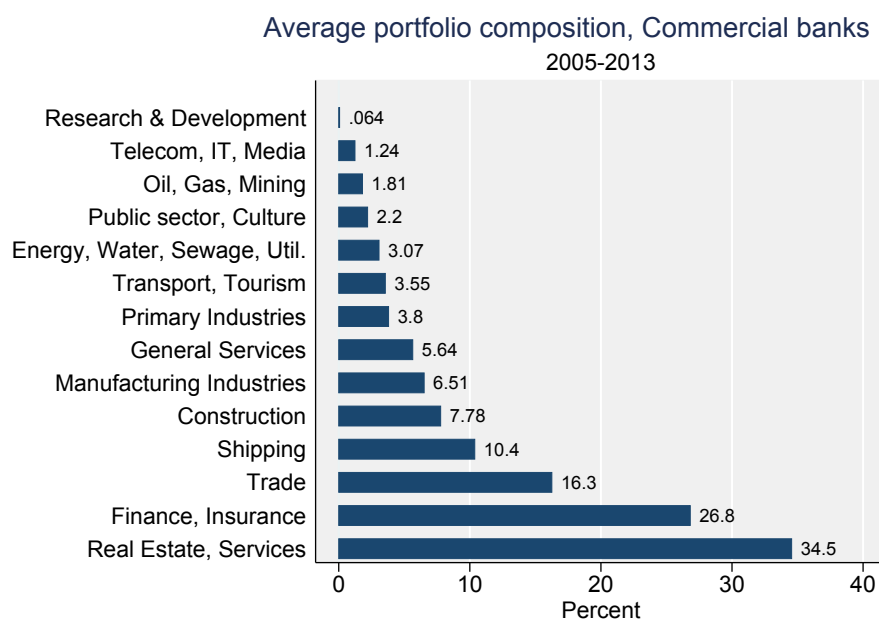


Figure 6.7: Average aggregated loan portfolio by industry for commercial banks, 2005-2013.

From figure 6.7, we observe that the average portfolio composition of commercial banks is relatively similar to the composition for the full sample. The main difference being that commercial banks on average have an even larger share of their aggregated loan portfolio in the industries trade (retail trade), finance and insurance and commercial real estate. The three industries that constitutes the highest shares of the credit portfolios are consistent for commercial banks and the full sample. Hence, their differing degrees of industrial diversification is accredited to the fact that the three largest industries in the aggregated loan portfolio in total comprises 75.3% of the loan portfolio for the full sample, compared to 77.6% of the aggregated loan portfolio of commercial banks.

It is interesting that the portfolio composition of commercial banks and the full sample follow a similar distribution of their decomposed loan portfolio in terms of industries. One potential reason might be that DNB is categorized as a commercial bank during the full length of our sample period, and the fact that DNB has a market share of approximately 30% in the corporate sector. Thus, both the full sample and the portfolio composition of commercial banks may be highly driven by DNB's credit portfolio composition. Separating the average portfolio decomposition by industries into sub-categories of commercial banks and savings banks somewhat supports this assumption due to the composition of commercial banks' loan portfolio having the same structure as for the full sample.

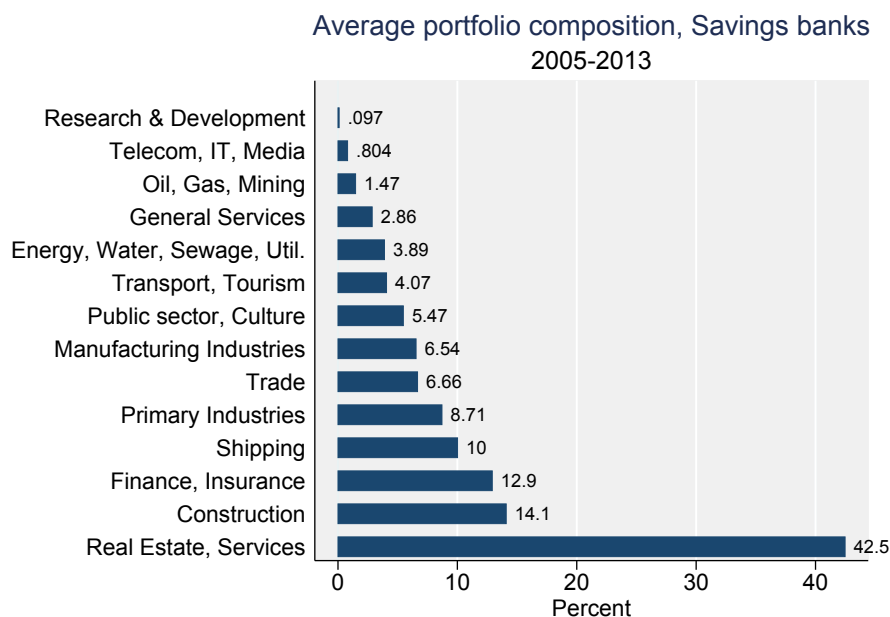


Figure 6.8: Average aggregated loan portfolio by industry for all savings banks, 2005-2013. Note: the figure is showing the average loan portfolio composition of both pure savings banks and EC-banks.

The average loan portfolio composition of savings banks differs somewhat from the full sample and from commercial banks. We observe from figure 6.8 that on average the real estate and service industry constitutes 42.5% of savings banks' loan portfolio. Savings banks' remaining aggregated loan portfolio composition is relatively evenly distributed among the remaining industries. Thus, even though savings banks on average have a higher concentration of their loan portfolio in one industry, they are more diversified. The three largest industry exposures of savings banks' loan portfolio comprise of 69.5% in total. This is in line with what we observe from figure 6.5, showing the average industry diversification for each bank type.

We observe that there is a tendency that savings banks lend more funds to the construction industry compared to commercial banks. Firms within the construction industry are typically small entrepreneurs and enterprises that typically only operate within a specific geographical area.

6.2.2 Geographical diversification

Figure 6.9 shows the development of the average loan portfolio diversification in terms of geography. The figure illustrates the development for the full sample of banks and for each bank type for the period 2005-2013. There is evidently a downward-sloping trend in terms of geographical concentration for the full sample and for savings banks. Indicating that on average

savings banks are increasing their degree of geographical diversification. The development of geographical diversification for commercial banks is however more varying. This might also be due to certain commercial banks exiting and entering the sample at different times, and that the degree to which certain data is reported for, especially branches of foreign owned banks, varies during the sample period.

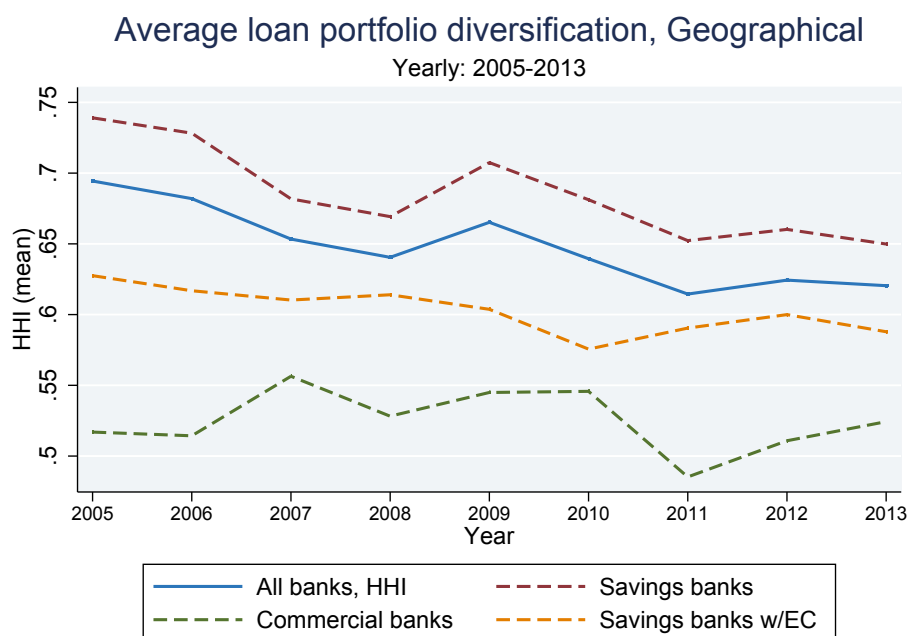


Figure 6.9: Average geographical diversification for the full sample of banks, and decomposed for each bank type for each year for the sample period 2005-2013.

The average value of the Hirschman-Herfindahl Index for geographical diversification is 0.65 for the full sample, which indicates that most of the banks in our sample have relatively concentrated loan portfolios in terms of geography. The degree of concentration ranges from 0.01 to 1, with large within variation. Commercial banks have a mean value of 0.52, and are overly represented among highly diversified loan portfolios in terms of geographical areas. Savings banks on the other hand, have a mean value of 0.67, and have typically highly concentrated loan portfolios in regards to geography.

An interesting, yet expected observation, is that small savings banks, especially members of the Eika alliance, have decreasing geographical concentration in their credit portfolios. Thus, indicating a trend of savings banks extending their customer base to new geographical areas. For instance, Sparebank 1 Ringerike Hadeland experience a decrease in the concentration measure HHI of 0.87 in 2005 to 0.52 in 2013. This is a relatively sharp increase in the level of diversification over a short amount of time. Further, we observe a decrease in the HHI from

0.83 to 0.47 and 0.82 to 0.55 in the period from 2005-2013 for members of The Eika Alliance, Skue Sparebank and Hønefoss Sparebank, respectively. This is line with what we expect from savings banks that are affiliated with alliances, due to their strategic collaboration and focus on sharing new technology and services. Through alliances, small savings banks are given the opportunity to utilize technology that enables them to reach new geographical areas through internet banking. Further, the increase in geographical portfolio diversification of savings banks might also be a result of increased competition from new entrants to local markets that force smaller savings banks to extend their customer base.

7. Methodology and the choice of estimation method

Since our dataset consists of a time series for each bank in the sample, we are dealing with panel data. Panel data gives us the advantage of being able to study the effect of lags in behavior and the result of decision making by the banks (Wooldrige, 2013). When analysing panel data, we cannot assume that the observations are independently distributed across time. To exemplify, unobserved factors such as bank strategy or management may affect banks' risk-taking in both 2005 and 2006. Consequently, special models and methods have been developed in order to analyse panel data. In the following we will present panel data estimation methods, the choice of estimator and lastly the model diagnostics.

7.1 The choice of estimation method

From chapter 4, we have the following extended general econometric model:

$$(2) \text{ risk}_{it} = \beta_0 + \beta_1 \text{div}_{it}^{\text{ind}} + \beta_2 \text{div}_{it}^{\text{geo}} + \beta_3 D_i^{\text{ownership}} + \sum_{n=4}^M \beta_n X_{nit} + \delta_t + \lambda_i + \varepsilon_{it}$$

The fact that we are using panel data means that the model error term in our regression both contain an unobserved time-invariant bank-specific effect, as well as a time- and bank varying component. Thus, the model error term:

$$v_{it} = \lambda_i + \varepsilon_{it}$$

There are several potential unique factors for individual banks in our sample that may be constant over time and that are likely to affect banks' risk-taking. Factors that are difficult to observe and measure with explicit variables will thus be included in the model as unobserved fixed effects in the error term, captured in the variable λ_i . Unobserved fixed effects can for instance be management style, banks' strategy, monitoring ability and risk preference of bank managers. The unobserved fixed effects, λ_i , may be a source of endogeneity in our model, which will cause a pooled ordinary least squares (OLS) estimator to be biased, and result in inconsistent estimates since unobserved bank-specific fixed effects are likely to affect our explanatory variables. Further, we include a time fixed effect, δ_t , to control for time-varying factors that are common to all banks. Whereas unobserved bank-specific effects that change and vary over time are captured in the error term ε_{it} .

7.1.1 Fixed effects estimation

An advantage of using the fixed effects (FE) approach is that it produces unbiased results even though there exists correlation between the unobserved fixed effects and the explanatory variables. By using the fixed effect transformation (within transformation), we can eliminate bank-specific effects that do not vary across time. Due to the fact that the bank ownership dummy is not time-varying, it is in general not possible to identify commercial banks and savings banks in the fixed effects regressions.⁸ Thus, using fixed effects estimation is problematic in our scope of research. Further, by eliminating λ_i , using fixed effects reduces the variation in the explanatory variables, making the estimation technique less efficient since it only utilizes the within-group variation.

An advantage of using the fixed effects transformation when having an unbalanced panel dataset, is that banks with missing observations for certain years or that drop out of the sample are captured by λ_i . Some units are more likely to drop out of the sample than others, and if the reason for certain banks dropping out is correlated with the unobserved fixed effects, this would cause biased estimators.

Even though time-invariant variables cannot be included separately in a fixed effects estimation, they can however be included as interaction terms with variables that are time-varying (Wooldridge, 2013). We therefore choose to include interactions between the diversification variables and bank ownership dummy in model specification (3):

$$(3) \text{ risk}_{it} = \beta_0 + \beta_1 \text{div}_{it}^{\text{ind}} + \beta_2 \text{div}_{it}^{\text{geo}} + \beta_3 D_i^{\text{ownership}} + \beta_4 \text{div}_{it}^{\text{ind}} D_i^{\text{ownership}} + \beta_5 \text{div}_{it}^{\text{geo}} D_i^{\text{ownership}} + \sum_{n=6}^M \beta_n X_{nit} + \delta_t + \lambda_i + \varepsilon_{it}$$

7.1.2 Fixed effects variance decomposition

A solution to the problem of not being able to estimate the time-invariant variables when applying the FE method, is to estimate the coefficients by using the fixed effects variance decomposition (FEVD) approach. The FEVD method was developed by Plümper and Troeger (2007) in order to produce improved estimates for time-invariant and slowly-changing

⁸ Banks rarely restructure from being a savings bank to a commercial bank during our sample period. DNB changes from being a per-definition savings banks to a commercial bank in 2015. However, we have chosen to categorize DNB as a commercial bank for the full length of our sample period. Several banks restructures within the main category of savings banks, from being a pure savings banks to a savings banks with equity certificates. Thus, when operating with only two ownership categories, the ownership dummy will be time-invariant for our whole sample period.

variables. The FEVD estimates are obtained by first regressing a fixed effects model in order to obtain the unit effects, $\hat{\lambda}_i$. In the second stage the unit effects, $\hat{\lambda}_i$, from the first stage is regressed on the time-invariant and slowly-changing variables. However, an important notion to make is that there should have been a correction for the degrees of freedom in FEVD. Additionally, the estimates are unbiased only if the time-invariant explanatory variables are exogenous, i.e. uncorrelated with the unobserved individual specific effects, λ_i . The estimated coefficients must therefore be interpreted with great caution.

7.1.3 Random effects estimation

In the random effects (RE) estimation approach it is assumed that the unobserved fixed effect, λ_i , is uncorrelated with the explanatory variables in all time periods, whether the explanatory variables are fixed over time or not. Thus, random effects estimation allows for inclusion of time-invariant explanatory variables as oppose to fixed effects. The assumption of no correlation between the time-invariant unobserved effect, λ_i , and explanatory variables allows us to include variables that are constant over time, such as bank ownership. However, it may be hard to argue that bank ownership has no effect on unobserved effects such as for instance banks' efficiency and monitoring abilities. If the assumption holds, RE estimation can be said to be more efficient since it is utilizing more of the variation between individual banks.

7.1.4 Choosing estimation method

When deciding between a fixed effects and random effects estimation method, it is essential to test whether the explanatory variables of the models are correlated with the unobserved time-invariant factors in the error term, λ_i . If the assumption fails to hold, the zero-conditional mean assumption of OLS will be violated, resulting in biased estimates from using the random effects estimation. By performing a Hausman test it is possible to test whether the estimation results are significantly different (Wooldridge, 2013). In the case of correlation between the unobserved fixed effect, λ_i , and the explanatory variables, the estimated coefficient from FE estimation and RE estimation will be significantly different, and the null hypothesis of zero correlation will therefore be rejected. If the null hypothesis of no correlation of the Hausman-test is rejected, that would indicate that the random effects estimator is inconsistent.

By performing the Hausman test we reject the null hypothesis of no correlation between λ_i and the explanatory variables for all our model specifications. We do however suspect that the rejection may be driven by differences in the estimated coefficients for the time dummies, and

we therefore choose to perform F-tests in order to investigate this further. The null hypothesis of the F-tests is that each of the estimated coefficients are not significantly different when applying the RE and FE method. The choice of estimation method will therefore depend on an overall assessment based on results from conducting the Hausman-test and the F-tests. We will therefore apply different estimation techniques on the econometric model specifications.

7.2 Model diagnostics

In order to obtain robust inference, we need the assumptions of no serial correlation and homoskedasticity to hold when applying our chosen estimation techniques to our panel data model. In the presence of serial correlation and heteroskedasticity, the standard errors and test statistics will be invalid. Consequently, leading to a deceitful impression of the significance level of the explanatory variables.

7.2.1 Testing and correcting for serial correlation and heteroskedasticity

One advantage of having panel data is that we can allow for serial correlation in the errors provided that the number of years is not too large (Wooldrige, 2013). Thus, serial correlation is not a problem when the panel data consists of a time series under 20 years, which is the case of our panel data (Torres-Reyna, 2007).

Furthermore, we test for heteroskedasticity by conducting the group-wise Wald test. The test rejects the null hypothesis of homoskedasticity in the standard errors. In order to compute standard errors that are robust to serial correlation and heteroskedasticity, we choose to cluster our panel data by each individual bank. Hence, each cross-sectional unit, in our case banks, will be defined as a cluster of observations over time, where serial correlation and changing variances are allowed within each cluster (Wooldrige, 2013).

7.2.2 A robust Hausman test

The standard Hausman test can however not be used when errors are clustered (Cameron & Miller, 2015). Additionally, the standard form of the Hausman test requires that neither λ_i or ε_{it} is heteroskedastic and that there is no within-cluster correlation in ε_{it} . We therefore perform a cluster-robust form of the Hausman test as proposed by Cameron and Miller (2015). The test rejects the null hypothesis of no correlation between the explanatory variables and the unobserved time-invariant factors in the error term λ_i for all our model specifications.

8. Results

We start by investigating the effect of industrial and geographical portfolio diversification on banks' risk using Z-score as a risk measure on the full sample, in line with other comparable studies. Further, we extend our model in order to investigate the effect of both loan portfolio diversification and the effect of bank ownership, first by including a dummy variable and lastly by including interaction terms. In order to test robustness of our analysis, we conduct similar regressions using the loan loss ratio as a risk measure in section 8.2.

8.1 Using Z-score as a proxy for risk

Increased portfolio concentration may entail monitoring and screening capabilities, in addition to increased competence within industrial sectors and geographical areas. Thus, in line with related empirical banking literature our assumption is that specialized banks tend to take on less risk. Further, the ownership structure of commercial banks should, based on arguments by Black and Scholes (1973), entail a positive effect on banks' risk-taking, since higher asset volatility increases the value of equity at the expense of other claimholders. Thus, our assumption is that the savings bank dummy variable will have a negative effect on banks' risk, implying that savings banks are less risky than commercial banks.

When conducting our regressions, we start by presenting the effect of credit portfolio diversification in terms of industries and geography, using both random effects and fixed effects estimation in column (1) and (2). Column (3) presents the effect of credit portfolio diversification and bank ownership by including a dummy variable using the random effects estimation method. Further, in sub-section 8.1.2 the interaction terms will represent the difference in the industrial and geographical diversification coefficients, given the banks ownership structure.

8.1.1 The effect of credit portfolio diversification and bank ownership on risk: dummy approach

Table 8.1: Regression results using Z-score as a risk measure.

Variables	(1) RE	(2) FE	(3) RE
Industrial diversification (div_{it}^{ind})	-3.186* (1.738)	-2.887* (1.703)	-3.223* (1.750)
Geographical diversification (div_{it}^{geo})	1.839* (0.947)	1.635* (0.944)	1.886** (0.953)
All savings banks			2.172 (1.778)
Return on Assets	147.1*** (32.38)	147.1*** (32.84)	147.5*** (32.44)
Ln Size	-14.05** (6.165)	-14.95** (6.814)	-14.12** (6.193)
Ln Size ²	0.505 (0.336)	0.504 (0.382)	0.513 (0.337)
Equity-ratio	48.39* (27.95)	44.59 (27.72)	48.68* (28.06)
Observations	925	925	925
Number of banks	146	146	146
Year dummies	YES	YES	YES
The modified Wald test	0.000	0.000	0.000

The reported standard errors in parentheses are clustered by each individual bank.

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

Notes: The dependent variable is the Z-score of bank i at time t . div_{it}^{ind} is the industrial diversification calculated as the sum of squares of banks' relative exposure to each industry over total loans (measured by HHI). div_{it}^{geo} is the geographical diversification measure, calculated as the sum of squares of banks' relative exposure to each county over total loans (measured by HHI). ROA_{it} is return on assets of bank i at time t . Equity-ratio ($Eq\text{-}ratio_{it}$) is the equity over total assets of bank i at time t . Savings banks=1 if a bank is categorized as a savings bank, and includes both pure savings banks and EC-banks. We report the p-values of the modified Wald-test. Year dummies are not reported in the output due to space limitations.

Column (1) and column (2) presents the effect of industrial and geographical diversification for the full sample, using RE estimation and FE estimation. The effect of both industrial and geographical diversification are significant at a 10% level.

We observe that the estimated coefficients from the RE and FE regression in column (1) and (2) are relatively similar. Although the Hausman test rejects the null hypothesis of no systematic difference in the coefficients, we suspect that the rejection may be driven by differences in the year dummies. Further, we observe that the FE estimation produces coefficients that lie within the confidence intervals from the RE estimation, and vice versa. By performing F-tests on the estimated coefficients from column (1) and (2), we are not able to reject the null hypothesis of no systematic difference between each of the estimated coefficients. Thus, indicating that the estimated coefficients from RE and FE (column (1) and (2)) are similar, and strengthens our

suspicion that year dummies may cause the rejection of the null hypothesis of the Hausman test. We therefore choose to rely on the random effects estimation method, and only report the RE estimation when including the dummy variable for bank ownership, in column (3).

From column (1) we observe that the effect of a more concentrated loan portfolio in terms of industries will entail a decrease in the Z-score of 3.186 when using RE estimation, which increases the risk of insolvency. However, the effect of a more geographical concentrated loan portfolio is positive, thus the average effect of banks' increasing their presence in geographical areas will be an increase in the Z-score of 1.839. Thus, a higher Z-score indicates that banks on average becomes more solvent and improves their loss-absorbing capacity when a bank becomes more focused in terms of geography. The effects are however not strong even though both diversification variables are significant.

Banks having more concentrated credit portfolios might be more sensitive to cyclical downturns when they have a greater exposure to a few industries. This due to the fact that certain industries might experience industry-specific fluctuations that do not correlate as strongly with the national business cycle. Industrial concentration being associated with higher risk can thus be explained by concentrated banks both being exposed to systematic risk and idiosyncratic risk in each industry. Additionally, the higher risk associated with industrial concentration may be attributed to the fact that the banks in our sample are greatly exposed to the commercial real estate sector, which historically has been associated with large losses in times of crisis. Related industries within the commercial real estate sector may for instance be the real estate development sector, which is an industry related to high bankruptcy risk and that is vulnerable to economic downturns. Interestingly, this contradicts the common view in the empirical literature that diversified banks are more exposed to credit portfolio risk than less diversified banks. However, the results found when using the Z-score as a measure of risk is consistent with the findings of Chen et al. (2013), and supports the traditional portfolio banking perspective of diversification being the preferred strategy.

Geographical concentration may offset the tendency of banks to increase the risk of insolvency. Thus, banks may often expand their loan portfolio within one geographic area without proportionally increasing their risk when the geographical concentration increases. Lower insolvency risk (higher Z-score) associated with increased geographical concentration supports the argument that banks with concentrated loan portfolios in certain geographical areas

increases their regional knowledge and expand their network within regions, leading to advantages related to screening and monitoring due to knowledge of the local community, which is in line with Liikanen et al. (2012). In addition, this is in support of arguments presented by Ghatak (2000), that asymmetric information can be alleviated by knowledge of the local community.

An important part of our analysis is to investigate whether bank ownership have an effect on banks' risk. In order to analyze the effect, we extend our model in column (1) to include a dummy variable in column (3). Consistent with the effect of credit portfolio diversification in column (1) and (2), we find in column (3) that a more concentrated credit portfolio in terms of industries increases banks' risk of insolvency, with an estimated coefficient of -3.223. Further, we find a stronger effect of the effect of geographical diversification when controlling for bank ownership. The effect of a more geographical concentrated portfolio is positive and significant at a 5% level. The magnitude of the estimated coefficient is 1.886, and is similar to the RE estimated coefficient from column (1). We observe that the bank ownership dummy is insignificant and has a positive coefficient when estimated using random effects in column (3).

Interestingly, we observe that the coefficients of return on assets are positive and highly significant, indicating that there is a positive relationship between higher return and lower risk.

8.1.2 The effect of credit portfolio diversification and bank ownership on risk: using interaction terms

It is interesting to further investigate the effect of credit portfolio diversification and if the effect differs between savings banks and commercial banks.⁹ By using interaction terms between the diversification variables and bank ownership dummy, we obtain a less restricted model compared to the model specification in section 8.1.1. Hence, in the following regressions we allow for the effect of diversification to be different for the two main bank types. Previously, in sub-section 6.2.1, we have seen somewhat puzzling findings indicating that commercial banks are more industrial concentrated. Additionally, we observe that commercial banks have a higher degree of macroeconomic (geographical) diversification. Thus, commercial banks are likely to be more affected by macroeconomic factors.

⁹ We have also investigated whether the impact of bank-specific variables, such as size, are different for the different types of banks (by interacting the size variable with the bank ownership dummy variable), but this has not led to any significant results.

Table 8.2: Regression results using Z-score as a risk measure.

Variables	(1) RE	(2) FE	(3) FEVD
Industrial diversification (div_{it}^{ind})	-7.885* (4.099)	-7.612* (3.895)	-39.967* (20.593)
Geographical diversification (div_{it}^{geo})	6.143** (2.446)	5.764** (2.379)	9.693 (19.947)
All savings banks	2.083 (2.390)		-10.108 (14.403)
div_{it}^{ind} *Savings banks	6.203 (4.502)	6.470 (4.063)	37.498 (30.601)
div_{it}^{geo} *Savings banks	-4.871* (2.832)	-4.677* (2.735)	-7.403 (23.233)
Return on assets	150.2*** (31.01)	149.6*** (31.29)	
Ln Size	-13.84** (6.282)	-14.57** (6.909)	
Ln Size ²	0.498 (0.337)	0.484 (0.381)	
Equity-ratio	50.24* (28.73)	46.35 (28.51)	
Observations	925	925	108
Number of banks	146	146	
Year dummies	YES	YES	
The modified Wald test	0.000	0.000	

The reported standard errors in parentheses are clustered by each individual bank.

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

Notes: The dependent variable is the Z-score of bank i at time t . The dependent variable when using the FEVD method is the predicted unobserved bank-specific effect ($\hat{\lambda}_i$) from the FE regression. div_{it}^{ind} is the industrial diversification calculated as the sum of squares of banks' relative exposure to each industry over total loans (measured by HHI). div_{it}^{geo} is the geographical diversification measure, calculated as the sum of squares of banks' relative exposure to each county over total loans (measured by HHI). ROA_{it} is return on assets of bank i at time t . Equity-ratio ($Eq-ratio_{it}$) is the equity over total assets of bank i at time t . Savings banks=1 if a bank is categorized as a savings bank, and includes both pure savings banks and EC-banks. Interactions between the diversification measures and bank ownership are included. We report the p-values of the modified Wald test. Year dummies are not reported in the output due to space limitations.

Similar to what we observed from the previous regressions, the estimated coefficients from RE and FE estimation are coinciding. We therefore perform the Hausman test and F-tests in order to investigate whether the estimated coefficients from column (1) and column (2) are significantly different. The Hausman test rejects the null hypothesis of no systematic difference in the coefficients. We do however not reject the null hypothesis of the F-tests. Thus, indicating that we can rely on the RE estimates.

The results from column (1) and (2) are consistent with our findings from previous regressions using the Z-score as a risk measure, indicating that industrial concentration increases banks' insolvency risk and geographical concentration decreases banks' risk. The magnitude of the estimated coefficient for the industrial diversification measure is greater when including interaction terms, and is significant at a 10% level. Thus, an increase in industrial diversification

will entail a decrease in banks' insolvency risk of 7.885 when using RE estimation. The effect of geographical diversification is stronger when including interaction terms in the regression model and turns significant at a 5% level and the magnitude of the coefficient increases. The estimated average effect of an increase in geographical concentration will be an increase in the Z-score of 6.143. Thus, suggesting that banks should diversify in terms of industries and specialize in terms of geographical areas.

We observe that the effect of geographical concentration is stronger for savings banks than commercial banks. Interestingly, compared to commercial banks, savings banks will have a stronger negative effect on the Z-score of being geographical concentrated. The average effect of an increase in geographical concentration will be a decrease in the Z-score of 4.871 for banks that are categorized as savings banks compared to commercial banks, when using RE estimation. The governance of Norwegian savings banks often has influence of local politicians, depositors and employees in their governance structure and strategies in favour of small and medium sized firms within their local areas. Banks with such influence may be prone to grant credit with favourable conditions to firms that might not have been granted credit otherwise with the argument of promoting the local development. This can be due to the proximity and close ties between the local community and the savings banks, indicating that savings banks to a larger extent than commercial banks may grant loans based on subjective criteria rather than profit maximization.

From descriptive statistics we observed that the diversification variables on average were relatively slowly changing. We therefore try to improve our estimates by applying the FEVD method. Additionally, this allows us to estimate the bank ownership dummy. In column (3), the estimated coefficient of the interaction between geographical diversification and bank ownership is insignificant when applying FEVD. Furthermore, the estimated signs of the coefficients for industrial and geographical diversification from the FE and FEVD estimation, are consistent with the findings from the previous regressions in table 8.1. Similar to previous findings we do not find a significant effect of bank ownership. The estimated coefficients from the FEVD estimation must be interpreted with caution due to the high standard errors indicating that the estimates are subject to a great amount of uncertainty.

8.2 Using the loan loss ratio as a proxy for risk

We test the robustness of our analysis by conducting similar regressions using the loan loss ratio as a risk measure instead of the Z-score.¹⁰ If the results are consistent, it suggests that our results are robust. The two risk measures are both based on balance sheet information, but the risk they reflect is somewhat different as the Z-scores reflects the overall risk related to the loss-absorbing capacity of banks' earnings and equity, whereas the loan loss ratio relates to the risk in banks' credit portfolios.

When we apply the loan loss ratio and execute similar regressions, we extend our bank-specific control variables to include credit rating ratios. We only include the shares of the loan portfolio in the different rating categories when regressing on the loan loss ratio, since this is a risk measure related to credit portfolio risk. Banks' loan losses are related to the solvency and debt-servicing capacity of the firms in banks' credit portfolios.

An important notion to make is that even though the sign of the coefficients is consistent when using the Z-score and the loan loss ratio, they are interpreted differently. A negative sign of a coefficient when using Z-score as a risk measure, thus a lower Z-score, is undesirable and increases risk, whereas a reduction in the loan loss rate (negative coefficient) is preferable as it reduces the risk of banks' loan portfolios.

¹⁰ We also attempted to conduct similar regressions using the standard deviation of the loan loss ratio. This in order to check for the effect of diversification and bank ownership on the unexpected credit risk of Norwegian banks. However, this resulted in insignificant coefficients and we therefore choose to not include these regression results. Thus, indicating that Norwegian banks have low unexpected credit portfolio risk.

8.2.1 The effect of credit portfolio diversification and bank ownership on risk: dummy approach

Table 8.3: Regression results using loan loss ratio as a risk measure.

Variables	RE			FE		FEVD
	(1)	(2)	(3)	(4)	(5)	(6)
Industrial diversification (div_{it}^{ind})	0.281 (0.277)	0.357 (0.325)	0.257 (0.277)	0.198 (0.271)	0.258 (0.322)	0.789*** (0.214)
Geographical diversification (div_{it}^{geo})	0.168 (0.125)	0.141 (0.108)	0.156 (0.112)	0.323* (0.172)	0.260* (0.137)	-0.00318 (0.150)
All savings banks			-0.181 (0.122)			0.126 (0.0957)
Return on assets	-22.97** (9.455)	-22.89** (9.581)	-22.78** (9.547)	-26.52*** (9.207)	-26.40*** (9.356)	
Ln Size	-0.146 (0.0923)	-0.146 (0.0932)	-0.128 (0.0924)	-0.791** (0.338)	-0.802** (0.343)	
Ln size ²	0.00536 (0.00462)	0.00549 (0.00468)	0.00350 (0.00465)	0.0447*** (0.0143)	0.0435*** (0.0141)	
Equity-ratio	-3.266*** (1.235)	-3.198*** (1.220)	-3.204*** (1.217)	-5.192*** (1.626)	-5.189*** (1.691)	
Credit rating AAA	-0.700** (0.281)	-0.643** (0.264)	-0.638** (0.264)	-0.892** (0.439)	-0.775** (0.388)	
Credit rating AA	-0.127 (0.181)			-0.253 (0.263)		
Credit rating A	-0.270 (0.168)	-0.233* (0.136)	-0.211 (0.130)	-0.373* (0.221)	-0.266* (0.144)	
Credit rating B	-0.259 (0.213)			-0.322 (0.242)		
Credit rating C	-0.0519 (0.424)			-0.220 (0.409)		
Observations	1,209	1,209	1,209	1,209	1,209	142
Number of banks	150	150	150	150	150	
Year dummies	YES	YES	YES	YES	YES	
The modified Wald test	0.000	0.000	0.000	0.000	0.000	

The reported standard errors in parentheses are clustered by each individual bank.

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

Notes: The dependent variable is the ratio of net loan loss to total loans of bank i at time t (NLL_{it}). The dependent variable when using the FEVD method is the predicted unobserved bank specific effect ($\hat{\lambda}_i$) from the FE regression. div_{it}^{ind} is the industrial diversification calculated as the sum of squares of banks' relative exposure to each industry over total loans. div_{it}^{geo} is the geographical diversification measure, calculated as the sum of squares of banks' relative exposure to each county over total loans. ROA_{it} is return on assets of bank i at time t . Equity-ratio ($Eq\text{-}ratio_{it}$) is the equity over total assets of bank i at time t . Savings banks=1 if a bank is categorized as a savings bank, and includes both pure savings banks and EC-banks. Credit rating AAA, AA, A, B and C is calculated as the share of each banks' credit portfolio in each credit rating category r over total exposure for each bank i at time t . We report the p-values of the modified Wald test. Year dummies are not reported in the output due to space limitations. We have scaled the loan loss ratio by multiplying the ratio by 100 to make the coefficients more presentable.

We observe that estimated coefficients from RE and FE estimations are relatively different when using the loan loss ratio as a proxy for risk. We perform a Hausman test and F-tests in order to investigate whether the estimated coefficients are significantly different. The Hausman test rejects the null hypothesis of no systematic difference between the estimated coefficients from the RE and FE estimations. Additionally, the F-tests supports the conclusion of the Hausman test. Thus, we prefer the FE model when using the loan loss ratio as a proxy for risk. The differing coefficients may be caused by the fact that time-invariant bank-specific factors, that are excluded from the fixed effect estimation and contained in the unobserved bank-specific effect, λ_i , are potentially affecting the diversification variables. One can argue that diversification strategy is a choice variable, meaning that the bank's level of diversification might be affected by a bank's risk preference which may be a bank-specific unobserved effect.

From column (5), we observe that the effect of geographical diversification is significant at a 10% level, whereas the effect of industrial diversification is insignificant. Even though the effect of industrial diversification is insignificant, we do observe that the sign of the coefficient is positive, which is in line with previous findings from using the Z-score as a risk measure. The effect of a more geographical concentrated loan portfolio is positive and indicates that the average effect of an increase in the county-specific focus of a bank will be an increase in the loan loss ratio of 0.260 percentage points. This finding contradicts the finding from using the Z-score as a risk measure, and this might be due to the fact that the risk measures are computed using different balance sheet variables. The Z-score utilizes the variation in return on assets and equity ratio, thus reflecting risk related to banks' capital structure and lending behavior, whereas the net loan loss ratio is computed using banks' impairment losses. Thus, the two risk measures reflect different types of risk.

Geographical concentrated credit portfolios may be riskier because of the potential of increased losses if the areas banks are greatly exposed to experience a county-specific economic downturn. To exemplify, it seems likely that banks highly exposed to the county Rogaland, experienced increased losses and expected losses during the oil crisis. In addition, banks with a strong concentration within counties may have stronger local ties to the counties in which they operate. This may lead to geographically concentrated banks being more prone to grant loans based on subjective criteria rather than profit maximization.

When applying the FEVD method in column (6), we observe changes in level of significance. Industrial diversification turns out significant at the 1% level, while geographical diversification turns out insignificant. An increase in banks' level of concentration in terms of industries will be an increase in the loan loss ratio of 0.789 percentage points. Thus, in line with previous regressions using the Z-score, we find that increased portfolio concentration in terms of industries increases banks' loan portfolio risk when applying FEVD.

Due to lack of explanatory value of certain credit rating categories in column (1) and column (4), we choose to only include the credit rating ratios in rating category AAA and A in following regressions. The inclusion of additional explanatory variables may also be a reason as to why the estimation results using the loan loss ratio as a risk measure differ from the results when applying the Z-score as a risk measure.

From column (5) we observe that the effect of holding a higher share of the loan portfolio in credit rating categories AAA and A is significant at a 5% and 10% level respectively, and both effects are negative. Thus, the average effects of holding a higher share of the loan portfolio in credit rating category AAA will lead to a decrease in the loan loss ratio of 0.775 percentage points. Whereas the effect of increasing the share of the loan portfolio in credit rating category A will be a decrease in the loan loss ratio by 0.266 percentage points. This is in line with what we expect to find, as increasing the share of banks' credit exposure in rating category AAA and A will entail a credit portfolio consisting of more financially reliable and creditworthy borrowers, that are less likely to default on their loans.

Further, we observe that bank ownership is insignificant using both RE and FEVD. This is consistent with the similar regression using the Z-score. In addition, we observe that the coefficients of return on assets are negative and highly significant, indicating that an increase in return on assets reduces the loan loss ratio, which is consistent with our findings using the Z-score as a risk measure.

8.2.2 The effect of credit portfolio diversification and bank ownership on risk: using interaction terms

Table 8.4: Regression results using loan loss ratio as a risk measure.

Variables	(1) FE	(2) FEVD
Industrial diversification (div_{it}^{ind})	0.0108 (0.767)	1.519*** (0.324)
Geographical diversification (div_{it}^{geo})	1.014 (0.627)	-0.415 (0.307)
All savings banks		1.030*** (0.221)
div_{it}^{ind} *Savings banks	0.0524 (0.760)	-1.828*** (0.478)
div_{it}^{geo} *Savings banks	-0.926 (0.621)	0.389 (0.354)
Return on assets	-26.20*** (9.059)	
Ln size	-0.718** (0.323)	
Ln size ²	0.0412*** (0.0139)	
Equity-ratio	-5.336*** (1.537)	
Credit rating AAA	-0.709** (0.324)	
Credit rating A	-0.247* (0.137)	
Observations	1,209	142
Number of banks	150	
Year dummies	YES	
The modified Wald test	0.000	

The reported standard errors in parentheses are clustered by each individual bank.

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

Notes: The dependent variable is the ratio of net loan loss to total loans of bank i at time t (NLL_{it}). The dependent variable when using the FEVD method is the predicted unobserved bank specific effect (λ_i) from the FE regression. div_{it}^{ind} is the industrial diversification calculated as the sum of squares of banks' relative exposure to each industry over total loans. div_{it}^{geo} is the geographical diversification measure, calculated as the sum of squares of banks' relative exposure to each county over total loans. ROA_{it} is return on assets of bank i at time t . Equity-ratio ($Eq-ratio_{it}$) is the equity over total assets of bank i at time t . Savings banks=1 if a bank is categorized as a savings bank, and includes both pure savings banks and EC-banks. Interactions between the diversification measures and bank ownership are included. Credit rating AAA and A is calculated as the share of each banks' credit portfolio in each credit rating category r over total exposure for each bank i at time t . We report the p-values of the modified Wald test. Year dummies are not reported in the output due to space limitations. We have scaled the loan loss ratio by multiplying the ratio by 100 to make the coefficients more presentable.

In column (1), using the fixed effects estimation approach, both diversification variables are insignificant. Additionally, the interaction terms between the Herfindahl indices and the bank ownership dummy turn out insignificant in explaining the loan loss ratio, when using the FE estimation approach. The bank-specific control variables are all significant at a 5% and 10% level. Both increasing the share of the loan portfolio in credit rating category AAA and A is still significant and have negative coefficients in line with our findings from previous regressions using the loan loss ratio as a proxy for banks' credit portfolio risk.

From column (2), when using the FEVD approach, the industrial diversification variable is significant at a 1% level. This may be due to the diversification variables being slowly-changing as observed in descriptive statistics. Explanatory variables with low within variation can result in these variables being insignificant, thus having low explanatory power and imprecise coefficient estimates, as we have previously discussed. The average effect of having a concentrated loan portfolio in terms of industries will be an increase in the loan loss ratio of 1.519 percentage points. Thus, the effect of a more industrial concentrated loan portfolio is an increase in banks' credit portfolio risk. This is consistent with the results from the similar regression when using the Z-score as a risk measure.

We observe that savings banks may be riskier than commercial banks, when using FEVD estimation. Hence, the coefficient of the savings bank dummy is significant at a 1% level and has a positive sign. Furthermore, we observe that the coefficient of the interaction between ownership and industrial diversification turns out significant at a 1% level. An increase in industrial concentration will entail a decrease in the loan loss ratio of 1.83 percentage points for savings banks compared to commercial banks. Thus, indicating that having a more industrial concentrated loan portfolio is reducing banks' risk for savings banks compared commercial banks. This result suggests that savings banks to a greater extent than commercial banks are able to obtain industry-specific knowledge through selection and monitoring abilities that reduces banks' credit risk. The sign of the coefficient of the interaction between ownership and industrial diversification changes when we apply FEVD instead of FE.

As previously noted, the estimation results obtained from the FEVD method must be interpreted with great caution. Even though there are gains using FEVD in our line of study with the use of time-invariant and slowly changing regressors, the method is not unproblematic. Firstly, there should have been correction for the degrees of freedom. Secondly, the estimates of

coefficients are only unbiased if the time-invariant explanatory variables are exogeneous, i.e. uncorrelated with the unobserved individual specific effects. We must therefore more heavily rely on results from applying the fixed effects estimation technique.

8.3 Summary

To sum up, our overall findings suggest that increased focus in terms of industries increases banks' risk. This finding is consistent when both the Z-score and the loan loss ratio are applied to capture the effect of industrial portfolio concentration on risk. The effect seems to be present in all model specifications when using the Z-score. When applying the loan loss ratio, the coefficient of industrial concentration is only significant when using the FEVD method. Thus, the relationship is less pronounced than in the case of the insolvency risk. Nonetheless, this gives an indication that such a relationship might exist.

The effect of a more geographical concentrated credit portfolio seems to be associated with a decrease in banks' insolvency risk. The positive effect is consistent for all model specifications when the Z-score is applied, however the magnitude of the effect differs when different model specifications and estimation techniques are applied. Additionally, the variable is significant for all model specifications and estimation techniques, except when the FEVD method is applied. When the loan loss ratio is applied, we only find the effect of geographical diversification to be significant using FE estimation in model specifications in 8.2.1. The coefficient of geographical diversification do however point in an opposite direction compared to when the Z-score is applied. Thus, the effect of increased geographical concentration on banks' credit portfolio risk is ambiguous.

There does not seem to be a strong effect of bank ownership on risk whether we apply the Z-score or the loan loss rate. We do however find evidence implying that savings banks might be exposed to greater risk compared to commercial banks, when the FEVD method is applied for the loan loss ratio and the model specification is both including bank ownership dummy and interaction terms. The evidence is however not strong, and we cannot fully argue that such an effect does in fact exist.

When investigating whether the effect of credit portfolio diversification differs between savings banks and commercial banks, we find results suggesting that increased industrial concentration

reduces the risk of savings banks compared to commercial banks. This effect is only present for banks' credit portfolio risk when applying the FEVD estimation technique. The effect of geographical diversification on risk for savings banks is ambiguous, and the effect is only significant when using RE and FE estimation applied on banks' insolvency risk. Hence, we cannot fully argue that such relationships do in fact exist, since we do not find consistent results when applying different estimation techniques and dependent variables.

As previously noted, our dependent variables applied to capture risk may reflect somewhat different types of bank risk. Thus, there may be a discrepancy in factors effecting banks' risk depending on the risk measure that is applied. This may be one potential reason why the effect of geographical diversification differs depending on which risk measure is applied, and why we find that savings banks have a differing effect on credit portfolio diversification on the two types of bank risk for different estimation techniques.

8.4 Sources of divergence

There are several factors that are likely to affect banks' level of diversification and ownership and the effect on banks' risk, and thus cause divergence from related literature and our initial beliefs. In addition, our findings must be seen in light of the sample period and the market characteristics of the particular years 2005-2013 when comparing our results to studies conducted in other countries. It is evident that the business cycle and the structure of the banking market might evolve through the years as new technology, industry specific downturns and new regulatory requirements arises. In the following we will address factors which may be potential sources of divergence.

We observed in descriptive statistics that the Norwegian banking market is relatively concentrated in terms of industries. Additionally, we find evidence suggesting that increased industrial concentration, increases banks' risk of insolvency, which is in contrast to the common view from the empirical literature that diversified banks are exposed to greater risk. In order to explain why the Norwegian banking market is relatively concentrated in terms of industries, we turn to the risk-weights associated with loans made to the specific industries. Risk-weights are employed when calculating capital adequacy. Over the past decades, there has been an increased focus on reinforcing the stability of the banking sector. As a consequence, Norwegian banks have continuously been faced with stricter capital requirements. In order to uphold the required capital ratios banks may increase profits, issue equity, reduce lending or shift their lending behavior. All of which may affect banks' risk-taking behavior and may influence banks when assessing their optimal portfolio diversification strategy.

The high concentration in terms of industries might be an indication that adjustment of the portfolio composition in terms of industries is the preferred strategy when adapting to stricter capital requirements. This may result in banks' shifting their focus away from lending to industries with high risk-weights, since higher risk-weighted assets reduces the banks' capital ratio. Hence, Norwegian banks might choose to expand their lending to industries with low risk-weights, while reducing their lending to industries that have high risk-weights in order to satisfy capital requirements. Consequently, making the Norwegian banking market concentrated in terms of industries. As previously mentioned, this effect might lead to an underestimation of risk since banks do not consider the arise of systematic risk when they collectively increase their lending to the same industries. In conclusion, distinctive Norwegian

capital requirements and risk-weights might serve as a reason as to why the Norwegian banking market is concentrated in terms of industries. Further, it indicates that industrial concentration might not be a result of diversification strategy, but rather a reaction and adjustment to stricter capital requirements.

It is worth noting that loans to households and banks' exposure to the housing market is much greater in Norway compared to Germany, Italy and Spain. This may be due to the introduction of Basel II that lead to a reduction in the risk weights of residential mortgage loans (Andersen, Johansen & Kolvig, 2012). The fundamental difference in residential housing market exposure may thus affect the general risk profile of the banks on average, which may affect their risk-taking behavior in the corporate sector.

Another potential reason as to why we do not necessarily find as strong evidences of the effect of diversification on banks' credit portfolio risk as comparable studies, may be that there are differing levels of risk associated with the industries in Norway. In addition, there are often sector-specific related downturns, such as downturns in shipping related industries in later years, as well as the recent oil crisis that greatly affected the oil related sector and increased banks' losses. The effect of diversification may not fully reflect the risk related to the effect of having exposures in more risky industries, since it assesses the implications of having a diversified portfolio. Hence, it would have been interesting to isolate the effect of having exposures in industries with historically high loan losses either by investigating the effect of increasing the relative credit exposures in risky industries or by risk-weighting the concentration measure by taking account of the systematic risk of the different industries, similar to Chen et al. (2013). We did not have access to retrieve the beta of the different industries, and we were thus not able to weight the concentration measures with their respective industry-specific risk.

Further, loan losses related to banks' credit portfolio risk both contain losses from loans made to private households and the corporate sector. Certain banks in our sample, typically savings banks and banks specialized in consumer lending, are likely to have a greater exposure to private households, which may partially explain why we do not find a strong relationship between industrial diversification and banks' credit portfolio risk.

Considering that there are 21 counties in our sample and the fact that several geographical areas may be relatively homogenous, we may not see a considerable effect of increased geographical diversification on banks' credit portfolio risk. There may however be varying degrees of regional specific cyclical downturns in certain regions over the different counties, which may result in the effect of geographical diversification being uncertain. In addition, the emergence of technological innovations and internet banking during our sample period may have diminished the monitoring effect on risk that we might expect to find when a bank is geographically concentrated within specific areas. Further, the existence of credit rating systems and registries of borrower's previous payment history and financial accounts, contributes to reduce the asymmetric information and thus, weakens the arguments of Ghatak (2000) and Liikanen et al. (2012). It can also be assumed that member banks of strategic alliances share information concerning borrowers, which reduces the variability in screening competence and monitoring abilities as an individual bank-specific effect. Thus, this may potentially explain why our results are inconclusive for the effect of geographical diversification and bank ownership on banks' credit portfolio risk.

There are factors in the Norwegian banking market that may serve as substitutes for the role of ownership as a disciplinary mechanism. The Norwegian banking market is characterized as being relatively concentrated compared to the EU average. As suggested by Bøhren and Josefsen (2013), competition may serve as a substitute for the role of ownership as a disciplinary mechanism. This might serve as a reason why we do not find strong evidence suggesting that bank ownership affects the risk of Norwegian banks as opposed to the case for the Spanish banking market. Additionally, in order to control for the effect of bank ownership, it might have been preferable to construct a variable measuring the EC-owners share of banks' joint equity capital. This would perhaps have provided a more nuanced reflection of banks' governance structure compared to only controlling for main bank type, when investigating whether there are differences in the bank's risk exposures. However, we were not able to retrieve this information for all years in our sample period and it was especially difficult for non-listed banks.

When comparing our result to similar studies conducted in other European counties (Italy, Germany, Spain), we must consider the differing structures of the banking market and especially with regards to the governance structure of the banks. The German and Spanish banking market can for instance be characterized by having pronounced differences in regards

to the governance and regulation of different bank types. Contrarily, Norwegian banks are to a greater extent similar as they are subject to the same regulations and to a larger extent operate on a national level.

The Italian banking sector comprises of joint-stock companies, cooperative banks and small mutual banks, and is dominated by small and middle-sized banks that operate as local banks (Bilotta, 2017). The financial crisis revealed shortcomings in cases of governance in the Italian banking sector. Italian banks are often owned by foundations, which are typically subject to political influence affecting banks' activities and have strong influence of decision-making bodies (Jassaud, 2014). Additionally, the Italian banking system is characterized by private ownership and for-profit banks in a state-controlled environment.

There are similar structures in the Italian and German banking sector, which is in line with studies finding similar relationships between diversification and risk conducted in these countries. The German banking sector is characterized by having large state-influence (Hüfner, 2010). German savings banks are owned by local government bodies, such as municipalities, and are by law obligated to contribute to society at large (Koetter, 2013). Norwegian savings banks, on the other hand, are expected to, but not legally obligated to retain profits in order to contribute to local development. Hence, Norwegian savings banks have the option of having profit maximization as their primary goal, making the difference between savings banks and commercial banks in Norway less distinctive, compared to Germany. Country-specific factors during the sample period may thus serve as one potential reason why our findings concerning diversification are contrasting compared to similar studies conducted in Italy and Germany.

During our sample period, Spanish savings banks (*cajas*), was similar to Italy and Germany, highly exposed to political influence in their governing bodies (Jassaud, 2014). Especially regional savings banks (*cajas de ahorro*) were often influenced by political interests. Similar to Norwegian savings banks, Spanish savings banks have historically focused on promoting community welfare and economic development in the regions in which they operate (Vives, 2016). At the time when related empirical studies were conducted, Spanish savings banks were not able to extract external financing. Compared to the Norwegian banking market and the existence of savings banks that have issued equity certificates, it can be assumed that there is a more distinct difference between savings banks and commercial banks in the Spanish banking market. The global financial crisis led to substantial structural changes in the Spanish banking

market (Ordóñez, 2011). One development was the conversion of Spanish *cajas* and the forming of foundations, similar to the savings banks in Norway and the savings banks foundations. Thus, if similar studies were to be conducted after the restructuring of the Spanish banking market, there might have been found more similar results in line with our findings from the Norwegian banking market.

Another source of divergence can be attributed to DNB. DNB is the largest bank in our sample with regards to market share, total assets and gross lending. By classifying DNB as a commercial bank, it is likely that DNB to a large extent is driving the results for our sample of commercial banks. Further, we do observe that the shares of lending to different industries for DNB and the commercial bank sample have similar distributions. Thus, confirming our suspicion that DNB to some extent is driving the results for the commercial bank sample.

Finally, we would like to make a notion about the computation of the Z-score. Even though the Z-score is a widely used risk measure in empirical studies related to banking, we would like to enlighten some important drawbacks. The problems are associated with the components used to compute the Z-score, and the possibility that one of the components is driving the variation in the Z-score over our sample period. We did for instance observe a close relationship between return on assets and the Z-score in figure 6.1. It would have been preferable to apply a Z-score computation that utilizes more of the individual bank-specific variation in return on assets. Preferably we should have applied a computation with instantaneous standard deviations of ROA. We attempted to compute a version of the Z-score that applied a 3-year moving average computation of the standard deviation, with a window width of 3 years ($t-1$ and $t-2$) that was calculated for each period. However, this Z-score computation produced some spurious volatility in the construction of the Z-score due to the Z-score being sensitive to outliers in the standard deviation of ROA.

9. Concluding remarks

In this master thesis, we aimed at providing empirical evidence on the effect of industrial and geographical diversification on banks' risk exposure, as well as the effect of bank ownership on risk. We measured the impact on two different variables exhibiting risk in two different ways; risk of insolvency by using the Z-score and banks' credit portfolio risk using the loan loss ratio. Further, we used comprehensive datasets provided by SNF, The Norwegian Tax Administration and Finance Norway that comprised of individual bank loans, information concerning the firms in banks' credit portfolios and banks' balance sheet information. The datasets retrieved from multiple sources enabled us to analyze the relationship between credit portfolio diversification and banks' risk exposure, as well as the effect of bank ownership on banks' risk for 142 banks in Norway over the sample period 2005-2013.

To answer our research question, we performed empirical analyses using different methodical approaches and model specifications to assert the effect of diversification and bank ownership on risk, and to compare the effect of diversification on risk for savings banks and commercial banks. We find evidence suggesting that banks' choice of diversification strategy has a significant impact on banks' risk exposure. The most salient effect is the increase in industrial diversification's effect on default risk. We do not find empirical evidence in support for the corporate finance theory in the Norwegian banking market. We do however find evidence suggesting that a more specialized bank in terms of industries will entail an increase in banks' risk of insolvency. We thus find that increased industrial portfolio diversification reduces banks' risk. Further, we observe that most of the banks in our sample have a relatively concentrated loan portfolios in terms of geography. We find evidence suggesting that geographical diversification increases banks' risk of insolvency. However, we do not find coinciding results for the effect on banks' credit portfolio risk.

Our results from different model specifications supports the view of the traditional portfolio and banking perspective from the theoretical literature, indicating that banks should consider their optimal level of industrial diversification when assessing their level of insolvency risk and banks' loss-absorbing capacity. Hence, our findings are consistent with the views held by Diamond (1984) and Ramakrishnan and Thakor (1984) on the effect of diversification on risk. However, our finding contradicts the common view in the empirical literature that diversified banks are exposed to greater credit portfolio risk than less diversified banks (Acharya et al.,

2006; Berger et al., 2010; Jahn et al., 2013). The contradicting results found in other countries may be explained by differing fundamental factors in countries' market structure, general risk-profile of the banks and economic conditions.

Contrary to findings presented by García-Marco and Robles-Fernández (2008), we do not find evidence suggesting there is a significant difference in the risk exposure between savings banks and commercial banks. We observe that savings banks on average have a lower loan loss ratio compared to commercial banks. This may be due to composition effects from loans attributed to the private household and corporate sector. Thus, we cannot draw conclusions on the effect of ownership on banks' risk exposure.

Financial crises tend to spread to other industries in the economy via the banking system. It can therefore be crucial to secure stability in the banking system. As a consequence, banks are being closely monitored and regulated in order to avoid build ups of risk. Lessons from previous crises have emphasized the importance of investigating banks' credit portfolio compositions. As previously mentioned, there might be a concentration risk in the Norwegian banking market (Norges Bank, 2018b). The effect of banks' diversification strategies are thus important for both bank managers and policymakers when assessing the underlying risk in the Norwegian banking market, and its contribution to financial stability. Moreover, bank lending to the commercial real estate sector accounts for 37.9% of the aggregated loan portfolio in the corporate sector of Norwegian banks. In the case of increased interest rates, and thus lowered earnings, the losses from commercial real estate might become substantial for banks that are greatly exposed to this industry. It will therefore be interesting to follow the development of bank regulation, and especially whether the concentration risk of Norwegian banks will be taken into account when policymakers are to develop new regulatory frameworks.

Increased insight into this topic will better position policymakers to make more informed decisions when they are to assess the capital adequacy and the resilience of the Norwegian banking market. Further, it would be interesting to study similar effects on banks' risk when isolating the effect of increasing the relative credit exposures to industries with historically high loan losses. Knowledge about the effect of credit portfolio diversification on banks' risk may thus contribute to financial stability and sound economic development.

Appendix

Table A.1 and A.2 present the main sample of banks categorized in their respective bank type and banks' average total assets (size) during the full sample period. The first table, table A.1, contains only pure savings banks, whereas table A.2 presents banks that are characterized as savings banks that have issued equity certificates (EC-banks) and commercial banks.

The number of banks within each bank type varies over the sample period since banks exits the sample due to mergers, bankruptcies and in certain cases banks restructures and thus change their ownership structure. Banks that have restructured during the sample period are in the table below listed under their latest bank type category. The same applies for banks changing their name during the sample period.

Table A.1: Banks categorized as pure savings banks and their average size during the sample period. Note that the letter E denotes banks that are members of the Eika Alliance, whereas S denotes banks within the Sparebank 1 Alliance (Sparebankforeningen, 2018b).

<i>Pure savings banks</i>		Average total assets (in mill)		Average total assets (in mill)	
1.	Sparebanken Hedmark	40 133	49.	Meldal Sparebank	(S) 2 024
2.	Sparebanken Sør	33 656	50.	Strømmen Sparebank	(E) 2 017
3.	Fana Sparebank	12 165	51.	Berg Sparebank	(E) 1 979
4.	Sparebank 1 Telemark	(S) 11 546	52.	Blaker Sparebank	(E) 1 962
5.	Sparebank 1 Nordvest	(S) 8 741	53.	Hjartdal og Gransherad Sparebank	(E) 1 925
6.	Haugesund Sparebank	6 292	54.	Trøgstad Sparebank	(E) 1 918
7.	Sparebank 1 Søre Sunnmøre	(S) 6 057	55.	Stadsbygd Sparebank	(E) 1 885
8.	Spareskillingsbanken	5 912	56.	Bø Sparebank	1 857
9.	Sparebank 1 Hallingdal Valdres	(S) 5 606	57.	Hønefoss Sparebank	(E) 1 827
10.	Lillestrøm Sparebank	(E) 5 331	58.	Andebu Sparebank	(E) 1 806
11.	Jernbanepersonalets Sparebank	(E) 5 296	59.	Sunddal Sparebank	(E) 1 790
12.	Skue Sparebank	(E) 5 042	60.	Ørskog Sparebank	(E) 1 766
13.	Modum Sparebank	(S) 4 925	61.	Klæbu Sparebank	(E) 1 735
14.	Sparebanken Grenland	4 899	62.	Spydeberg Sparebank	(E) 1 731
15.	Time Sparebank	4 866	63.	Seljord Sparebank	1 625
16.	Sparebanken Narvik	(E) 4 587	64.	Drangedal og Tørdal Sparebank	(E) 1 546
17.	Skudenes & Aakra Sparebank	4 476	65.	Aasen Sparebank	(E) 1 539
18.	Flekkefjord Sparebank	3 793	66.	Grue Sparebank	(E) 1 506

19.	Halden Sparebank		3 790	67.	Bjugn Sparebank	(E)	1 441
20.	Sparebank 1 Gudbrandsdal	(S)	3 711	68.	Ankenes Sparebank		1 441
21.	Sparebank 1 Jevnaker Lunner	(S)	3 558	69.	Sparebanken Hemne	(E)	1 424
22.	Rørosbanken Røros Sparebank	(E)	3 395	70.	Etne Sparebank		1 418
23.	Larviksbanken Brunlanes Sparebank	(E)	3 377	71.	Hegra Sparebank	(E)	1 362
24.	Lom og Skjåk Sparebank	(S)	3 304	72.	Åfjord Sparebank	(E)	1 360
25.	Sparebanken Hardanger		3 258	73.	Ofoten Sparebank	(E)	1 255
26.	Kvinnherad Sparebank		3 146	74.	Evje og Hornnes Sparebank	(E)	1 244
27.	Askim Sparebank	(E)	3 133	75.	Valle Sparebank	(E)	1 133
28.	Odal Sparebank	(E)	3 067	76.	Gjerstad Sparebank		1 124
29.	Bamble Sparebank	(E)	3 013	77.	Rindal Sparebank	(E)	1 113
30.	Søgne og Greipstad Sparebank		2 900	78.	Soknedal Sparebank	(E)	1 073
31.	Eidsberg Sparebank	(E)	2 835	79.	Birkenes Sparebank	(E)	1 071
32.	Orkdal Sparebank		2 810	80.	Sauda Sparebank		1 062
33.	Kragerø Sparebank	(E)	2 797	81.	Fjaler Sparebank		1 041
34.	Marker Sparebank	(E)	2 793	82.	Haltdalen Sparebank	(E)	953
35.	Surnadal Sparebank	(E)	2 710	83.	Tingvoll Sparebank		903
36.	Voss Sparebank		2 641	84.	Vik Sparebank	(E)	883
37.	Selbu Sparebank	(E)	2 499	85.	Tysnes Sparebank	(E)	850
38.	Sparebank 1 Gran	(S)	2 325	86.	Vegårshei Sparebank		783
39.	Harstad Sparebank	(E)	2 305	87.	Øystre Slidre Sparebank		724
40.	Tinn Sparebank	(E)	2 257	88.	Aurland Sparebank	(E)	711
41.	Luster Sparebank		2 161	89.	Vestre Slidre Sparebank		598
42.	Lillesands Sparebank		2 160	90.	Lofoten Sparebank	(E)	540
43.	Bien Sparebank	(E)	2 147	91.	Etnedal Sparebank	(E)	492
44.	Ørland Sparebank	(E)	2 129	92.	Gildeskål Sparebank	(E)	476
45.	Bud, Færna og Hustad Sparebank		2 106	93.	Vang Sparebank		457
46.	Opdals Sparebank	(E)	2 092	94.	Tjeldsund Sparebank	(E)	159
47.	Tolga-Os Sparebank	(E)	2 062	95.	Verran Sparebank		138
48.	Arendal og Omegns Sparekasse	(E)	2 043				

Table A.2: Banks categorized as commercial banks and savings banks with equity certificates and their average size during the sample period. Note that the letter E denotes banks that are members of the Eika Alliance, whereas S denotes banks within the Sparebank 1 Alliance (Sparebankforeningen, 2018b).

<i>Savings banks w/EC</i>			Average total assets (in mill)	<i>Commercial banks</i>	Average total assets (in mill)	
1.	Sparebank 1 SR-Bank	(S)	117 879	1.	DNB	1 398 381
2.	Sparebank 1 SMN	(S)	87 509	2.	Nordea bank Norge	460 947
3.	Sparebanken Vest		85 062	3.	Fokus Bank/Danske Bank	199 911
4.	Sparebank 1 Nord-Norge	(S)	64 151	4.	SEB	104 542
5.	Sparebanken Møre	(E)	38 583	5.	Santander Consumer Bank	40 684
6.	Sparebanken Pluss		30 930	6.	Swedbank	37 308
7.	Sparebanken Sogn og Fjordane		26 731	7.	BNBank	35 303
8.	Sandnes Sparebank	(E)	26 276	8.	Storebrand Bank	34 625
9.	Sparebanken Øst		22 730	9.	Nordlandsbanken	31 014
10.	Sparebank 1 BV	(S)	17 660	10.	Bank 1 Oslo	24 408
11.	Helgeland Sparebank		17 549	11.	Skandiabanken	23 120
12.	Sparebank 1 Østfold Akershus	(S)	13 380	12.	BNP Paribas	21 491
13.	Totens Sparebank	(E)	11 035	13.	Obosbanken	13 405
14.	Sparebank 1 Ringerike Hadeland	(S)	10 898	14.	Gjensidige Bank	12 444
15.	Sparebank 1 Kongsberg	(S)	8 557	15.	Landkreditt Bank	11 659
16.	Aurskog Sparebank	(E)	6 059	16.	SEB Privatbanken	9 970
17.	Klepp Sparebank		5 399	17.	KLP Banken	7 773
18.	Sparebank 1 Nøtterøy-Tønsberg	(S)	5 320	18.	Pareto Bank	6 253
19.	Nes Prestegjelds Sparebank	(E)	5 042	19.	Glitnir/Kredittbanken	5 723
20.	Melhus Sparebank	(E)	4 269	20.	Bank Norwegian	3 777
21.	Høland og Setskog Sparebank	(E)	3 468	21.	Terra Kortbank	3 144
22.	Indre Sogn Sparebank	(E)	2 986	22.	Voss Veksel og Landmandsbank	(E) 2 688
23.	Kvinesdal Sparebank	(E)	2 300	23.	Bank 2	(E) 1 965
24.	Hol Sparebank	(E)	2 174	24.	yA Bank	1 572
25.	Hjelmeland Sparebank	(E)	2 113	25.	Verdibanken	1 319
26.	Grong Sparebank	(E)	1 928			
27.	Fornebu Sparebank	(E)	1 664			
28.	Neset Sparebank	(E)	1 056			
29.	Setskog Sparebank		410			
30.	Cultura Sparebank		387			

References

- Acharya, V., Hasan, I., & Saunders, A. (2006, May). Should Banks Be Diversified? Evidence from Individual Bank Loan Portfolios. *The Journal of Business*, 79 (3), pp. 1355-1412.
- Allen, F., Carletti, E., & Marquez, R. (2009, September 16). *Stakeholder Capitalism, Corporate Governance and Firm Value*. Retrieved from Finance.wharton.upenn.edu: <http://finance.wharton.upenn.edu/~allenf/download/Vita/JF-MS6731-Revision-corporate-governance-with-figures-16sep09-final.pdf>
- Aamo, B. S. (2016). *Læring fra kriser*. Oslo: Fagbokforlaget.
- Andersen, H., Johansen, R., & Kolvig, K. (2012). *Effects of changing banks' risk weights*. Norges Bank Staff Memo, No.15 .
- Bøhren, Ø., & Josefsen, M. G. (2013, July 17). Stakeholder rights and economic performance: The profitability of nonprofits. *Journal of Banking & Finance*, pp. 4073-4086.
- Behr, A., Kamp, A., Memmel, C., & Pfingsten, A. (2007). *Diversification and the banks' risk-return characteristics - evidence from loan portfolios of German banks*. Deutsche Bundesbank, Series 2, No. 05/2007.
- Beltratti, A., & Stulz, R. M. (2012, July). The credit crisis around the globe: Why did some banks perform better? *Journal of Financial Economics*, Vol. 105 (1) , pp. 1-17.
- Berger, A. N., & Bouwman, C. H. (2013, July). How does capital affect bank performance during financial crisis? *Journal of Financial Economics*(Volume 109, issue 1), pp. 146-176.
- Berger, A. N., Hasan, I., & Zhou, M. (2010, July). The effects of focus versus diversification on bank performance: Evidence from Chinese Banks. *Journal of Banking & Finance*, 34 (7), pp. 1417-1435.
- Berger, A. N., Molyneux, P., & Wilson, J. O. (2015). *The Oxford Handbook of Banking*. Oxford: Oxford University Press.
- Bilotta, N. (2017). *The Italian Banking System*. Retrieved from Seven Pillars Institute: <https://sevenpillarsinstitute.org/wp-content/uploads/2017/11/Italian-banking-system-final-EDITED.pdf>
- Black, F., & Scholes, M. (1973, May-June). The Pricing of Options and Corporate Liabilities. *Journal of Political Economy*(Volume 81, Number 3).

-
- Cameron, C., & Miller, D. E. (2015, February). *A Practitioner's Guide to Cluster-Robust Inference*. Retrieved from Economics UC Davis:
http://cameron.econ.ucdavis.edu/research/Cameron_Miller_JHR_2015_February.pdf
- Chen, Y., Wei, X., & Zhang, L. (2013). A New Measurement of Sectoral Concentration of Credit Portfolios. *Procedia Computer Science* 17, pp. 1231-1240.
- De Nicolò, G., Jalal, A. M., & Boyd, J. H. (2006, December 1). *Bank Risk-Taking and Competition Revisited: New Theory and New Evidence*. Retrieved from International Monetary Fund: <https://www.imf.org/en/Publications/WP/Issues/2016/12/31/Bank-Risk-Taking-and-Competition-Revisited-New-Theory-and-New-Evidence-20126>
- Denis, D. J., Denis, D. K., & Sarin, A. (1997, March). Agency Problems, Equity Ownership, and Corporate Diversification. *The Journal of Finance*, Vol. 52 (1), pp. 135-160.
- Diamond, D. W. (1984, July). Financial Intermediation and Delegated Monitoring. *The Review of Economic Studies*, Vol. 51(3), pp. 393-414.
- García-Cestona, M., & Surroca, J. (2008, June). Multiple goals and ownership structure: Effects on the performance of Spanish savings banks. *European Journal of Operational Research*, Vol. 187 (2), pp. 582-599.
- García-Marco, T., & Robles-Fernández, M. D. (2008, August). Risk-taking behaviour and ownership in the banking industry: The Spanish evidence. *Journal of Economics and Business*, Vol. 60 (4), pp. 332-354.
- Ghatak, M. (2000). Screening by the company you keep: joint liability lending and the peer selection effect. *Economic Journal*, Vol. 110 (465), pp. 601-631.
- Hüfner, F. (2010). *The German Banking System: Lessons from the Financial Crisis*. OECD, Economics Department Working Papers, No. 788,. OECD Publishing, Paris.
- Hjelseth, I. N., & Raknerud, A. (2016). *A model of credit risk in the corporate sector based on bankruptcy prediction*. Norges Bank Staff Memo, 20/2016.
- Hjelseth, I. N., Turtveit, L.-T., & Winje, H. (2016). *Banks' credit risk associated with the oil service industry*. Norges Bank, Economic Commentaries, No.5 .
- Jahn, N., Memmel, C., & Pfingsten, A. (2013). *Banks' concentration versus diversification in the loan portfolio: new evidence from Germany*. Deutsche BundesBank Discussion Paper, No. 53.
- Jassaud, N. (2014, September). *Reforming the Corporate Governance of Italian Banks*. Retrieved from International Monetary Fund:
<https://www.imf.org/external/pubs/ft/wp/2014/wp14181.pdf>

- Koetter, M. (2013). *Market structure and competition in German banking: Modules I and IV*. German Council of Economic Experts and the Monopolies Commission.
- Kreutzer, I. (2015, Februar 25). *Finansnæringen og den digitale revolusjon*. Retrieved from Finans Norge: https://www.finansnorge.no/aktuelt/presentasjoner/fintech-finansnaringen-og-den-digitale-revolusjon/?fbclid=IwAR3OT4wsioJHvLLtuIjsBm_ro0bctVKcbcMd6nlk2ngb4bqwsViQrntKwcQ
- Lang, L. H., & Stulz, R. M. (1994, December). Tobin's q, Corporate Diversification, and Firm Performance. *Journal of Political Economy*, Vol. 102(6), pp. 1248-1280.
- Lepetit, L., & Strobel, F. (2013, July). Bank insolvency risk and time-varying Z-score measures. *Journal of International Financial Markets, Institutions and Money*(Volume 25), pp. 73-87.
- Liikanen, E., Baenziger, H., Campa, J., Gallois, L., Goyens, M., Krahnen, J., . . . Wij_els, H. (2012). *High-level Expert Group on reforming the structure of the EU banking sector - Final Report*. European Commission.
- Moe, T. G., Solheim, J. A., & Vale, B. (2004, May). *The Norwegian Banking Crisis*. Retrieved from Norges Bank: https://static.norges-bank.no/contentassets/ed5dd397dce345338046a22c7e07f959/hele_heftet.pdf?v=03/09/2017122240&ft=.pdf
- Nicolò , G. D., & Loukoianova, E. (2007). *Bank Ownership, Market Structure and Risk*. International Monetary Fund, Working Paper 07/215.
- Norges Bank. (2018a). *Det Norske Finansielle Systemet*. Oslo: Norges Bank.
- Norges Bank. (2018b). *Financial Stability Report*. Oslo: Norges Bank.
- Norges Bank. (2018c). *Monetary Policy Report 3/2018*. Oslo: Norges Bank.
- Ordóñez, M. F. (2011, February 21). *The restructuring of the Spanish banking sector and the Royal Degree-Law for the reinforcement of the financial system*. Retrieved from Afi: <http://www.afi.es/EO/mfo210211e.pdf>
- Plümper, T., & Troeger, V. E. (2007). *Efficient Estimation of Time-Invariant and Rarely Changing Variables in Sample Panel Analyses with Unit Fixed Effects*. Retrieved from Cambridge University Press: <https://www.cambridge.org/core/journals/political-analysis/article/efficient-estimation-of-timeinvariant-and-rarely-changing-variables-in-finite-sample-panel-analyses-with-unit-fixed-effects/FAB7B48ABDA1928E95F588846F8C9731>

-
- Ramakrishnan, R. T., & Thakor, A. V. (1984, July). The Review of Economic Studies Information Reliability and a Theory of Financial Intermediation. *The Review of Economic Studies*, Vol. 51(3), pp. 415-432.
- Salas, V., & Saurina, J. (2002). Credit Risk in Two Institutional Regimes: Spanish Commercial and Savings banks. *Journal of Financial Services Research*, Vol. 22 (3), pp. 203-224.
- Saunders, A., Strock, E., & Travlos, N. G. (1990, June). Ownership Structure, Deregulation, and Bank Risk Taking. *The Journal of Finance*, pp. 643-654.
- Sparebankforeningen. (2015, December 3). *About equity certificates*. Retrieved from Sparebankforeningen.no:
<https://www.sparebankforeningen.no/en/egenkapitalbevis/about-equity-certificates/>
- Sparebankforeningen. (2017). *Samarbeid og allianser*. Retrieved from Sparebankforeningen :
<https://www.sparebankforeningen.no/siteassets/dokumenter/samarbeid-og-allianser.pdf>
- Sparebankforeningen. (2018a). *Antall sparebanker*. Retrieved from Sparebankforeningen :
<https://www.sparebankforeningen.no/banker-og-stiftelser/antall-sparebanker/>
- Sparebankforeningen. (2018b). *Medlemmer*. Retrieved from Sparebankforeningen:
<https://www.sparebankforeningen.no/banker-og-stiftelser/medlemmer/>
- The Financial Supervisory Authority of Norway. (2018, October 19). *Finanstilsynet foreslår endringer i regelverket for identifisering av systemviktige finansforetak*. Retrieved from Finanstilsynet:
https://www.finanstilsynet.no/nyhetsarkiv/nyheter/2018/finanstilsynet-foreslar-endringer-i-regelverket-for-identifisering-av-systemviktige-finansforetak/?utm_campaign=97a1c8ccda&utm_medium=email&utm_source=newsletter
- Tirole, J. (2001, January). Corporate Governance. *Econometrica* (Vol. 69, No. 1), pp. 1-35.
- Torres-Reyna, O. (2007, December). *Panel Data Analysis. Fixed and Random Effects using Stata (v. 4.2)*. Retrieved from Princeton.edu:
<https://www.princeton.edu/~otorres/Panel101.pdf>
- Vives, X. (2016). *Competition and Stability in Banking - The role of regulation and competition policy*. Princeton: Princeton University Press.
- Winton, A. (1990). *Don't Put All Your Eggs in One Basket? Diversification and Specialization in Lending*. Wharton School Center for Financial Institutions, Center for Financial Institutions Working Papers 00 (16) .

-
- Wooldridge, J. M. (2013). *Introductory Econometrics: A Modern Approach, Fifth Edition*. Ohio : South-Western, Cengage Learning.
- Yeyati, E. L., & Micco, A. (2007, June). Concentration and foreign penetration in Latin American banking sectors: Impact on competition and risk. *Journal of Banking & Finance*(Volume 31, issue 6), pp. 1633-1647.