THE RELATION BETWEEN EFFICIENCY, NON-PERFORMING LOANS AND CAPITALIZATION IN THE NORDIC BANKING SECTOR

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Lund, 06.06.2016

ABSTRACT

This paper analyzes relationships between efficiency, non-performing loans and capitalization in the Nordic banking sector (Denmark, Finland, Norway, Sweden and Iceland) based on a panel dataset of 40 banks from the period of 2006 to 2015. Efficiency is measured by the ratio of non-interest expense to net operating income, the ratio of loan loss provision to total loans serves as a proxy for non-performing loans and capitalization is the ratio of equity to total assets. The paper applies the Granger-causality technique and tests four hypotheses as suggested by Berger and De Young (1997): "bad management", "skimping", "moral hazard" and "bad luck" and one additional the "regulatory" hypothesis. All five hypotheses are tested based on the relationships between the three variables. The paper finds evidence of the "bad luck" hypothesis only, which suggests that external factors increase the non-performing loans and management deals with this situation by accruing additional resources, which lowers the efficiency of the bank.

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1. INTRODUCTION

Financial markets are a crucial part of the economic and the banking sector in particular. Thus, it is important to understand the operation of banks and factors that affect their efficiency. Managers with their inside knowledge about firms and understanding about markets have a big impact on the development, the efficiency and performance of firms. Thus, the connection between this important sector and the key role of the management is of importance to study.

There have been several studies about the efficiency of banks. One of the most inspiring papers is Berger and DeYoung's "Problem Loans and Cost Efficiency in Commercial Banks" (1997). Applying the Granger-causality technique, they investigated the relationship between bank efficiency, non-performing loans and capitalization for US commercial banks. A stochastic frontier approach was used to estimate efficiency, see Aigner *et al.*, 1977; Kumbhakar and Lovell (2004), a measure of loan quality is the ratio of non-performing loans to total loans and bank capital is the ratio of equity to total assets. The model was built on three equations in which each variable is gradually dependent and regressed with its previous lags and other lagged variables. These equations were used to test four hypotheses "bad management", "skimping", "moral hazard" and "bad luck". There is a relationship between non-performing loans and efficiency in both directions[1]. But the paper found only evidence in one direction: "bad management", meaning that an increase in non-performing loans is due to a lack of skills of the management (Berger and DeYoung, 1997). Many later studies were based on the Granger-causality approach and the four hypotheses as mentioned by Berger and De Young for example "Management Behavior and Cost/Profit Efficiency in the Banking Sectors of Central and Eastern European Countries" by Rossi *et al.*, (2005) or "Bad Luck or Bad Management?" by Podpiera and Weill (2007). The former found evidence on "bad luck" whereas the later found a consistent result with Berger and De Young, meaning "bad management".

In this paper, the goal is to investigate bank efficiency, non-performing loans and capitalization and the link to managerial behavior particularly for banks in the Nordic region. By the end of 2015, there are 706 banks in the Nordic region[2] including commercial banks, saving banks, private banks and other financial institutions. A sample of the most updated data of 40 of these banks from 2006-2015 is obtained, and the Granger-causality technique is applied. Four

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[1] The Granger-causality of high non-performing loan with low efficiency supports the "bad luck" hypothesis. The Granger-causality of low efficiency with high non-performing loans supports the "bad management" hypothesis.
[2] Bankscope data

hypotheses following the previous papers "bad management", "skimping", "moral hazard", "bad luck" and one new hypothesis denoted as "regulatory" hypothesis are tested. Applying suitable ordinary least square estimations, the equation as suggested by Berger and De Young and an additional one are estimated. However building an efficiency frontier is out of the scope of this paper. Instead, the ratio of non-interest expense to total operating income to measure the efficiency is used see (Hays *et al.*, 2009).

The contribution of this paper is to provide empirical evidence on the Nordic banking sector with an up-to-date sample since previous research did not focus on that region. Only Denmark was considered in "Determining Management Behavior in European Banking" by (Williams, 2004). Furthermore, the additional "regulatory" hypothesis adds a new research aspect. This hypothesis can be tested within the framework of equations stating that there is a positive relationship between non-performing loans and capitalization of the banks.

The theoretical background is presented in section 2 of the paper covering an overview of the Nordic banking industry, the regulations of the sector, efficiency measure of banks, determinants of non-performing loans and moral hazard problems. Followed by section 3 describing the hypotheses in detail and empirical findings of researchers applying the same hypotheses. The methodology is provided in section 4, mainly the panel data method and the Granger-causality technique. Section 5 covers a description of the data as well as an explanation of the variables and equations. The model implementation and results, as well as discussion, are presented in section 6. Lastly, a conclusion in section 7 ends the thesis.

2. Theoretical Background

2.1. Overview of the Nordic Banking Sector

The Nordic region is comprised of five countries Denmark, Finland, Norway, Sweden and Iceland. They have outstanding economic performance, tightly interconnect and opened to a global market and because of that they also share related policies and institutions. Due to this close attachment, they are also subjected to similar financial risks (Agarwal *et al.*, 2013, p. 4). Although the whole region faced a financial crisis in the early 1990s, the way Nordic banks overcame this crisis is considered to be among the most successful in history. Resolving this crisis stood out because of the openness and transparency which was shown (Anderson, 2009, pp. 1–2). Not only is the way the crisis was overcome special but the performance of the banks as well. An indicator of banking profitability shows that Nordic retail banking generates a higher return on assets and net interest margins compared to other European countries (Smidt and Molbaek, 2006, pp. 21–22).

Nevertheless, there are some risks associated with the Nordic banking industry. A characteristic of these countries is the large banking sectors. By 2012 the banking sector's assets are three to four times of the country gross domestic product[3], in Finland for example, it is nearly 3.5 times the size of GDP. As a consequence of tied financial relationships and the big size of banking sectors, Nordic banking is exposed to vulnerabilities which implies large possible contingent liabilities for these countries (Agarwal *et al.*, 2013, pp. 7–8).

Another point to consider is that a small group of Nordic banks dominates the market, which in the event that one of these big banks fails may lead to substantial economic burden across these countries. In addition, there are potential risks associated with the location of the banks, in which Sweden has a central role. From the six biggest banks within that region, four[4] of them have the parent banks in Sweden (Agarwal *et al.*, 2013, p. 23).

In comparison with OECD[5]'s peers, Nordic banks have higher private sectors debt. This may add up to the risk in the banking system because "high private sector debt can constrain

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[3] Abbreviated as GDP following.

[4] Nordea, Swedbank, Svenska Handelsbanken and SEB have parent banks in Sweden, the other two of the six biggest banks are DNB and Danske bank.

[5] Organization for Economic Co-operation and Development. All Nordic countries are member of OECD. There are now 38 member including America, Canada, Japan, Korea and some European countries.

corporations' balance sheets with the potential to slow down growth and generate another adverse feedback loop with the banking sector[6]" (Agarwal *et al.*, 2013, pp. 7–8).

Since the large Nordic banks that have an enormous impact on the financial market and the economy of the whole region, it is essential to understand banking efficiency and how to the management behaves.

2.2. REGULATION OF THE BANKING SECTOR

This section will cover the Basel regulation and its purpose indented by the regulators, as well as empirical result that the authors found regarding the effectiveness of the regulation. The 2008 financial crisis followed by the economic crisis in 2009 showed how fragile the financial system is. This vulnerability is supposed to be reduced by Basel III. This regulation is a tightened version of the Basel II framework and has the purpose to further discourage risk taking (Koudstaal and van Wijnbergen, 2012, p. 4). The banking industry needs to cope with these stricter regulations meaning that they have to hold 4.5% of minimum equity tier 1 and conservation buffer which restricts dividend payouts. A bank holding company is subjected to hold risk-weighted asset ratio of 7% and 9.5%, whereas large complex institutions have even stricter requirements. These should have been implemented by the end of the previous year and the conservation buffer until the end of 2018 (Casimano and Hakura, 2011, p. 3).

According to Rime, the motivation for capital regulation is the concern that banks hold less capital than socially optimal in relation to their riskiness. Because in practice a bank would never hold more capital than what is required by the regulators or the market (Rime, 2001, pp. 791–792). Using a sample of Swiss banks he answered the question how they react to the constraints imposed on them by the regulators (Rime, 2001, p. 789). He found that banks which are close to the minimum capital requirement tend to increase their capital, indicating pressure from the regulators. As a result, he concludes that the penalty for having less than the minimum capital has the desired effect on the banks' behavior (Rime, 2001, p. 803).

Nier and Baumann identify three conditions need to be satisfied for the market discipline to be efficient: investors need to feel the risk of loss if the bank defaults, changes in the bank's risk profile need to have a cost effect on the bank and its management and lastly the market has to

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[6] A big part is household debt which is supposed to be less liquid and subject to the fluctuation of housing prices. Household assets are mostly illiquid in Nordic region.

have adequate information regarding the riskiness of the bank (Nier and Baumann, 2006, p. 334).

Jaques and Nigro investigated if the (back then newly introduced) capital standards have an effect on bank capital and the portfolio risk. They found that the new standards increased the capital ratios and reduced the portfolio risk. Banks which already exceeded the minimum capital requirement continued to do so and had a larger increase in capital than those banks, which were slightly above the minimum requirement (Jacques and Nigro, 1997, pp. 544–545).

Barth et. al. examined the relationship between different bank regulations and the development of the banking sector using a cross-country database. Among other things, they observed the regulation on capital adequacy. Non-performing loans are negatively related to stringent capital regulations, so the more stringent the regulation the less non-performing loans a bank has (Barth *et al.*, 2004, p. 244). It can be concluded that the quality of the loan is better when strict regulations are implemented.

The regulators try to stabilize the banking sector through the Basel regulation. Empirical evidence suggests that the regulation is not as effective as desired. The main problem seems to be that the banks which are close to the minimum requirement already continue with their path engaging in the suboptimal behavior.

2.3.   EFFICIENCY OF BANKS

Efficiency can be defined as "[a production of] a given output with fewer inputs or utilizing a given set of inputs to produce greater output" (Daley and Matthews, 2007, p. 3).   It is not about increasing income, but also how the costs are controlled. There are several factors which form the efficiency of a bank for example technology improvement, more productive communication and data processing. These may help to increase the quality of operation while decreasing the operational costs. The key factors to banking success are how to reduce and control the costs and maximize the utilization of resources (Spong *et al.*, 1995, pp. 1–2). The efficiency of banks also depends on external factors that govern the operation of banks, such as property rights, legal or regulatory requirements, and market conditions. A different operating environment has an impact on banking operations, this can be expressed by the difference in accounting principles, chartering rules or labor market (Hughes and Mester, 2008, p. 2). The manager and their behaviors also play an important part in the operation of banks by making decisions about structures, strategies, or how the cost is controlled.

In order to understand how well a bank performs or how efficient it is there are many approaches. Every bank has its own financial reports in which there is information about bank's income. However looking at the income statement only is not sufficient to say if a bank is operating efficiently or not. Any increasing income does not always imply that the bank is improving efficiency. It may mean that the profitability is increasing, but the bank is still inefficient (van der Westhuizen, 2013, p. 127). One of the most simple ways to measure efficiency is using financial ratios for example return on asset (ROA); return on equity (ROE) or ratio of income to cost. These ratios can be applied in any industry. The Banking sector, however, has some different and particular ratios such as non-interest income to interest income, rates of growth in deposits and advances, net interest income and net interest margin (van der Westhuizen, 2013, p. 128) or the ratio of non-interest expense to operating income (Hays *et al.*, 2009, p. 4).

Another approach which is supposed to be more accurate when assessing efficiency is the frontier approach, which is used by many scholars when investigating banking efficiency. All the output and input factors are transferred to a single measure of efficiency which lies between 0 to 1, where 0 means inefficient and 1 is efficient (van der Westhuizen, 2013, p. 128). There are non-parametric and parametric frontiers. Nonparametric frontier, however, assumes that there is no random error which may cause problems with the accuracy of the frontier. Parametric frontier, such as stochastic frontier approach or thick frontier approach, allow for a random error. It is difficult to determine which frontier is a better estimation. The solution lies in adding more flexibility to the parametric approaches and introducing a degree of random error into the non-parametric approaches (Berger and Humphrey, 1997, pp. 182–183).

In Berger and De Young's model, they use a stochastic frontier with input factors including the prices of labor and physical capital and outputs including different types of loans, transaction deposits and fee-based income (Berger and DeYoung, 1997, p. 858). This approach is also used widely by Tabak (2011); Rossi (2005); Altunbas (2007); Daley and Matthews (2007).

This section shows that there are different ways to measure a bank's efficiency, one relies on ratios and the other based on the frontier analysis. Furthermore, it can be concluded that an increasing income does not necessarily imply rising efficiency of banks. The frontier is more accurate as an efficiency measure, however as already mentioned his paper will apply non-interest expense/total operating income.

2.4. DETERMINANTS OF NON-PERFORMING LOANS

There has been a wide analysis of the financial crisis and how the financial sector influences the economy. Rather than looking at this aspect the section will focus on the opposite: How are banks, especially non-performing loans of the bank, affected by the economy.

According to the International Monetary Fund the definition of a non-performing loan is as followed:

> "A loan is nonperforming when payments of interest and/or principal are past due by 90 days or more, or interest payments equal to 90 days or more have been capitalized, refinanced, or delayed by agreement, or payments are less than 90 days overdue, but there are other good reasons […] to doubt that payments will be made in full" (Bloem and Freeman, 2005, p. 4).

A wide research area exists which tries to determine the factors that affect non-performing loans[7] Messai and Jouini (2013); Louzis (2010); Klein (2013); Boudriga (2009). Mainly there are two groups of factors influencing NPL: one is the macroeconomic factors and the other is the bank-specific factors, both are of interest for this paper.

Klein studied the determinants of non-performing loans and considered macroeconomic factors and bank-specific factors for Central, Eastern and South-Eastern Europe in 1998-2011. He finds that higher unemployment, exchange rate depreciation[8], and higher inflation are the macroeconomic factors which lead to a higher level of non-performing loans. The use of a vector autoregression approach showed that positive shocks to GDP growth result in a lower NPL amount and higher inflation lead to a higher NPL amount. As bank-specific factors, he considered previous period's profitability (as a measure of the quality of the management), low equity (as a measure for "moral hazard" incentives) and loans-to-assets as well as the growth of the bank's loans (as a measure of excessive risk taking). Klein finds conformation of the "moral hazard" effect in his paper because a higher equity-to-asset ratio leads to a lower NPL. On the contrary, excessive risk-taking increased NPL (Klein, 2013, p. 20). Although the impact of bank-specific factors on NPL is significant they explain relatively little of the variation of NPL (Klein, 2013, p. 4).

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[7] Abbreviated as NPL following.
[8] Against the Euro

Messai and Jouini analyzed the factors influencing NPL for Italy, Greece, and Spain using 85 banks from 2004-2008, considering both macro and specific variables. Consistent with Klein, they found that the growth rate of the GDP, as well as the profitability of banks, relate to problem loans negatively. The level of unemployment, the loan loss reserves to total loans and the real interest rate have a positive relationship with non-performing loans (Messai and Jouini, 2013, p. 853). Louzis et. al. investigated the same problem only for Greek banks from 2003-2009. Their result was that GDP growth, unemployment rate, and lending rates affect NPL to a large extent. The first and second effect negatively whereas the later positively (Louzis *et al.*, 2010, p. 26).

Bouldriga et. al. answered a similar question like the above authors and found consistent results with a sample of banks from 59 countries during the time from 2002-2006. What they considered as well is if the supervisory framework has any influence on the non-performing loans. Using the variables level of corruption, the degree of political openness and the rule of law there was no evidence that there is any effect. As a result, they question the effectiveness of the regulation (Boudriga *et al.*, 2009, p. 308).

What all authors have in common is that the result that non-performing loans are determined by macroeconomic and bank-specific factors. The authors found a consistent result on how the unemployment rate and GDP effect the level of NPL. Regarding bank-specific factors, there was a broader range of included variables for each author, but profitability or ROA, as well as a variable accounting for the loans of the bank, were used.

2.5. MORAL HAZARD IN BANKING

"Moral hazard" has been a widely studied topic for several decades now Holmstrom (1979; Mirrlees (1999); Spence and Zeckhauser (1971). According to Spence and Zeckhauser, it exists if on the one hand behavior is unobservable, but the consequences, on the other hand, are observable (Spence and Zeckhauser, 1971, p. 387). Mirrlees adopts to a similar definition: "[moral hazard arises when there is][…] uncertainty about the outcome of people's actions, the actions being themselves unobservable though the outcomes are observable." (Mirrlees, 1999, p. 4). Holmstrom adds the assumption of asymmetric information in a principal-agent framework for a more realistic view of the problem (Holmstrom, 1979, p. 88).

The banking sector is particularly prone to "moral hazard" related issued because of the nature of the business. Areas in which this problem can arise is between owners (or shareholder-

friendly management) and creditors of the bank, banks and its borrowers and banks and the regulators. Of interest for this paper is the relation between banks and the supervision and shareholders/managers and creditors. Recently some new research has been conducted on "moral hazard" in the setting of the banking industry such as Duran and Lozano-Vivas (2015); Koudstaal and van Wijnbergen (2012); Zhang et al. (2016); Nier and Baumann (2006); Niinimaki (2012).

According to Jensen and Meckling, managers engage in riskier lending than optimal because of two primary "moral hazard" problems. These are that management rather maximizes their own benefits than those of the firm and secondly a conflict arises between shareholders and creditors since shareholders prefer risk and try to shift it to creditors[9] (Jensen and Meckling, 1976, p. 306). This is because equity is equivalent to a call option on the firm's assets and is increasing in volatility. Duran and Lozano-Vivas state that the "moral hazard" issue between equity holders and debtholders arises because in case of default most of the losses will be carried by debtholders, whereas equity owners have limited downside. As a result, shareholders prefer riskier assets with larger returns (Duran and Lozano-Vivas, 2015, p. 39).

Duran and Lozano-Vivas analyzed the risk shifting problem in a regulatory context to assess whether the Basel regulation has the desired effect. They concluded that the pillars of Basel II do not solve the "moral hazard" incentive, but the capital requirements disincentives risk shifting among banks with no buffer (no capital above the minimum requirement). If a bank has capital above the legal requirements, they seem to be less incentive to transfer risk to creditors (Duran and Lozano-Vivas, 2015, p. 29).

Nier answered the question whether market discipline is efficient in providing incentives for banks to limit their risk through holding more capital against adverse outcomes in portfolio risk. Banks are likely to engage in "moral hazard", because if there is a strong government safety net rather than defaulting they are bailed out, and thus they engage in riskier behavior since they know that they are being saved. They found that government safety nets lead banks to have less capital. A significant amount of uninsured funding has a disciplinary effect. As a result, banks hold more capital (Nier and Baumann, 2006, p. 357).

Kaudstaal and van Wijnbergen answered the question if highly levered banks take on excessive risk. They tested several hypothesis, of which one is of primary interest for this paper. The

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[9] Shareholders own a call option on the firm's assets, which is increasing in volatility. Essentially debtors sell a put option which allows the firm to sell the assets for the put option price.

"gambling for resurrection" hypothesis states that banks increase risk taking in distressed situations with a high proportion of bad loans. Risk under management control, measured by standard deviation of return on assets, was regressed on bad loan reserve[10] and leverage (Koudstaal and van Wijnbergen, 2012, pp. 7–8). Using a large sample of US banks Kaudstaal and van Wijnbergen did not find support for this hypothesis. Thus according to them, banks with more trouble loan portfolio do not take on excessive risk (Koudstaal and van Wijnbergen, 2012, p. 25).

The problem of hidden bad loans was analyzed by Niinimaki. He answered the question if the hidden loans worsen the "moral hazard" problem between banks and the supervision and found that the problem exists and can also not be solved through diversification (Niinimaki, 2012, p. 13). According to him, the banks hide these loans by rolling over the bad loans (extending the maturity of the loan) or approving a new loan to pay for the old loan. Thus, banks seem to be highly profitable but actually hold a large amount of problem loans (Niinimaki, 2012, p. 1).

Zhang et al. investigated how non-performing loans[11] are related to "moral hazard" in the Chinese banking industry. Since "moral hazard" is not observable excessive risk taking in lending, measured by non-performing loans, is used as a proxy. They used a threshold value for the non-performing loans expecting that above the threshold risk-taking by banks increases and the non-performing loans worsen (Zhang *et al.*, 2016, p. 51). For Chinese banks, there was evidence that facing high NPL results in "moral hazard" behavior (Zhang *et al.*, 2016, p. 59).

As can be seen from this section there is a broad range of "moral hazard" related problems within the banking industry. The main issue is that each involved party has their own interests which are not aligned and thus engage in suboptimal behavior for the other party.

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[10] In this paper the wording is loan loss provision.

3. MANAGEMENT BEHAVIOR

3.1. THE HYPOTHESES

Section 2 showed that efficiency, non-performing loans and capitalization affect the banks to a large extent. Previous papers have examined management behavior with these three variables (Berger and DeYoung, 1997; Podpiera and Weill, 2007; Reddy, 2011; Rossi *et al.*, 2005; Williams, 2004; Fiordelisi *et al.*, 2010; Tabak *et al.*, 2011). They tested the following: "bad management", "skimping", "moral hazard" and "bad luck". The hypotheses proposed will be tested and together with one addition which is "regulatory" hypothesis. The tests follow the Granger-causality technique. Whether a hypothesis is supported by the data or not depends on the causality and the sign of the causality between variables. There are three variables inputted in three equations which will be mention in section 5. The basis for the hypotheses and expected relationship between the variables according to each hypothesis will be presented in this section.

The first hypothesis is "bad management". Management is assumed to be bad when they lack the skills for e.g. credit rating and thus, allow for a high amount of loans which have a negative net present value. Moreover, they are incompetent in assessing the value of collateral for the loans and lastly they have difficulties in appropriately monitoring the borrowers. So low efficiency is a sign of poor management performance and should result in a greater volume of non-performing loans (Podpiera and Weill, 2007, p. 5). According to this hypothesis, the relation between NPL and efficiency should be negative (Berger and DeYoung, 1997, p. 853).

"Skimping" behavior is tested with the same variables but the relation between the variables is expected to be the opposite. There is a trade-off between short-term operating costs and future loan quality. Managers that engage in "skimping" decide to reduce the near-term costs in order to increase long-term profits. The costs are reduced by cutting underwriting, monitoring and controlling of the borrower or devoting fewer resources to assess collateral suggesting that banks are cost efficient in the short-term. These banks deal with the worsened asset quality later in time. So the efficiency increases due to short-term cost reduction but the lagged value of NPL which can be understood as deteriorating asset quality increases as well (Williams, 2004, p. 2431).

The theoretical review showed that there are several "moral hazard" related problems within the banking sector. If the management acts on behalf of the shareholders, they have an incentive to shift risk to the creditors. The managers are less risk averse and engage in riskier lending. As

a result, they are more eager to accept worse loans because the expected return is positively related to the higher risk. Low capitalized banks have relatively less capital to loose in case of default. So low capitalization results in management increasing the risk of the loans hold by the bank. According to the "moral hazard" hypothesis, NPL is increasing while the capitalization of the bank is decreasing. Thus, a negative relationship is expected (Berger and DeYoung, 1997, p. 854).

"Bad luck" hypothesis predicts a negative relationship between NPL and efficiency (Rossi *et al.*, 2005, p. 26). As can be seen from section 2.4., there is strong evidence that macroeconomic factors influence NPL. Thus, if the GDP growth reduces, unemployment rises or interest rates fall, this increases the amount of non-performing loans. Managers have to deal with this adverse situation (lower quality loans) by accruing additional resources, which results in higher operating costs followed by lower efficiency. Higher operating costs can result from monitoring borrowers, valuing collateral and in case of default seizing, storing and disposing of collateral as well as protecting the quality of current loans. So the same relation between the two variables is expected as for "bad management", but the dependent variable is opposite (Williams, 2004, p. 2431).

Whereas the hypotheses already mentioned are based on the same paper (Berger and DeYoung, 1997) the following hypothesis is added in order to contribute a new research aspect. Section 2.2 showed that the purpose of the Basel regulation is for the banks to hold the amount of capital, which is in line with the portfolio risk (Jacques and Nigro, 1997, p. 535). Otherwise, banks might hold less capital than socially optimal in relation to its riskiness (Rime, 2001, p. 791). The regulators have specified that the more risky loans a bank has, the more capital it is supposed to hold and through the Basel III framework these requirements are even tightened. So according to the "regulatory" hypothesis the relation between NPL and capitalization should be positive (Altunbas *et al.*, 2007, p. 52).

3.2.   PREVIOUS EMPIRICAL FINDINGS

Berger and De Young studied this topic first in 1997 with commercial banks in the US. They found that efficiency positively relates to NPL, which is what predicted by "skimping" hypothesis and provide evidence that the increase in non-performing loan is due to external events, this supports the "bad luck" hypothesis (Berger and DeYoung, 1997, pp. 861–862)[12]. Williams provided a robustness test for the result of Berger and De Young. A sample from European savings bank from 1990-1998, including banks from Denmark[13], showed evidence of "bad management". He substitutes, like the authors of this paper, non-performing loans with the loan loss provision (Williams, 2004, p. 2427).

The same method with efficiency frontier, Granger-causality technique and loan loss provision as a proxy was used by Rossi et. al. which investigated the managerial behaviors and efficiency in banking sectors of Central and Eastern European countries. However, they do not find any evidence of the "bad management" hypothesis, although there is a significant negative correlation between problem loans and efficiency. They suggest that the failure and efficiency of banks in their study are rather due to external factors than the control of management which supports "bad luck" hypothesis (Rossi *et al.*, 2005, p. 26).

With a focus on emerging banking market, Podpiera and Weill studied management behavior, and found confirmation in "bad management" and reject the possibility of "bad luck". They estimate the efficiency frontier with the inputs prices of labors, physical capitals and borrowed funds. The outputs are total loans and investment assets. Due to a lack of data on non-performing loans they use loan loss provision as well (Podpiera and Weill, 2007, p. 10).

In the paper "Efficiency and Risk in European Banking", Fiordelisi et. al. also find support for "bad management" as well as "moral hazard", tested with a subsample of banks with efficiency below the median (Fiordelisi *et al.*, 2010, p. 23).

In 2011, Tabak et. al. used the same approach to research bank efficiency and default in Brazil. They analyzed the relationship between the three variables in order to discover the main reason of banking failure in Brazil. There is again, evidence on "bad management". According to this paper, when banks maximize profits they reduce the cost of loan monitoring and control to have

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[12] Berger and De Young perform the test for efficient banks only because "bad management" hypothesis dominates skimping hypothesis for the whole sample. As a consequence they expect to find evidence for the "skimping" hypothesis in banks that have higher efficiency than the sample median.

[13] To the authors' knowledge this is the only paper considering any Nordic countries in their sample.

a short-term efficiency. As a consequence when the rate of default increases in the long term, banks become inefficient which means that the covered inefficiency is the main source of non-performing loans. To eliminate this problem, banks may make efforts to increase efficiency, which later on leads to the rising of NPL. Banks cannot maintain this strategy suggesting that "bad management" is the key explanation for the increase in default (Tabak *et al.*, 2011, p. 15).

Reddy studied the management behavior of Indian banks. Whereas the country might not be comparable to Nordic region it is still worth mentioning his result. He found support for three hypotheses: "bad management", "moral hazard" and "bad luck" (Reddy, 2011, p. 70). This suggests that Indian banks have management which behaves suboptimal in several ways.

Louzis studied this topic in a different context, more focused on internal and external factors that influence NPL. Although he did not adjust to the same variables used by the researchers above he used the identical hypotheses. The relation between inefficiency and NPL was significant and positive. This result can be viewed as a support for the "bad management" hypothesis which states that inefficiency is due to the lack of skills of management. He did not find significance between the bank's risk attitude, measured by solvency and loans-to-deposit ratio, and NPL thus no support for the "moral hazard" hypothesis in the Greek banking sector. (Louzis *et al.*, 2010, p. 25).

"Bad management" seems to be the most supported hypothesis as six papers found evidence on this followed by the "bad luck" hypothesis.

4. METHODOLOGY

4.1. PANEL DATA APPROACHES

Since the data will cover several banks over a period of years, considering three different variables there are several panel data methods possible. This section will cover three methods with the following order: pooled regression, fixed effect as well as random effect.

Consider any panel dataset given by the following equation:

$$y_{it} = \alpha + \beta x_{it} + u_{it} \qquad (1)$$

Where y is the dependent variable and x is the independent variable, α is the intercept and u is the error term. The notion "it" describes what cross-sectional unit $i=1,\ldots,N$ and what time $t=1,\ldots,T$ (Baltagi, 2011, pp. 305–306).

One option to estimate panel data is running a pooled regression. This is done simply by stacking up the data of the dependent variable y in a single column, as well as the independent variable x, and treating it as one big cross section. The downside of this is that information is lost. With this estimation methods, it is assumed that observations from one cross-section are not related which is highly unlikely because it is expected that within one cross-section one observed variable at time t is related to the one observed at t-1. In order to account for the heterogeneity in panel data fixed or random effects can be implemented (Brooks, 2011, p. 488).

The fixed effect allows for a different intercept for each cross–sectional unit which does not differ over time while the slope is fixed on both dimensions. In equation (1) the error term u can be decomposed into the following:

$$u_{it} = \mu_i + v_{it} \qquad (2)$$

Where v_{it} is the error-term which differs over time and entities and μ_i is the remainder effect. Thus, equation (1) can be rewritten by plugging in equation (2):

$$y_{it} = \alpha + \beta x_{it} + \mu_i + v_{it} \quad (3)$$

With the least squares dummy variable approach this model can be estimated:

$$y_{it} = \beta x_{it} + \mu_1 D1_i + \mu_2 D2_i + \mu_3 D3_i + \ldots + \mu_n DN_i + v_{it} \qquad (4)$$

D1 is a dummy which takes on the value 1 for all observations of entity one and zero otherwise and so on. It would be quite cumbersome to estimate if N is large, thus, the within

transformation is used to simplify. The within transformation subtracts the time-mean from each entity from the value of the variables in order to arrive at the demeaned value (Brooks, 2011, pp. 490–492).

A simple way to determine if fixed effect is appropriate is to use an f-test in order to assess if the dummies in equation (4) are significant. Thus, under the null hypothesis[14]: $\mu_1 = ... = \mu_n = 0$ and under H1: $\mu_1 \neq ... \neq \mu_n \neq 0$. (Baltagi, 2011, p. 308). So if the p-value is below the significance level 1%, 5%, 10% H0 is rejected and the dummies are not equal to zero.

The random effect model introduces an intercept for each entity constant over time like fixed effect. Random effect can be written as:

$$y_{it} = \alpha + \beta x_{it} + w_{it}, \qquad w_{it} = \varepsilon_i + v_{it} \qquad (5)$$

Where cov $(\varepsilon_i, v_{it}) = 0$ and cov $(\varepsilon_i, x_{it}) = 0$.

Here these intercepts arise from a common intercept α, which is constant for all cross- sections and over time, plus a random variable ε_i, which varies over cross-sections and captures the cross-sectional heterogeneity (Brooks, 2011, p. 498). Two underlying assumptions of the model are that α has drawn randomly from a common population and that the explanatory variables are strictly exogenous meaning that the error term is uncorrelated with the regressor (Hsiao, 2007, p. 43). If both fixed and random effect are well specified, random effect should be preferred since it is more efficient because it does not lose degrees of freedom due to a high number of parameters (Baltagi, 2011, p. 308).

If the random effect specification is suited for the data can be conducted with the Hausman-Test. It determines if there is any systematic difference between fixed or random effects where H0 states that both models are applicable (error term is uncorrelated with the regressor) and H1 states that just fixed effect can be used (error term is correlated with the regressor). (Hsiao, 2007, pp. 49–51).

Through applying the fixed effect f-test and Hausman-test the method which best fits the sample at hand will be determined.

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[14] Abbreviated as H0, alternative hypothesis abbreviated as H1.

4.2.   GRANGER-CAUSALITY TECHNIQUE

The standard definition of Granger-causality is that the independent variable x is causing dependent variable y if the prediction of y is better when including x (Hurlin and Venet, 2003, p. 2). This framework introduced by Granger aims to find if the change in one variable cause the change in other variables (Granger, 1969). If the x variables Granger-cause the dependent variables y, then the coefficients must be significant in the equation of the dependent variable. Unidirectional causality exists if there is significance in one direction and not vice versa, if it exists in both directions it is bi-directional causality and if neither of x and y are significant as independent variable then there is no Granger-causation (Brooks, 2011, p. 335). Only consistency with a hypothesis can be specified, but no proof of economic causation is given by the Granger-causality model. It can be shown if there is a correlation between the current value of the dependent and the past value of the independent variable. (Berger and DeYoung, 1997, p. 855; Brooks, 2011, p. 298).

Fundamental of this technique is applied by Berger and De Young: that the lags of the independent variables Granger-cause the dependent variable (Rossi *et al.*, 2005, p. 13). However, the variables are not only tested for the Granger-causality with other independent variables but also with their own lagged values. The tests are performed in both directions for each variable. For this reason, in the equation system used by this Granger-causality, each variable will be the dependent variable in an equation but the independent variable in other equations and all equations have the similar dependent variables. The current value of the independent variables are not of interest but the past value of them. However, each lag's coefficient is not the main interest but the significance of the sum of coefficients are the primary concern. The relationships between variables are revealed by the significance and the signs of the coefficients.

5. DATA

5.1. DESCRIPTION OF THE SAMPLE

A panel dataset has several advantages compared to cross-sectional or time-series data. Not only can it improve the efficiency of the econometric estimates through a higher number of observations and thus increased the number of degrees of freedom, but it allows to answer a broader range of questions (Hsiao, 2007, p. 10). It also reduces the collinearity among regressors (Hurlin and Venet, 2003, p. 5). Some effects can only be revealed through panel data. According to Baltagi panel data especially suited to study complex issues of dynamic behavior, which is applicable for management behavior (Baltagi, 2011, p. 305).

Data was collected from Bankscope for 40 banks in 5 Nordic countries: Denmark (DK), Finland (FI), Norway (NO), Sweden (SE), and Iceland (IC). Yearly data of 40 banks from 2006-2015, which is the most updated one, is supposed to give significant statistical meaning. Not many banks have data available on Bankscope for more than 10 years and smaller banks tend to lack information, which may cause bias problems for the model. In addition, large banks dominate the Nordic market (see section 2.1.) and that is why banks are selected based on their total assets in descending order. As a consequence due to the size of banks in IC no bank was selected[15].

Different currencies were converted into thousand USD for consistency purpose. The exchange rate is the end of day value available in Bankscope. All data was taken from financial profile, income statement, balance sheet and additional balance sheet in Bankscope. After the needed data is selected it results in an unbalanced panel data set with 400 observations. The distribution of selected banks across countries is as below:

Country code	DK	FI	NO	SE	Total
Number of selected bank	14	6	7	13	40
Total assets (mil USD 2015)	1,487,676	661,955	818,134	2,084,852	5,052,617
Total asset of selected banks/ total assets of banks in the country	70%	65%	37%	83%	62%

Table 1: Data Distribution[16]

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[15] By end of 2015, there are 53 bank in Iceland in Bankscope, but none of them is big enough to be selected.
[16] Source: Bankscope and own calculation. All data as end of 2015.

The table shows that among those banks, SE banks have the highest total assets, followed by DK, FI and NO. As expected, DK and SE have a greater number of large banks than the rest of the region. Although the data represents only 5.6%[17] of the total number of banks in the region, these banks occupy 62% of the total assets of all banks in their countries. Thus, this data can be considered representative of the banking sector in the Nordic region.

5.2.   VARIABLE EXPLANATION AND EQUATIONS

Some explanation of the variables was already made in previous sections now a more detailed description is given. Below the variables that are used in the test to investigate management behavior are shown.

Variable	Explanation
CAP	Total equity/Total asset
LLP	Loan loss provision/Total loan
EFF	Non-interest expense/Total operating income

Table 2: Variable Explanation

A measure of the banks' capitalization is total equity over total asset and (Rossi *et al.*, 2005, p. 11). One important variable to investigate the quality of loan management is based on non-performing loan as suggested in Berger and De Young (1997) model. However, due to the unavailability of NPL, loan loss provision is used as a measurement of loan quality. This variable is supposed to be less significant than non-performing loans (Podpiera and Weill, 2007, p. 5), however, some researchers have shown the high validity of using the loan loss provision when evaluating management behavior models (Rossi *et al.*, 2005; Podpiera and Weill, 2007). Nevertheless, there is a concern with the loan loss provision because it is missing for some banks, mostly cluster in the middle of the sample. This may cause bias estimation towards bigger banks and relatively small banks of the sample.

To determine the efficiency non-interest expense to total operating income is used. This ratio measures how efficient banks are regarding using person expenses and other non-interest operating expense. Other things being equal, a smaller ratio is better because a high and

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[17] There are 706 banks in total in Nordic region by end of 2015.

increasing ratio indicates less efficiency. This ratio can temporarily increase when banks expand their business since banks will need new investment and recruit more employees which lead to an increase in non-interest expense. However, in the long run, this ratio is not expected to increase. There is a potential delay in interest income because new loans may not be directly subjected to interest payments. Same applies to fee income and as a consequence there is a delay in the operating income. This may cause a short-term jump in the ratio (Hays *et al.*, 2009, p. 4).

	CAP	LLP	EFF
Mean	0.068147	0.008288	0.328233
Standard Error	0.005947	0.000761	0.079135
Median	0.046345	0.004303	0.469679
Standard Deviation	0.118933	0.013511	1.580713
Sample Variance	0.014145	0.000183	2.498653
Range	0.89941	0.09693	28.63525
Minimum	0	-0.00012	-24.0233
Maximum	0.89941	0.096808	4.611991

Table 3: Descriptive Statistics for the Sample

The equations which are supposed to give insights about management behavior are the following:

$$LLP_{i,t} = f_1(LLP_{i,lag}, EFF_{i,lag}, CAP_{i,lag}) + \varepsilon_{1i,t} \qquad (6)$$

$$EFF_{i,t} = f_2(LLP_{i,lag}, EFF_{i,lag}, CAP_{i,lag}) + \varepsilon_{2i,t} \qquad (7)$$

$$CAP_{i,t} = f_3(LLP_{i,lag}, EFF_{i,lag}, CAP_{i,lag}) + \varepsilon_{3i,t} \qquad (8)$$

Following Berger and DeYoung the equations (6)-(8) are based on the idea of Granger-causality and are able to show the intertemporal relation between the variables. In each equation, the dependent variable is on the left-hand side of the equations as well with its lagged value and other lagged explanatory variables on the right-hand side. Equation (6) tests the hypotheses "bad management", "skimping" and "moral hazard". The "bad luck" hypothesis is examined

through equation (7). Previous papers have included equation (8) only to complete the model, but in this paper it is used to test the "regulatory" hypothesis.

6. EMPIRICAL RESULT

6.1.   IMPLEMENTATION OF THE MODEL

Equation (6) to (8) are estimated using panel least square method. Before the model can be implemented the first thing check is for potential multicollinearity. The pairwise correlations of variables are in the interval [0.00 0.68] indicating no significant multicollinearity in the data [see Table A.1 in Appendix]. Heteroscedasticity problem in panel data can be tested manually in Eviews by saving the residual of equation (6) to (8), squaring them and running the regression with ordinary least square again with the squared residuals as dependent variables. The result [see Table A.2 in Appendix] shows that the f-statistics are significant in all three equations which indicate that the residual variance is not constant. As a result, there is a presence of heteroscedasticity in the data. To mitigate this problem appropriate White Correction in either cross sectional or period dimension or both for each equation is used, depending on whether fixed effects or random effects was applied.

Because the model needs to be built with lagged values, it is important to determine the optimal lag length. In general, there are several alternatives for example vector auto regression. However, they are not highly suitable in this case since all separate equations generate different results but they must have the same number of lags. Reddy suggests a method which is based on an f-test to determine the number of lags. Gradually increasing the number of lags the optimal lag length is identified through the change in f-statistic and the significance of the coefficients (Reddy, 2011, p. 79)[18]. The model of this paper is based on three lags, and this decision is motivated by following reasons:

The more lags included, the less the f-statistic becomes and some variables become insignificant in the model. On the other hand, there must be a sufficient number of lags to explain the relationship among variables because there is delay in the book data of banks, less cautious loan granting practice is reflected in an increase of NPL only after a few years (Podpiera and Weill,

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[18] A summary table of the result when increasing the number of lags from 1 to 6 can be found in the appendix of this paper.

2007, p. 9). In addition the measure of efficiency is affected by slow movement of loans and fee income (see section 5.2.).

By looking at the f-statistic and t-statistic of the coefficients, the most appropriate model with the largest amount of significant coefficients is the model with three or four lags [see Table A.3 in Appendix]. Furthermore, most of the previous studies have shown significant results using three to four lag models (Aigner *et al.*, 1977; Rossi *et al.*, 2005; Williams, 2004; Podpiera and Weill, 2007). Berger and De Young also showed no big difference between using a three or four lag model (Berger and DeYoung, 1997).

Gradually fixed and random effects are applied on each equation. The fixed effects f-test has the null hypothesis that the fixed effects dummies are jointly zero is strongly rejected, this leads to high evidence of heterogeneity in the data and vindication of the use of fixed effects approach (Baltagi, 2011, p. 308) . The presence of heterogeneity in both dimensions indicates that pooled regression is not appropriate. The Hausman-test, which has the null hypothesis that random effect is well-specified is rejected in all equations [see Table A.4 in Appendix]. As a consequence, in this case, the best estimation approach is fixed effect because it takes heterogeneity into account. Similarly, in equation (7) the redundant fixed effects – likelihood ratio in Eviews test rejects the null hypothesis, which also means no significant evidence of heterogeneity in either cross-section or period dimension. In equation (8), the test reveals significant evidence of heterogeneity in the cross-sectional dimension only. Thus, appropriate estimations for equation (7) and (8) are pool regression and cross-sectional fixed effects respectively. As mentioned before White corrections are applied accordingly to mitigate heteroscedasticity problem.

Beside ordinary least square regression to check for the relationship between variables pairwise Granger-causality test is performed to investigate how each variable affects the others.

6.2. REGRESSION RESULT AND DISCUSSION

Equations (6)-(8) are estimated with three lags using fixed effects and pooled regression. The result is presented in appendix 5-6. Because the influence of the independent variable as a whole (with all lags) is of main interest, the sum of the coefficients are important (Berger and DeYoung, 1997, pp. 856–857).

With the estimation of equation (6) four of the five hypotheses can be tested. According to the "bad management" hypothesis, the relation between LLP and EFF should be negative, whereas

according to the "skimping" hypothesis it should be positive. There was no evidence found for "bad management" since the relationship between the two variables is positive, with a coefficient of 0,0003697 but since it is not significant it is not appropriate to interpret any results [see Table A.5 in Appendix].

Only "bad luck" is supported by the data. The coefficient is -49.857727 and significant at a 1% level [see Table A.5 in Appendix]. Deteriorating asset quality, increasing LLP is a proxy for this, results from external events and consequently the operating cost increase. This results in a decrease of efficiency. So it can be said that a one unit increase in LLP results in a decrease of EFF by roughly 49.86 units.

The "moral hazard" hypothesis was estimated with a subsample of banks with capitalization below the median since those managers are more likely to engage in "moral hazard" behavior. The coefficients of CAP in equation (6) are insignificant, thus, no evidence for "moral hazard" problems in the Nordic banking sector are found [see Table A.6 in Appendix].

When the sum of the coefficients for LLP is considered in equation (8), it can be drawn whether the regulation has the effect desired by the regulators. A positive relation between LLP and CAP was not found since the total coefficient is -0.071151and insignificant [see Table A.5 in Appendix]. It does not apply to Nordic banks that the higher the risk the more capital they hold. According to this result, "regulatory" hypothesis is not supported by the data.

Pairwise Granger-causality test result can be found in Table A.7 in Appendix. The test result shows that the null hypothesis which states that EFF does not Granger-cause CAP and LLP does not Granger-cause EFF are strongly rejected with f-statistic 20.46 and 5.79 respectively. These rejections suggest that the movement in EFF Granger-cause the movement in CAP. Although this result was found this relation is not stated by any hypothesis. However, there might be an explanation which has not been considered yet. Furthermore, this result shows that movement in LLP Granger-cause movement in EFF. Which verifies the result of the regression for the "bad luck" hypothesis. One of the drawbacks of the Granger-causality test is it does not give the sign of the movement. However, the result from equation (7) shows a negative relation between LLP and EFF in accordance with the "bad luck" hypothesis.

The result is partly consistent with Berger and De Young because they find two way relationship between NLP and EFF, the data supported both "bad management" and "bad luck", which is possible since the hypotheses are not mutually exclusive (Berger and DeYoung, 1997). Rossi et. al. also detected evidence on "bad luck" for Central and Eastern European banks

(Rossi *et al.*, 2005). Lastly, Reddy has proof of "bad luck" among other hypotheses for Indian banks as well (Reddy, 2011).

In summary, there is only support for the "bad luck" hypothesis. There is no evidence on a reverse relationship and no significant support for the other hypotheses either. This result shows that external conditions are the key factors that affect the non-performing loans and thus the level of efficiency in Nordic banks. The fluctuations of the economy or unemployment have a big impact on the banks. This seems to be predicted because as mentioned in part 2.1 "Overview of Nordic Banking Sector", private debt occupies a large part of the loan portfolio. The heavy share of household loan makes banks more exposed to the risk of fluctuating housing price and the low liquidity of household assets. Reducing household loans does not seem to be an adequate solution to mitigate this exposure to external factors for Nordic banks, but a diversified loan portfolio could be a possible resolution.

Some notes have to be made when looking at this result: As already mentioned the sample might be biased towards smaller and bigger banks since the loan loss provision is only available for them, thus middle size banks are dropped from the sample. So with a different sample at hand which is not biased, other results might have been found.

Comparing to the previous paper the ratio of non-interest expense/operating income is a proxy for efficiency, rather than an estimation of a stochastic efficiency frontier (Aigner *et al.*, 1977; Kumbhakar and Lovell, 2004). There are potential problems with respect to financial ratios as an efficiency measure. Yeh identifies two problems. One problem is that financial ratios are only meaningful when compared to a benchmark and finding good benchmark can be difficult. The other problem with financial ratios is that they only use a fraction of the available data. So it could be the case that one ratio indicates the bank performs efficient, but another ratio can indicate the opposite (Yeh, 1996, p. 980). These problems can be solved through the stochastic frontier, which uses all input and output of a firm.

Another problem arises with the variable non-performing loans or loan loss provision. Ninnimaki shows that non-performing loans are subjected to managerial discretion and can be manipulated in ways which do not show the true condition of the bank. There are two ways how these loans can be hidden, either the banks extends the maturity of the loan, which might become overdue, or grants a new loan to pay for the old (Niinimaki, 2012, p. 1). Thus also drawing a conclusion from NPL might not give a realistic picture of the management behavior since the reported and actual number of non-performing loans might differ.

7. CONCLUSION

The goal of this thesis is to explore the relation between efficiency, non-performing loans (proxy loan-loss provision) and capitalization in the Nordic banking industry. Through this relation between variables the management behavior in Nordic banks is made visible. For that reason, a theoretical review is conducted in part 2 followed by five hypotheses that the paper covers based on the Granger-causality technique. Lastly, an empirical investigation is conducted with the data collected from 40 biggest bank in the Nordic region over the 10 years period from 2006 to 2015.

Unique features distinguish the Nordic banking sector from others. Mainly they have shown how well they can handle a financial crisis. But it is also noticed that Nordic countries have a large banking sector compared to their GDP, which makes them more vulnerable. Sweden is a key country for the whole region since the biggest banks have their parent company located there. A large amount of private debt is held by the Nordic banks making them subjected to fluctuating housing prices.

Not only in the Nordic region but in the whole world the banking sector is the most regulated sector of an economy. Due to the financial crisis in 2008, the regulation became even stricter and the capital requirements were tightened. The theoretical review shows that there are different ways to measure the efficiency of a bank. Mainly a traditional one relying on financial ratios and a sophisticated based on a frontier analysis. Furthermore, the non-performing loans of a bank are affected by external and bank-specific factors. The external influence is mostly by GDP and unemployment. Within this sector, there is a number of moral hazard problems which can arise. The main issue is that the managers acting on behalf of the shareholders have an incentive to strengthen their position by increasing the risk, either to shift risk to the creditors or to engage in riskier lending than socially optimal.

With a panel dataset, the five hypotheses are tested and the Granger-causality technique is applied. The finding of this paper supports the "bad luck" hypothesis because a negative relationship between loan loss provision and efficiency was found. This means that external factors, for example, a rising unemployment rate, induce the quality of the loans (rising loan loss provision). This adverse situation is handled by the management through assigning additional resources. Consequently, the efficiency of the bank is lowered because these additional resources mean more input factors. This paper, however, does not answer what kind of external factors increase the provision. Having variables as GDP or unemployment included

might have given more insights on what the actual reason was for the increase. But from section 2.1. it can be determined that this sensitivity towards external event might result from a large amount of private loans within the Nordic region.

As outlined in section 6.2., using the ratio of non-interest expense to total operating income as a measure of efficiency is not the most optimal choice. But the complexity of the stochastic frontier was out of scope for this paper. As already mentioned in the discussion (section 6.2.) the non-performing loans of a bank are subject to managerial discretion because they can hide these loans or roll them over, thus making the bank appear in a better condition than it actually is. So it is likely that the Nordic banks hold more non-performing loans than reported.

It would be of interest to consider also smaller banks of the Nordic region since they might have different results. The problem here remains for all researchers that there is a lack of data for these smaller sized banks. This is quite difficult to overcome. In addition, it would be desirable that more up to date research would be conducted on this topic and on the Nordic banks using the stochastic frontier to see if the results are consistent with the ones from this paper.

The introduction showed that the banking sector is a crucial part of the economy and the management with their key position in any firm will remain an important topic to study. The changing environment for banks will continue to challenge the managers and very likely change their behavior.

REFERENCES

Agarwal, R., Aslam, A., Mordonu, A. and Shirono, K. (2013), *Nordic Regional Report: Selected Issues.* International Monetary Fund, IMF Country Report, No. 13/275, available at: https://www.imf.org/external/pubs/ft/scr/2013/cr13274.pdf (accessed 17 May 2016).

Aigner, D., Lovell, K. and Schmidt, P. (1977), *Formulation and Estimation of Stochastic Frontier Production Function Models*, Journal of Econometrics, No. 6, pp. 21–37, available at: https://www.rand.org/content/dam/rand/pubs/papers/2008/P5649.pdf (accessed 17 May 2016).

Altunbas, Y., Carbo, S., Gardener, E. and Molyneux, P. (2007), *Examining the Relationship between Capital, Risk and Efficiency in European Banking*, European Financial Management, No. 13, pp. 49–70, available at: www.ugr.es/~scarbo/ALTUNCAR.pdf (accessed 17 May 2016).

Anderson, R. (2009), *Resolving a Banking Crisis, the Nordic Way.* Federal Reserve Bank of St. Louis, Short Essays and Reports on the Economic Issues of the Day, No. 10, available at: https://research.stlouisfed.org/publications/es/09/ES0910.pdf (accessed 17 May 2016).

Baltagi, B.H. (2011), *Econometrics,* 5th edition, Berlin, Heidelberg.

Barth, J.R., Caprio, G. and Levine, R. (2004), *Bank Regulation and Supervision. What Works Best?*, Journal of Financial Intermediation, Vol. 13 No. 2, pp. 205–248, available at: www.sciencedirect.com/science/article/pii/S1042957303000603 (accessed 17 May 2016).

Berger, A.N. and DeYoung, R. (1997), *Problem Loans and Cost Efficiency in Commercial Banks*, Journal of Banking & Finance, Vol. 21 No. 6, pp. 849–870, available at: www.sciencedirect.com/science/article/pii/S0378426697000034 (accessed 17 May 2016).

Berger, A.N. and Humphrey, D. (1997), *Efficiency of Financial Institutions:. International Survey and Directions for Future Research*, European Journal of Operational Research, No. 98, pp. 175–212, available at: www.sciencedirect.com/science/article/pii/S0377221796003426 (accessed 17 May 2016).

Bloem, A. and Freeman, R. (2005), *The Treatment of Nonperforming Loans: Clarification and Elaboration of Issues Raised by the December 2004 Meeting of the Advisory Expert Group of the Intersecretariat Working Group on National Accounts.* International Monetary Fund, Issue Paper, available at: https://www.imf.org/external/pubs/ft/bop/2005/05-29.pdf (accessed 17 May 2016).

Boudriga, A., Boulila Taktak, N. and Jellouli, S. (2009), *Banking Supervision and Nonperforming Loans. A Cross-Country Analysis*, Journal of Financial Economic Policy,

Vol. 1 No. 4, pp. 286–318, available at: https://mpra.ub.uni-muenchen.de/18068/1/MPRA_paper_18068.pdf (accessed 17 May 2016).

Brooks, C. (2011), *Introductory Econometrics for Finance,* 2. edition, Cambridge.

Casimano, T. and Hakura, D. (2011), *Bank Behavior in Response to Basel III: A Cross-Country Analysis.* International Monetary Fund, IMF Working Paper, WP/11/119, available at: https://www.imf.org/external/pubs/ft/wp/2011/wp11119.pdf (accessed 17 May 2016).

Daley, J. and Matthews, K. (2007), *Measuring Bank Efficiency: Tradition or Sophistication?* University of West Indies, Cardiff Business School, available at: http://business.cardiff.ac.uk/sites/default/files/e2009_24.pdf (accessed 17 May 2016).

Duran, M.A. and Lozano-Vivas, A. (2015), *Moral Hazard and the Financial Structure of Banks*, Journal of International Financial Markets, Institutions and Money, Vol. 34, pp. 28–40, available at: www.sciencedirect.com/science/article/pii/S1042443114001231 (accessed 17 May 2016).

Fiordelisi, F., Marques-Ibanez, D. and Moyneux, P. (2010), *Efficiency and Risk in European Banking.* European Central Bank, Working Paper Series, No. 1211, available at: www.sciencedirect.com/science/article/pii/S0378426610003869 (accessed 17 May 2016).

Granger, C. (1969), *Investigating Causal Relations by Econometric Models and Cross-Spectral Methods*, Econometrica, No. 37, pp. 424–438, available at: http://links.jstor.org/sici?sici=0012-9682%28196908%2937%3A3%3C424%3AICRBEM%3E2.0.CO%3B2-L&origin=repec (accessed 17 May 2016).

Hays, F.H., Lurgio, S.A. de and Gilbert Jr., A.H. (2009), *Efficiency Ratios and Community Bank Performance*, Journal of Finance and Accountancy, No. 1, pp. 1–16, available at: www.aabri.com/manuscripts/09227.pdf (accessed 17 May 2016).

Holmstrom, B. (1979), *Moral Hazard and Observability*, The Bell Journal of Economics, No. 10, pp. 74–91, available at: http://www.jstor.org/stable/3003320 (accessed 17 May 2016).

Hsiao, C. (2007), *Analysis of Panel Data*, Vol. 34, 2. edition, Cambridge.

Hughes, J. and Mester, L. (2008), *Efficiency in Banking: Theory, Practice and Evidence.* Federal Reserve Bank of Philadelphia, available at: http://www.philadelphiafed.org/research-and-data/publications/working-papers//2008/wp08-1.pdf (accessed 17 May 2016).

Hurlin, C. and Venet, B. (2003), *Granger Causality Tests in Panel Data Models with Fixed Coefficients.* University Paris IX Dauphine, available at: https://www.researchgate.net/profile/Baptiste_Venet/publication/229050746_Granger_Ca usality_Tests_in_Panel_Data_Models_with_Fixed_Coefficients/links/5616442d08ae7327 96415e17.pdf/download?version=vtp (accessed 17 May 2016).

Jacques, K. and Nigro, P. (1997), *Risk-Based Capital, Portfolio Risk, and Bank Capital: A Simultaneous Equations Approach*, Journal of Economics and Business, No. 49, pp. 533– 547, available at: http://www.sciencedirect.com/science/article/pii/S0148619597000386 (accessed 17 May 2016).

Jensen, M. and Meckling, W. (1976), *Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure*, Journal of Financial Economics, No. 4 Vol.3, pp. 305– 360, available at: www.sciencedirect.com/science/article/pii/0304405X7690026X (accessed 17 May 2016).

Klein, N. (2013), *Non-Performing Loans in CESEE: Determinants and Impact on Macroeconomic Performance.* International Monetary Fund, IMF Working Paper, WP/13/72, available at: https://www.imf.org/external/pubs/cat/longres.aspx?sk=40413.0 (accessed 17 May 2016).

Koudstaal, M. and van Wijnbergen, S. (2012), *On Risk, Leverage and Banks: Do highly Leveraged Banks take on Excessive Risk?* Duisenberg school of finance, Tinbergen Institute Discussion Paper, available at: http://papers.tinbergen.nl/12022.pdf (accessed 17 May 2016).

Kumbhakar, S. and Lovell, K. (2004), *Stochastic Frontier Analysis,* 1. edition, Cambridge.

Louzis, D., Vouldis, A. and Metaxas, V. (2010), *Macroeconomic and Bank-Specific Determinants of Non-Performing Loans in Greece: a Comperative Study of Mortage, Business and Consumer Loan Portfolios.* Bank of Greece, Working Paper, No. 118, available at: www.sciencedirect.com/science/article/pii/S0378426611002895 (accessed 17 May 2016).

Messai, A. and Jouini, F. (2013), *Micro and Macro Determinants of Non-Performing Loans*, International Journal of Economics and Financial Issues, No. 4, Vol.3, pp. 852–860, available at: www.econjournals.com/index.php/ijefi/article/viewFile/517/pdf (accessed 17 May 2016).

Mirrlees, J.A. (1999), *The Theory of Moral Hazard and Unobservable Behaviour: Part I*, Review of Economic Studies, No. 66, pp. 3–21, available at: https://www.jstor.org/stable/2566946 (accessed 17 May 2016).

Nier, E. and Baumann, U. (2006), *Market Discipline, Disclosure and Moral Hazard in Banking*, Journal of Financial Intermediation, Vol. 15 No. 3, pp. 332–361, available at: www.sciencedirect.com/science/article/pii/S1042957306000179 (accessed 17 May 2016).

Niinimaki, J.-P. (2012), *Hidden Loan Losses, Moral Hazard and Financial Crisis*, Journal of Financial Stability, No. 8, pp. 1–14, available at: www.sciencedirect.com/science/article/pii/S1572308909000394 (accessed 17 May 2016).

Podpiera, J. and Weill, L. (2007), *Bad Luck or Bad Management? Emerging Banking Market Experience.* Czech National Bank, available at: www.sciencedirect.com/science/article/pii/S1572308908000120 (accessed 17 May 2016).

Reddy, K.S. (2011), *Management Behavior in Indian Commercial Banking*, International Review of Accounting, Banking and Finance, No. 3, pp. 70–92, available at: http://www.irabf.org/publication/4Management%20Behaviour%20in%20Indian%20Commercial%20Banks%20Kalluru%20Siva%20Reddya.pdf (accessed 17 May 2016).

Rime, B. (2001), *Capital Requirements and Bank Behavior:. Empirical Evidence for Switzerland*, Journal of Banking & Finance, No. 25, pp. 789–805, available at: www.sciencedirect.com/science/article/pii/S0378426600001059 (accessed 17 May 2016).

Rossi, S., Schwaiger, M. and Winkler, G. (2005), *Managerial Behavior and Cost/Profit Efficiency in the Banking Sectors of Central and Eastern European Countries.* Oesterreichische Nationalbank, Working Paper, No. 96, available at: https://www.oenb.at/dam/jcr:0c81fef8-c381-4dc8-a527-7462da792b43/wp96_tcm16-27319.pdf (accessed 17 May 2016).

Smidt, C. and Molbaek, J. (2006), *Competition in Nordic Retail Banking.* Nordic Competition Authorities, Report from the Nordic competition authorities, No. 1/2006, available at: http://en.samkeppni.is/media/skyrslur95-07/norraen_skyrsla_um_bankamarkadin_-_competition_in_nordic_retail__banking.pdf (accessed 17 May 2016).

Spence, M. and Zeckhauser, R. (1971), *Insurance, Information and Individual Action*, The American Economic Review, No. 61, pp. 380–387, available at: http://www3.uah.es/econ/MicroDoct/Spence_Zeckhauser_1971_Insurance_Information_Individual%20actions.pdf (accessed 17 May 2016).

Spong, K., Sullivan, R. and DeYoung, R. (1995), *What makes a Bank Efficienct?: -A Look at Financial Characteristics and Bank Management and Ownership Structure.* Federal Reserve Bank of Kansas City, Financial Industry Perspective, available at: http://www.kansascityfed.org/PUBLICAT/FIP/prs95-1.pdf (accessed 17 May 2016).

Tabak, B., Carveiro, G. and Cajueiro, D. (2011), *Bank Efficiency and Default in Brazil: Causality Test.* Banco Central Do Brasil, Working Paper Series, No. 253, available at: http://www.bcb.gov.br/pec/wps/ingl/wps253.pdf (accessed 17 May 2016).

Van der Westhuizen, G. (2013), *Bank Productivity and Sources of Efficiency Change. A Case of the Four Largest Banks in South Africa*, International Business & Economics Research Journal, No. 2, Vol. 12, pp. 127–138, available at: www.cluteinstitute.com/ojs/index.php/IBER/article/view/7625 (accessed 17 May 2016).

Williams, J. (2004), *Determining Management Behavior in European Banking*, Journal of Banking & Finance, Vol. 28 No. 10, pp. 2427–2460, available at: www.sciencedirect.com/science/article/pii/S0378426603002735 (accessed 17 May 2016).

Yeh, Q. (1996), *The Application of Data Envelopment Analysis in Conjunction with Financial Ratios for Bank Performance Evaluation*, Journal of the Operational Research Society, No. 47, pp. 980–988, available at: http://www.palgrave-journals.com/jors/journal/v47/n8/pdf/jors1996125a.pdf (accessed 17 May 2016).

Zhang, D., Cai, J., Dickinson, D. and Kutan, A. (2016), *Non-performing Loans, Moral Hazard and Regulation of the Chinese Commercial Banking System*, Journal of Banking & Finance, No. 63, pp. 48–60, available at: www.sciencedirect.com/science/article/pii/S0378426615003192 (accessed 17 May 2016).

APPENDIX

Table A.1: Multicollinearity test

Correlation Probability	CAP	EFF	LLP
CAP	1.000000		

EFF	0.022730	1.000000	
	0.6878	-----	
LLP	0.260213	-0.163285	1.000000
	0.0000	0.0037	-----

Table A.2: Heteroscedasticity test

Equation	Dependent variable	F-statistic	Prob. (F-statistic)
6	LLP resid. squared	4.97297	0.000005
7	EFF resid. Squared	4.095631	0.000074
8	CAP resid. squared	3.477984	0.000511

Table A.3: Fixed effects and Random effects

			Equation 6 (LLP)	Equation 7 (EFF)	Equation 8 (CAP)
Cross-section Random Effect		F-statistic	276,74674	41,12323	139,75272
		Probability	0,00000	0,00000	0,00000
Fixed effect	Cross-section fixed (dummy variables)	F-statistic	7,16918	1,24407	5,60172
		Probability	0,00000	0,18760	0,00000
	Period fixed (dummy variables)	F-statistic	0,51350	0,84841	11,73961
		Probability	0,79750	0,53440	0,00000

Table A.4: F-test for the number of lags

Equation	Number of lag included	1	2	3	4	5	6
(6)	F test value	350.56	154.43	86.73	219.30	220.24	171.43
	R-Square	0.79	0.79	0.79	0.94	0.96	0.97
(7)	F test value	3.92	2.32	2.38	5.20	10.80	13.15
	R-Square	0.04	0.05	0.10	0.27	0.55	0.72
(8)	F test value	410.40	211.13	176.47	171.63	99.81	69.67
	R-Square	0.82	0.84	0.89	0.92	0.92	0.93

Table A.5: Model main results

SUMMARY						***, **, * significance level 1, 5, 10%
	LLP		**EFF**		**CAP**	
INTERCEPT	0,010058	***	0,329229		0,02269	***
	3,289538		*0,691961*		*8,536503*	
LLP(-1)	0,322351	***	-3,212883		0,04705	
	4,726502		*-0,162299*		*1,17931*	
LLP(-2)	-0,171962	**	-7,345704		-0,053635	
	-2,412017		*-0,261616*		*-1,785048*	
LLP(-3)	-0,03406		-39,29914	*	-0,064566	
	-0,57871		*-1,748762*		*-1,966571*	
LLP total	0,116329		-49,857727	***	-0,071151	
	0,5152		*-4,133435*		*-1,188207*	
EFF(-1)	0,000425	**	-0,077323		-0,00091	***
	2,239498		*-1,107142*		*-3,059105*	
EFF(-2)	0,0000242		0,06265		0,000213	
	0,071295		*0,532441*		*0,945265*	
EFF(-3)	-0,0000795		0,384417		0,001241	
	-0,084649		*1,226338*		*1,546854*	
EFF Total	0,0003697		0,369744		0,000544	
	1,146378		*1,143548*		*0,600104*	
CAP(-1)	-0,078338		-7,667299		0,482068	***
	-1,020074		*-0,338966*		*7,26932*	
CAP(-2)	0,080132		24,09169		-0,053264	
	0,964175		*0,741031*		*-0,695598*	
CAP(-3)	-0,023343		-13,36449		0,153826	**
	-0,395416		*-0,647582*		*2,550609*	
CAP Total	-0,021549		3,059901		0,58263	***
	-0,567515		*0,305217*		*10,04243*	

Table A.6: Moral hazard test

***, **, * significance level 1, 5, 10%

Dependent variables: LLP

Bank with CAP smaller than sample median

	Coefficients		**t-statistic**
INTERCEPT	0.009309		5.26127
LLP(-1)	0.321246		1.573322
LLP(-2)	-0.172794		-1.05549
LLP(-3)	-0.033847		-0.415898
LLP total	0.114606		0.505986
EFF(-1)	0.000425	*	1.707867
EFF(-2)	2.40E-05		0.281938
EFF(-3)	-1.10E-06		-0.005228
EFF Total	4.48E-04		1.169353
CAP(-1)	-0.074323		-0.91302
CAP(-2)	0.082968		1.4272
CAP(-3)	-0.021782		-0.43199
CAP Total	-0.013137		-0.339734

Table A.7: Granger-causality test

Null Hypothesis:	F-Statistic	Prob.
EFF does not Granger Cause CAP	20.4609	6.E-12
CAP does not Granger Cause EFF	0.24196	0.8670
LLP does not Granger Cause CAP	2.07434	0.1048
CAP does not Granger Cause LLP	1.89974	0.1308
LLP does not Granger Cause EFF	5.79297	0.0008
EFF does not Granger Cause LLP	0.21854	0.8835