

**Lund University**  
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# Master Thesis

## The Impact of Credit Risk Management on Profitability of Nordic Commercial Banks

Master's program in Finance

by

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# **ABSTRACT**

This thesis investigates credit risk management in Nordic commercial banks and its effect on profitability. Two determinants of credit risk are chosen according to relevant literature, namely loan loss provision ratio and capital adequacy ratio. Thirteen banks in total are then investigated across the 16 year time frame from 2000-2015. The results seek to address two essential questions. Firstly, it seeks to capture the relation between credit risk management and profitability of Nordic commercial banks in the full data sample. Loan loss provision ratio is found to have negative effect on the performance of banks, while capital adequacy ratio presents mixed results. Second part of the thesis focuses on the financial crisis component, most notably its impact on the change in credit risk management. It is shown that macroeconomic environment plays a bigger role in the decrease in profitability after the financial crisis than credit risk management does.

**Key Words:** credit risk management, profitability, Nordic countries, commercial banks, loan loss provision, capital adequacy ratio

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## **Abbreviations**

<b>CAR</b>	Capital Adequacy Ratio
<b>CRM</b>	Credit Risk Management
<b>IRB</b>	Internal Ratings- based
<b>LLPR</b>	Loan Loss Provision Ratio
<b>NPL</b>	Non-performing Loan
<b>NPLR</b>	Non-performing Loan Ratio
<b>ROA</b>	Return on Assets
<b>ROE</b>	Return on Equity

# 1. Introduction

The past decades presented one of the most turbulent times for the banking industry. The primary objective of banks is to provide loans as it captures a large part of their income. The issue occurs when debtors cannot repay their loans, or in the worst case, these loans go default. It then depends on the financial situation of banks how to handle large default rates. In essence, pressure is on management to keep default rates low and be financially strong, in other words having a solid credit risk management. This leads to an assumption that better credit risk management should be advantageous for banks' performance. Nevertheless, findings on the effects of credit risk management profitability of banks widely differ and establishing such relationship has been more difficult than expected for many scholars.

The aim of the thesis is to evaluate the effect of credit risk indicators on profitability of commercial banks and compare how this relationship developed since the financial crisis. Researchers studying this topic either focus on the large market, mostly US and Europe, or small countries, mostly situated in Africa. One of the pioneers in CRM papers was Berger (1995) who studied US banks in 1980s. He found credit risk management, measured by capital adequacy ratio, to be positively related to return on equity. Erdinç and Gurov (2016) also examined a rather large market, more specifically European Union. Their study found positive effect of credit risk management not only on profitability but also on solvency of banks. Mixed results were provided by study conducted for UK commercial banks by Kosmidou, Tanna and Pasiouras (2005). According to their research, loan loss provision ratio has a positive and significant impact on net interest margin while having negative impact on ROAA. Studies focusing on smaller markets also possess contradicting results. Kithinji (2010) conducted a research on Kenyan banks and determined a neutral effect of CRM on banks' performance meaning profits were not affected by the increase in credit risk. In contrary, completely different result was provided by Noman, Pervin and Chowdhury (2015) who in their study examined commercial banks in Bangladesh. Their results showed a negative and significant association between CAR and ROE.

To the extent of my knowledge, no such research has focused on the Nordic market. Bearing this in mind, it is of utmost interest to determine if and to what extent is performance of Nordic commercial banks susceptible to their credit risk management. As such, this thesis aims to fill the gap in the relevant literature not only in the market sample but also in the methodology of the research. While some studies omit some credit risk indicators or some

control variables, I will try to integrate all relevant measurements for the successful results. In this manner, the relationship between credit risk indicators and profitability measures will have been established by the end of this thesis. I further contribute to this research area by comparing how this relationship has changed from pre-crisis period to a post-crisis period. No study has conducted such approach to the extent of my knowledge. The beneficiaries of such study can be managers, banks and regulatory institutions. More than that, by evaluating impact of regulations on profitability of banks, the results can determine if much more regulated banking sector can decrease commercial banks' profitability. Taking into account that Nordic market has produced the lowest default rates in Europe it will be interesting to evaluate how the results compare to other larger and smaller markets.

This paper is divided into several sections. Section 2 will describe background of the general topic as well as overall situation in the banking industry after the financial crisis. It will then focus on the development of the Nordic banking sector, more specifically non-performing assets distribution across Nordic banks compared to the rest of Europe. The last part will specify main regulations that have been put in place and are a big factor in the banking development. The following section will address relevant academic articles in two instances. First, the importance of credit risk management will be discussed from the overall perspective. Secondly, variety of studies with a specific focus on profitability and credit risk management will be discussed in depth. Section 4 will focus on the regression itself with the emphasis on the data collection, choice of variables, and methods of the model. Thorough analysis of all empirical results will be captured and discussion will also be provided. Last section will cover conclusion focusing on the explanations of the whole thesis, contribution to the topic and possible further research to be implemented.

## 2. Background of the Banking Sector

This section will provide an overview of the banking sector in the post-crisis period. To specify the market of this thesis, history and characteristics of Nordic banking industry will be thoroughly described. Last part of this section serves as an insight to current state of banks as it specifies regulations that have been put in place in the last decades.

### 2.1 Banking Sector after Crisis

The introduction part has outlined some issues the banking sector has experienced after the financial crisis had started. Few consequences that the lay public is mostly familiar with are worsened available credit to consumers, frozen lending, and defaulted loans. This study will look closely on the last one mentioned and that is credit risk management. The most widely used proxy for credit risk management is the percentage of non-performing loans in banks' portfolios. To get a little perspective behind the issue, the post crisis numbers (of NPL ratio) in two big economies shall be compared.

#### **Figure 1: Evolution of nonperforming loans in EU and US (Peterson Institute for International Economics, 2016)**

This figure present trend analysis of nonperforming loans and its difference between two large markets: USA and EU. The time frame of the graph is from 2005-2015 while the significant point is between 2008 and 2009 as it demonstrates the financial crisis.

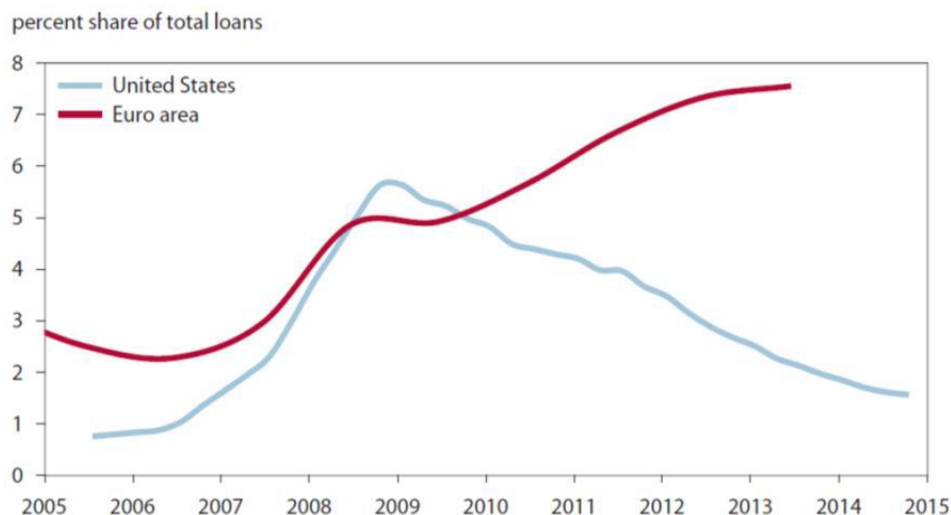


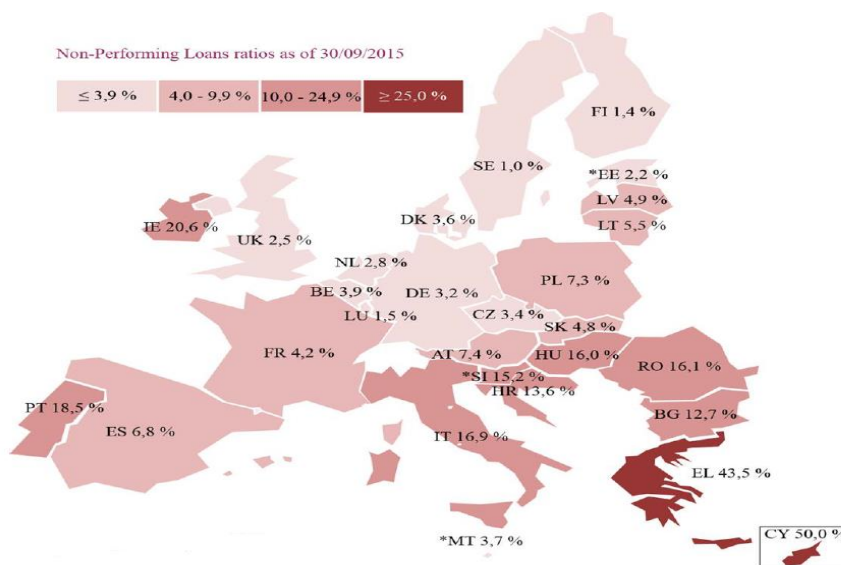
Figure 1 shows the trend of non-performing loans from 2006 to 2014 in two developed economies- Euro area and the United States. Both economic areas were not able to slow down the increasing trend from 2006 to 2009. From that point on, however, both areas went the opposite direction. While 2009 was a turning point for the United States and NPLR has been decreasing each year since, the Euro area was experiencing a different situation. It looks

worrisome as this trend in Europe continued well after the crisis and the recession. This trend has changed in the recent past as the average rate of non-performing loans for Euro area was 5.9% as of September 2015. At the same time when compared to other major developed countries, both Japan and the US had their ratio of NPL lower than 2% at the end of 2015 (Economic Governance Support Unit, 2016).

Based on the previous analysis, disparity of defaulted loans in the world economy is undeniable. Looking into the Euro area state by state, it is surprising how the amount of NPLs cluster in different regions. As demonstrated in figure 2 below, the dispersion of NPLR among EU countries is high, especially when comparing southern and northern parts. Not even considering Greece and Cyprus which had their own issues, the southern region consisting of Hungary, Croatia, Bulgaria, Romania, and Portugal reported NPLR above 10%. On the other hand, Scandinavian countries (Denmark, Sweden, Finland) report ratio below 4% which is comparable to those of other major developed countries. This seems as an interesting paradox which will be analyzed through in the next sections as this thesis focuses on Scandinavian banks. It will be discussed why is the NPLR so small in aforementioned countries and also what impact it has on profitability on the commercial banks (Economic Governance Support Unit, 2016).

**Figure 2: Distribution of loan losses in EU (Economic Governance Support Unit, 2016)**

This figure presents the distribution of nonperforming loans across countries in EU. It shall signify the disparity across regions, especially south and north areas.





## 2.2 Recent History of Scandinavian Banking Sector

As touched upon in the previous section, different countries across EU perform differently in terms of credit risk management. Nordic sector is very homogenous in terms of NPLR having the lowest ratios in all of Europe. Thus it is of great importance to demonstrate policies and background of the Nordic banking history.

Nordic sector comprises of four countries Denmark, Finland, Norway, and Sweden. All of these countries but Denmark experienced a severe banking crisis in the early 1990's. Especially loan losses of these countries had increased rapidly in a short period of time, as shown in the table 1 below. The whole issue started with the deregulation of the banking sector which led to a rapid expansion in credit. Finland and to some extent Sweden even dealt with huge capital inflows due to the interest rates being higher than in neighboring countries. This led to an increase in information asymmetry and the impact on defaulted loans was substantial, as shown in table 1. Regulations were, on the other hand, much stricter for Danish banks than for those in other Nordic countries leading to less information asymmetry. Therefore Denmark can be excluded from the rest of the Nordic group for this specific banking crisis (Honkapohja, 2009).

**Table 1: Loan losses in Scandinavian banks in the early 1990's (Anderson, 2009)**

This table describes development of nonperforming loans in Nordic banking sector during the crisis period.

Country	1989 (1987 for Norway)	1992 (1991 for Norway)
Finland	0.5 %	4.7%
Sweden	0.3%	7%
Norway	0.7%	6%

According to Anderson (2009), the way with which this crisis was handled should be among the most successful resolutions in history. Honkapohja (2009) selects three crucial aspects that were behind this resolution. First, creating a crisis resolution agency such as Bankstödsnämnden BSN in Sweden provided same opportunities for all banks to receive public support. Secondly, restructuring was achieved via mergers and acquisitions, mostly in Norway and Finland. This strategy succeeded in terms of troubled banks being merged into healthier banks and thus preventing liquidations of those banks. Third, transparency of

support actions were crucial in a public eye. For instance, supporting both debt-holders and equity holders was of utmost importance, although debt-holders were taken care of first.

## 2.3 Characteristics of Scandinavian Banking Sector

The Nordic 4 are through its shared history a very close group with similar economic, political and social profile. Agarwal et al. (2013) describes the ‘Nordic model’ as their common approach focusing on financial openness and improved trade.

Since many positive similarities can be found among these 4 countries, same notion should apply to risks as well. First, although financial openness providing benefits for the country, spillovers coming from such openness can be harmful to a large extent. Especially in case some shock or crisis hits, it might be a suspect to spread across banks easily. Furthermore, risks are mostly concentrated in one area, Sweden. This is due to the fact that most large banks in the region have parent bank residing in Sweden. For instance, subsidiaries of Swedish bank Nordea which are located in Finland and Denmark are both larger in size than their parent bank in Sweden (Agarwal et al., 2013).

Second risk is also related to crisis but now it regards the potential severity of it due to large size of banks. Larger banking system can be seen in the amount of publicly-listed assets of banks. In Nordic region, these types of assets are on average almost 400 percent of GDP. As a consequence, the banking sector can be vulnerable and exploited due to its size (Agarwal et al., 2013).

Another type of risk common across these 4 countries is the certain type of funding which takes places across Scandinavian banks. This type of funding is a wholesale funding which again can be very beneficial if used under the stable conditions but due to the intra- linkage of Nordic economies can be harmful as well (Agarwal et al., 2013). The most common source of funding for banks is retail deposits which is long-term in its nature, while wholesale funding is usually short-term oriented. This combination can in times of credit crunch be devastating for banks. As Nordic banks are heavily reliant on wholesale funding, it increases their risk overall (Brown, 2017). Based on the analysis of the risks shared in the Nordic region it is clear banks in these 4 countries are very interconnected and share common risks which supports the idea to analyze this region as a whole.

## 2.4 Regulation of the Banking Sector

The introduction of the thesis has outlined types of risks banks have to face regularly. These risks, however, have to be regulated either internally by banks or externally by institutions with the power to do so. First of such regulations was done to ensure the stability of the banking sector, it was labeled as Basel Capital Accord (Basel I). Its main focus was to set a limit for the amount of capital the banks were supposed to keep in their reserves. The ratio of this minimum capital compared to risk-weighted assets was set to be at least 8%. This regulatory measurement basically forced banks to cover their risks with the funds they have and not with what they do not have. However, the definition of the own fund was not that clear which was later specified by the introduction of Basel II. The Basel II is composed of three significant pillars which are highlighted in table 2.

**Table 2: Basel II Pillars (Bakicaol et al., 2017)**

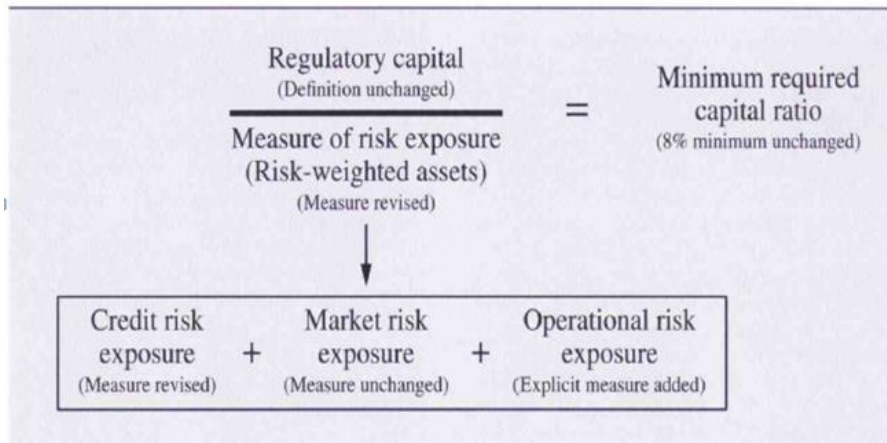
This table describes biggest changes required by Basel II accords. They are organized into three pillars for a better comprehension.

Pillar 1	Pillar 2	Pillar 3
<b>Minimum Capital Requirements:</b> <ul style="list-style-type: none"> <li>• Risk management incentives</li> <li>• New operational risk capital charge</li> <li>• Risk weighted assets (RWA) for credit more risk sensitive</li> <li>• Market risk largely unchanged</li> </ul>	<b>Supervisory Review:</b> <ul style="list-style-type: none"> <li>• Solvency reports</li> <li>• Regulatory review</li> <li>• Capital determination</li> <li>• Regulatory intervention</li> <li>• Addresses risks that are not captured in Pillar 1 like concentration, interest rate, and liquidity risks</li> </ul>	<b>Market Discipline:</b> <ul style="list-style-type: none"> <li>• Minimum disclosure requirements</li> <li>• Scope</li> <li>• Capital transparency</li> <li>• Capital adequacy</li> <li>• Risk measurement &amp; management</li> <li>• Risk profiling</li> </ul>

Under Basel II, the minimal capital requirement remains unchanged but the way of calculating risk-weighted assets is slightly adjusted. This is highlighted in table 3 as the calculation of credit risk presents the most distinguished change since Basel I. Basel II distinguishes three methods for a credit risk measurement. The first and the least sophisticated is the standardized approach (STA). It does not require banks to assess risks of their portfolio on their own. The other method is based on internal ratings; the Internal Rating-Based (IRB) approach which allows banks to use their own internal ratings to assess risk. Compared to STA, banks can save capital and use it for other business activities making this approach very appealing to bank managers. There are two ways to use the IRB: the basic and advanced approach. They differ in the way that weights are assigned to capital requirements and to risk.

**Table 3: Capital ratio under Basel II (Roger & Ferguson, 2003)**

This table outlines biggest changes in the calculation of minimum capital ratio as required by Basel II Accords.



That is where Basel III accord comes to place. Its main focus is on capital requirements for banks as well as stating new rules to prevent another crisis. While it is considered a completely separate accord in numerical order, this third Basel continues on the idea of Basel II with much more focus on capital ratios and its stricter calculations. (Feess & Hege, 2012).

Hull (2015) in his book identified six essential parts of Basel III: capital definition and requirements, capital conservation buffer, countercyclical buffer, leverage ratio, liquidity ratio, counterparty credit risk.

As mentioned before, the first part regarding capital requirements is the most distinctive one. The definition of total capital has been changed as it must include Tier 1 and Tier 2 capital. Tier 1 capital must include common equity and additional Tier 1 capital and in total Tier 1 must be at least 6% of risk-weighted-asset constantly. Total capital (Tier 1+ Tier 2) must be at least 8% of risk-weighted-assets at all times (Hull, 2015).

Second part of the new Basel accord is established for periods of stress. To be able to survive during these periods, banks should accumulate capital conservation outside of stressful periods. On the other hand, countercyclical buffer aims for banks to take macro- financial aspects into consideration when setting capital requirements. To prevent the accumulation of leverage in the banking industry as it happened during the crisis, Basel III introduces non-risk based leverage ratio. To ensure banks would have enough liquidity for 30 days of significant stress period, liquidity coverage ratio and net stable funding ratio are introduced. The last part of the third Basel is established in case of default by the counterparty and reduction of

counterparty credit risk (BCBS, 2011). It is essential to note all these parts of Basel III should and are being implemented from January 2014 until 2018 (Vlad, 2016).

### 3. Literature Review

While the preceding paragraphs were to highlight key changes in the banking sector, the following section narrows it down to a more specific topic. The most relevant articles to date relating to CRM overall, its relationship with efficiency, profitability, leverage, etc. will be investigated thoroughly. This section in turn serves as a bridge between two pillars providing academic sense behind the topic, its results and impact on future research. In addition, the bundle of such literature leads to certain expectations for the outcomes of this thesis making it comparative across various articles. More than anything, variety of CRM articles can provide such a needed basis for an inexperienced reader who may not be familiar with the banking sector, for instance. Ultimately, providing not only results but also holes in the existing articles justifies the need and purpose for thesis such as this one.

#### 3.1 Importance of credit risk management

Commercial banks, just like any other institution, battle with different types of risk on a daily basis. Van Gestel and Baesens (2008) identify three main risks of banks: operational risk, market risk and credit risk. In terms of the potential amount of losses, they further argue, credit risk being the largest of the three. The importance of CRM has been further elaborated in many recent studies. Some studies even attribute bad CRM of commercial banks as one of the factors for the global financial crisis. For instance, Chaplinska (2012) analyzes Latvian commercial banks in a wake of crisis. During this period of time, she observes that volume and quality of credit portfolios decrease rapidly. This in her estimation is a result of inefficient management of credit risk in Latvian banks. In addition, this credit crunch leads to a destabilized economy causing a vicious circle between the banks and a state. When the stability of economy is in question, assessment of creditworthiness becomes very difficult for banks. One, they are afraid of larger losses in the volatile economy more than in the stable economy. Secondly, assessment models of the potential borrowers are harder to identify in the bad-performing economy. Essentially, this squeeze in providing loans may cause a credit crunch causing economy to be even more destabilized and unpredictable. As a result, management of credit distribution and credit risk are as essential for banks as they are for the economy of the country.

Mileris (2012) observes the rise in defaulted rates in 22 EU countries and tries to point out causes of such trend. He observes various macroeconomic indicators and confirms a

significantly positive relationship between the economic situation in the country and credit risk management in banks. Thereinafter he discusses that it is possible to predict the amount of the defaulted loans in the future based solely on the macroeconomic measurements. These findings signify the role that the economic environment plays in the distribution of nonperforming assets in the banking sector. Bearing this in mind, economic state of affairs has to be accounted for when conducting research on credit risk management in banks.

In terms of the overall banking sector, Naceur and Kandil (2009) question regulatory incentives by financial institutions and its necessity in the banking sector. The idea of such regulations, as these authors argue, is to stabilize both the banking and economic sector. It is especially important at times of crisis to prevent large credit losses on the books of banks. The authors of this article however argue that too many regulation policies might have the adverse impact on the performance of the banking sector. Profitability can be in question as high regulations can increase intermediate costs of banks which in turn reduce their profitability. In addition, regulations regarding the amount and methods of providing credit to borrowers can cause certain banks to be credit constrained. This not only decelerates growth of the banking industry but has an undeniable impact on the growth of the entire economy.

Erdinç and Gurov (2016) conduct their research in a way that corresponds with the aforementioned increased regulation in the banking sector. In essence, the first part focuses on Basel II regulations and its effect on the amount of non-performing loans. The underlying notion is to compare the intensity of implementing IRB (internal-ratings based) in each European country and the impact it has had on credit risk management. Their results confirm that higher usage of IRB standards directly lead to a decrease in the amount of non-performing loans in banks. Given these results, it might be suggested that more regulated banking sector shall lead to a decrease in default rates and thus better provide control of risk in banks.

### 3.2 Impact of CRM on profitability of banks

Conventional notion about credit risk management has changed drastically over the last decades. With more papers being focused on CRM, scholars and professionals have contributed to the increasing interest from both regulators and banks. One of those breakthrough research papers in this topic was Berger's (1995) article focusing on the relationship between CRM and earnings in the US banking sector in the 1980's. At the time of writing this paper, the general wisdom was that capital-adequacy ratio, being the proxy for

CRM, leads to lower return on equity. One way to justify this rationale was that CAR reduces expected ROE that is required by shareholders by reducing the risk of shareholder's equity. This and more arguments were in favor of a negative relationship between CAR and ROE. In contrast, research done by Berger (1995) showed positive relationship of these two measurements, both economically and statistically. His arguments for such different results were related to the relaxation of some assumptions in his study. Most notably, the assumption of symmetric information along with perfect capital markets was relaxed as well as the one-period model was changed leading to increased earnings. Relaxing the assumptions of perfect capital market and symmetric information reduces the costs, whether it is through lower bankruptcy costs in times of financial distress or easier transformation of information about banks' earnings. Nevertheless, the author himself admits that the results may not hold in the future as he (rightfully so) expects more regulated banking sector in the future. In addition, his data contained only US banks in a much deregulated banking sector in 1980's thus not adequately mirroring today's situation.

Turning to European banking sector, paper written by Erdinç and Gurov (2016) proved several benefits of a better management of nonperforming loans. Their arguments start efficient credit risk management being a significant factor in avoiding the situation of banking distress. Due to banks' healthy financial position, management can focus its work on the operations of banks rather than on solving the financial distress position. The authors then argue and empirically that decrease in the amount of nonperforming assets affects profitability and solvency of the banking sector in a positive way.

Kosmidou, Tanna and Pasiouras (2005) also conduct their study on the European market, mainly for UK commercial banks. Their focus was not only CRM but also other determinants of bank profitability. While capital strength affects banks' profits positively, management efficiency and bank size produce a negative impact on the profitability of UK banks. Two other factors present very mixed results. Firstly, liquidity measurement produces different results depending on different profitability indicators. Secondly, the proxy CRM measure called loan loss reserve ratio possesses positive effects on net interest margins (NIM) and negative impact when comparing against ROAA (return on average assets).

Naceur and Kandil (2009) studied actions taken by the Central Bank of Egypt to regulate the banking sector. More concretely, the specific aim of the paper was to establish a relationship between capital regulations and banks' performance. In essence, this study confirmed the



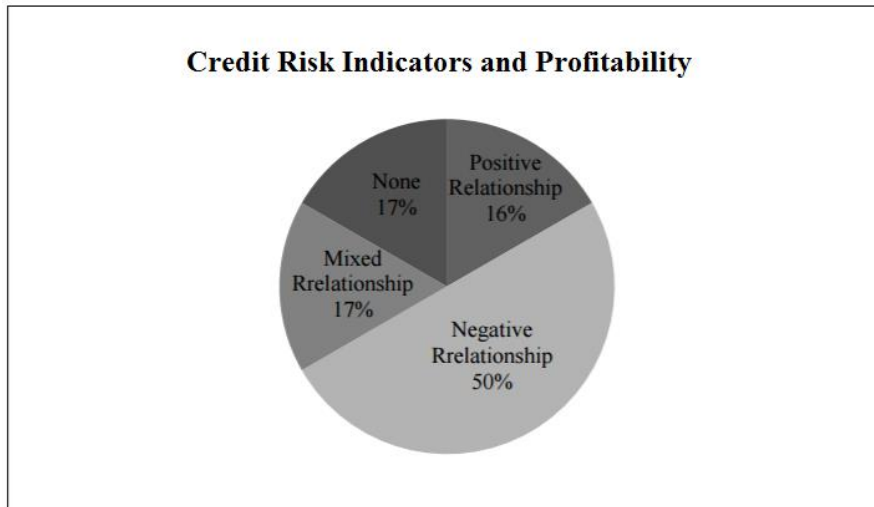
results of Berger's (1995) research in the way that higher CAR positively affects ROA and ROE through a higher cost of intermediation. Several other aspects were evaluated to give more specific answers behind this relationship. First of all, the bank-specific variables such as efficiency of the management, bank size or higher intermediary costs cause bank's profitability to go down. From the macro perspective, inflation and output growth are among the most influential factors of banks' stability. The post-regulation period also shows certain factors being very positive for banks' success, such as increased management efficiency or stricter capital requirements. As a result, this study claims a positive effect of regulations in the banking sector.

Another paper with emphasis on the smaller market is a research conducted by Muhamet and Arbana (2016). Unlike the preceding paper, their focus is on the European country, namely Kosovo. The methodology is organized in a way that corresponds to previous literature. Most notably, the ratio of nonperforming loans is used as a primary proxy for credit risk management. The second proxy is a risk asset ratio giving the opportunity to compare results between the individual measures. The findings of the research are mixed as the collected data do not present many observations. Thus each bank in the study presents different results.

Kurawa and Garba (2014), on the other hand, focused their research on Nigerian banks. Besides traditional measures (default rate, and CAR) this study introduces another proxy for CRM called cost per loan (CLA). The outcome of the paper provides evidence in the positive relationship between CRM and profitability of banks. Another contribution that this paper provides is in mapping out recent relevant literature and putting it into perspective. Figure 3 below presents results of several articles and groups it into four groups. Half of the studies, according to Kurawa and Garba (2014), produce negative relationship between credit risk measurements and profitability indicators. Essentially, this means a positive relationship between credit risk management and performance of banks. Rest of the studies presents mixed results, no results, or negative association between CRM and profitability of banks. This chart leads one to think there are either gaps in the research methodology or the banking sector differs drastically across countries as academics have not been able to come up with generalizable findings.

**Figure 3: The Percentage distribution of outcomes of relevant studies (Kurawa & Garba, 2014)**

In this figure, relevant studies on the relationship between CRM and profitability are summarized into a graph. It serves for a better comprehension of different results being not conclusive.



Based on the previous analysis of the existing relevant literature, it is of highest belief of the author of this thesis that CRM topic can be improved upon. First of all, most studies in this field have been focusing on USA, Europe, or Africa. European study by Erdinç and Gurov (2016) that has been analyzed in depth in previous paragraphs focuses on overall European sector. However, it is hard to comprehend that such study can generalize these results across all areas of Europe. As was outlined in the background section, the differences of credit risk management in different regions are astronomic. Thus the focus of this thesis will be on one specific area, more specifically Nordic countries. Hence, a comprehensive dataset along with a large sample period allows for contribution to the existing research.

## 4. Methodology

The following section turns its focus on the methodology that is appropriate for answering the research question. First, motives behind data collection are described followed by the characterization of the variables that were deemed the most appropriate to answer our hypothesis. Last subsection will determine the hypothesis of presented thesis and the regression estimation.

### 4.1 Data Description

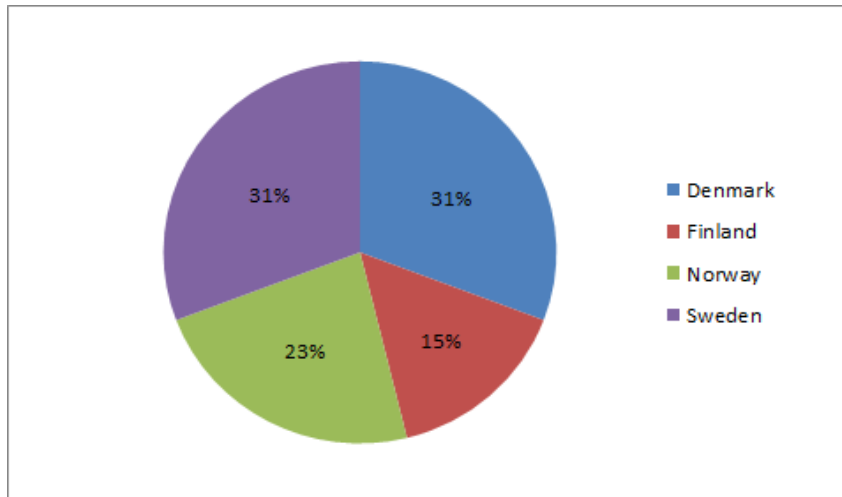
Data of this study were collected from database called Datastream. They are composed of 13 commercial banks in four Nordic countries: Denmark, Finland, Norway, and Sweden. Bank distribution for each country in the sample is provided in figure 4. It is a yearly data in the time frame of 2000-2015 which results in total of 186 observations. This time frame was put in place to have a sufficient time period to capture the effect of credit risk management for the pre- and post- crisis period in Europe (2009). Thus the type of data used for this study is a balanced panel dataset. The advantage of it compared to two other types (cross-section, time-series) has been highlighted by Hsiao (2007). In his paper, the number one benefit of using the panel dataset is said to be efficient econometric estimates. This is done because this type of dataset allows a researcher to use large amounts of data points which increases the degrees of freedom and in turn causes a reduced collinearity between independent variables (Hurlin & Venet, 2003). Another advantage compared to cross-section and time-series data sets is that panel dataset addresses important questions that other data sets are not capable of doing (Hsiao, 2007).

### 4.2 Variables

The data described above have been collected for several variables. These are grouped into the three types: dependent, independent, and control variables. Each variable will be carefully evaluated and discussed.

#### Figure 4: Bank distribution in the data sample

This graph represents the distribution of relevant banks in this study's sample. Four countries are given a percentage value based on the number of commercial banks being included in the study. Denmark and Sweden represent two thirds of the sample.



#### 4.2.1 Proxy Measures of profitability

The performance of the banking industry has been a large topic discussed in the prior research. Recent financial crisis has demonstrated how the banking sector is so important in every economy. As Athanasoglou, Brissimis and Delis (2005) point out stability of the financial system is dependent on the banking sector that is profitable, which applies especially during periods of negative shocks. Thus it is obvious that there exist many stakeholders (academics, investors. etc.) interested in the performance of banks. Most of the academics use the same two proxy indicators for bank performance- return on assets (ROA) and return on equity (ROE). Adefeya et al. (2015) define ROA as a measure of utilizing the bank's assets to generate profit. They argue transactions that are not included on balance sheet may cause bias of this measure. On the flipside, their definition of ROE quantifies profits made by shareholders given how much equity was invested in a bank (Adefeya et al., 2015). It has been shown that operating asset ratio such as ROA is higher if a bank chooses a higher equity structure (low leverage level). Operating equity ratios (ROE), on the other hand, perform worse with such debt structure in banks. This can be explained by ROE not taking into account the amount of risk associated with leverage. Thus ROA is considered as the most informative indicator for bank profitability (IMF, 2002). This statement is backed off by Hassan and Bashir (2003) who go as far as stating that ROA is preferred by most regulators. ROA is calculated as the ratio of net income to total assets, reflecting bank's ability to generate profits given the amount of assets they possess. ROE will be calculated by

dividing earnings by total equity, showing to shareholders how much income the bank generates on their equity.

#### 4.2.2 Proxy Measures of credit risk management

Due to the unavailability of data and different methods preferred, researchers use a variety of independent variables to measure credit risk. The most accurate measure and also most widely used across articles has been NPLR (non-performing loans ratio). Its accuracy rests in a direct incorporation of loan losses. More than that, it indicates how effective the management is in managing credit risk in banks because it determines the ratio of loans that have defaulted or are close to being default to the total loans. In addition, Noman, Pervin and Chowdhury (2015) emphasize that lower NPL ratio is the evidence of lower amount of loans being doubtful which in turn means a lower credit risk. This signifies the importance of NPLR as a CRM proxy.

In case of unavailability of data for nonperforming loans, researchers use a proxy indicator for measuring the default rate. Altunbas and Marques (2008) confirm this notion by concluding that several European countries do not provide information on non-performing loans. In their paper, a possible proxy to use as a measure for the estimation of credit risk is the loan loss provision compared to total loans, or loan loss provision ratio (LLPR). It is the provision that is set aside in case of defaulted or uncollected loans. In other words, provision represents the reserved amount of money that the bank assumes is going to lose on bad loans which in turn accurately assesses the financial position of the bank. The intent of the thesis was to use non-performing loans as a credit risk management proxy measure. However, due to the unavailability of data for this variable, loan loss provision ratio is used instead. As Podpiera and Weill (2007) point out it might be that LLPR is less relevant due to the fact that bank's management has influence on loan loss reserves. On the other hand, other researchers such as Rossi, Schwaiger and Winkler (2015) find significance of using such measure in terms of management's performance. Whether LLPR is relevant or not will be estimated in the empirical results section. The calculation of this ratio is will be calculated by dividing a loan loss provisions by the total amount of loans.

Another measure frequently used in many research papers is capital adequacy ratio (CAR). Noman, Pervin and Chowdhury (2015) motivate its use as a credit risk indicator in the sense that higher CAR indicates higher asset quality which in turn means lower credit risk for a bank. Another reason CAR is used as a proxy for credit risk management is Bhavani and

Bhanumurthy (2012) define it as one of the two measures (along with NPLR) to determine the soundness of the banking system. Capital adequacy ratio (CAR) puts regulations on capital requirement and it is a ratio of (tier 1+ tier 2) capital to the percentage of risk-weighted- assets (RWA). This calculation is based on the previous literature and is mandatory due to Basel regulations.

#### 4.2.3 Control Variables

Kosmidou, Tanna and Pasiouras (2005) identify two kinds of influences on bank profitability; internal and external. They further describe external factors as being the ones that management has no control over, e.g. economic growth, inflation, interest rates, etc. They distinguish internal factors as being the ones that management can control, for instance liquidity and capital adequacy, so the ones that can be directly impacted by management's action. Kosmidou, Tanna and Pasiouras (2005) conclude that although internal factors explain banks' profitability almost fully, external factors also contribute to the influence on profitability as well.

#### Bank specific factors

Notwithstanding credit risk, several authors agree on certain bank- specific aspects that affect profitability. Significance of efficiency of management, capital strength, and size of banks is supported by several studies (Staikouras & Wood, 2011; Kosmidou et al. 2005; Petria, Capraru and Ilnatov, 2015). Cost per loan or (CLA) has been used mostly as an indicator of the efficiency with which management distributes its loans to borrowers. For instance, Kolapo, Ayeni and Oke (2012) find significance of using this ratio (CLA) as a CRM proxy as it highlights how efficient the banks are in loan distribution to customers. More importantly, Athanasoglou, Brissimis and Delis (2005) discuss that although there are various costs when it comes to banks, only type of costs- operating expenses, are a true indicator of management's actions. It will be calculated as a ratio of operating expenses divided by total amount of loans and its expected sign is negative. Capital strength, as one of the aforementioned factors, is already included in the regression under capital adequacy ratio. Therefore, there is no need to control for capital strength of banks twice. As of bank size factor, most studies use a logarithm of banks' total assets. As the relationship has proven to be significant across several articles, the log of total assets will be included as a control variable. Based on other research papers, the expected relationship of bank size with performance measures is positive.

## Macroeconomic Factors

In relation to external factors, Kosmidou, Tanna and Pasiouras (2005) evaluate small impact of such variables on banks' performance. This supports the results from the previous relevant literature in the sense that internal factors are more explanatory in explaining bank performance. However, some macroeconomic variables are still significant in relation to banks' profitability. Most of them vary study by study but most of studies such as Staikouras and Wood, (2011), Kosmidou, Tanna and Pasiouras (2005), Petria, Capraru and Ihnatov (2015) have one variable that is significant in common. That variable is real GDP annual growth rate of the economy. So as research is pretty consistent with this one, it will be used as a macroeconomic control variable. It is expected that GDP variable will have a positive effect on profitability. All variables, their calculation and expected sign in the regression are summarized in the table 4 below. This serves as a better overall view on what to expect from the analysis of this thesis.

**Table 4: Variables and Expected signs**

This table summarizes each variable used in this thesis. It also highlights calculation and the expected sign for the regression results of each variable.

	<b>Variable Name</b>	<b>Calculation Method</b>	<b>Expected Sign</b>
<b>Dependent Variables</b>	ROE	Net Income/Total Equity	
	ROA	Net Income/ Total Assets	
<b>Independent Variables</b>	LLPR	Loan Loss Provision/ Total Loans	-
	CAR	Total Capital/ Risk Weighted Assets	+
<b>Control Variables (bank- specific)</b>	Cost per Loan	Total Operating Cost/ Total Loans	-
	Bank Size	Log Total Assets	+
<b>Control Variable (macroeconomic)</b>	GDP Growth (real)	% annual change	+

### 4.3 Regression Analysis

Now that all the variables have been explained and analyzed thoroughly, the hypotheses of this study can be presented. There are four separate hypotheses due to the inclusion of 2 dependent variables. First pair of hypothesis will test if credit risk management positively affects profitability of Nordic commercial banks. Following the results of relevant research, the expectations are that this relationship is positive. The question will be how strong the relationship is and whether it is negligible compared to, for instance, economic factors. Second pair of hypothesis will be related to global financial crisis more specifically the focus will be on the year 2009. As Erdinç and Gurov (2016) pointed out, the Eurozone crisis covered the period from 2009 to 2011. Considering the data at hand, there is a considerable amount of data for both the pre and post- crisis period. Thus the sample will be divided into two sub-periods: pre-crisis (pre- 2009) and post-crisis (post-2009). This method gives an opportunity to evaluate the impact of crisis on the CRM impact. The expectations of this hypothesis are hard to predict as no other study has done similar research. Nevertheless, the expectations are that the relationship between CRM and profitability has grown in strength post-crisis.

In order to test the hypothesis with the (dependent and independent) variables analyzed in previous sections, regression has to be structured to statistically prove any relationship between variables. Since this study uses variety of variables across many years in time, there will be three panel data methods used: pooled regression, fixed effect and random effect. First off, the regression equation will be written as following:

$$Y_{it} = \alpha + \sum \beta_n X_{nit} + \epsilon_{it}$$

Where:

$y_{it}$  – the dependent variable

$x_{nit}$  - independent variables

$\alpha$  - the intercept

$B_n$  - coefficients of the regressors

$\epsilon_{it}$  - the residuals

Subscript ‘i’ represents cross- sectional unit  $i= 1, 2, \dots, N$ , while subscript “t” denotes time periods with  $t=1, 2, \dots, T$  (Baltagi, 2011).

First option, as outlined in previous paragraphs, of estimating the panel data is a pooled regression. The idea is to pool all 186 observations and run the regression model neglecting



the cross- section and time series nature of data. Although the technique is quite straightforward, it brings a major downside with it. The problem with this model is that it does not distinguish between the various banks thus denying the heterogeneity that may and should exist among them. According to Forssbäck (2015), there are two different types of models with error components that allow for cross- sectional heterogeneity: random effects model and fixed effects model.

The fixed effects model allows each cross-sectional unit to have a different intercept while at the same time it is time invariant, meaning it does not vary over time. On the other hand, random effects model, or the error components model, uses different intercepts for each cross- sectional unit and they are time invariant, which is the same as in the fixed effects model. However, the difference is that in the random effects model, all these intercepts for different units have a common mean value that they arise from (Brooks, 2014).

In order to determine whether to use the random or the fixed effects model, the Hausman- Test is in disposal. Hausman- Test, among other things, tests the validity of the random effects model thus showing if performing the fixed effects model instead is necessary (Brooks, 2014). Thus Hausman- Test provides a statistically significant P- value, the fixed-effects model shall be used, otherwise the random- effects model will be used. By analyzing relevant literature it is possible to highlight further tests which have to be accounted for. Multicollinearity and heteroscedasticity in particular have been present in some studies and are advised by authors to be aware of them.

## 5. Empirical Results

This section is organized into four main blocks beginning with the simple descriptive statistics. These are organized in a way to highlight changes of variables from pre- to post-crisis, which then serves as a basis for the further analysis. Next subsection is dedicated to multicollinearity and heteroscedasticity tests to ensure the data do not violate assumptions of OLS. Afterwards, main regression results are presented and analyzed in depth as to discuss the individual effects of variables as well as evaluate comparisons of results to those from other relevant studies. To end this section, the data sample is divided into two sub-periods to analyze how financial crisis has changed this relationship between CRM and profitability of Nordic commercial banks.

### 5.1 Descriptive statistics

The following section addresses situation in the banking industry and how it has changed since the financial crisis. Table 5 provides descriptive statistics to highlight the biggest changes from pre- to post- crisis period. With results at hand, there are few points to be addressed. First point is in relation to differences in the banking sector performance from pre-crisis to a post-crisis period. Unsurprisingly, Nordic commercial banks have experienced lower profitability since 2009. The reasons can be decomposed into few points. On one hand, recession in these economies leads consumers to be more cautious towards taking on more debt which in turn pushes banks to lower interest rates in order to make up for losses. Since lending credit is such a crucial part of banks' business models, credit crunch may be one of the reasons for worse performance of banks. Furthermore, as outlined in the second section, regulatory pressures forced banks to be more cautious of capital reserves which can be another factor in profitability decrease.

Another reason can be found when evaluating the trend of other measures. Looking at LLPR first, the increase in the ratio is evident although the percentage value is still below 1%. This comes as no surprise as the second section described Nordic market being the one with the lowest default rates. What is more worrisome is the trend of capital adequacy ratio. Its percentage value has more than doubled from 7.5% before 2009 to more than 15% after 2009. Minimal regulatory requirements for this measure are at 8% making an average 15% value almost a twice of what is required. The motives for such conservative approach may be dedicated to regulatory pressures by financial institutions. Even more so, precautionary

measures by managers keeping higher capital on their books rather than investing in risky assets may have had something to do with a decreased profitability which will be later supported or rejected by more elaborate analysis. Management efficiency in terms of cost per loan has stayed stable while macroeconomic factors have changed rapidly. GDP growth before crisis had a mean value of 2.4% while in the after-crisis period it was less than 1%. Whether more damage on profitability was done by credit risk management or macroeconomic factors will be evaluated in the following sections.

### Table 5: Descriptive Statistics

This table shows regression results performed for 2 dependent and several independent variables. It also presents values for two sub-periods (before and after crisis). Mean value and standard deviations are highlighted for each independent variable.

	<b>Pre-crisis</b>		<b>Post-crisis</b>	
	<b>Mean</b>	<b>St. Dev.</b>	<b>Mean</b>	<b>St. Dev.</b>
<b>ROA</b>	0.017	0.006	0.011	0.009
<b>ROE</b>	0.127	0.071	0.068	0.081
<b>LLPR</b>	0.0014	0.0025	0.0072	0.0125
<b>CAR</b>	0.075	0.062	0.154	0.057
<b>Cost per Loan</b>	0.055	0.029	0.051	0.031
<b>Bank Size</b>	7.44	0.987	7.55	1.02
<b>GDP growth</b>	0.024	0.016	0.007	0.027

## 5.2 Multicollinearity and Heteroscedasticity

In order to be fully certain of the regression model, few tests have to be run. One of the OLS assumptions is the variance of errors being constant. This assumption is also known as homoscedasticity. If this requirement to run OLS is violated, the data supposedly contains heteroscedastic variables. To ensure this is not the case, several methods can be applied to test this assumption. Breusch- Pagan test was selected as appropriate due to the smaller size of the sample. The results for both dependent variables (ROA, ROE) are presented in the appendix section. As can be concluded, values for both ROA (0.16) and for ROE (0.99) are not significant and thus the null hypothesis of homoscedasticity cannot be rejected. In other words, there is no heteroscedasticity presented in the data.

It is also necessary to test if the independent variables are close to being linearly dependent. This assumption is called multicollinearity. First, the correlation matrix is constructed where the final table is presented in appendix. The minimum value of correlation to be causing multicollinearity is 0.8. Since each correlation is lower than 0.8 there should be no multicollinearity in the study. However, a test to check these results was used called variance inflation factor, also known as VIF. Table A2 in the appendix section shows that the values of VIF are in a range from 1.12 to 2.38. This supports the findings from the correlation matrix as no value exceeds 10 meaning multicollinearity is not present.

### 5.3 Regression Results

As described in the preceding chapters, the OLS estimation is the primary method to estimate the effect of credit risk on profitability of Nordic commercial banks. To ensure the right version of OLS is used, pooled regression, random effects and fixed effects are all run in Stata. To decide which of the tests is the most suited for this type of data the Hausman test is run in Stata to choose between random and fixed effects. Tests have to be again run for both dependent variables: ROA, ROE. The results, as presented in the appendix section, differ for these two variables. Running the test with ROA as an explained variable, the null hypothesis is rejected with the p-value being 0.048. Consequently, fixed effects model shall be used for this model. On the other hand, the p-value with the ROE being the dependent variable is 0.527 which presents no significance and as a result the random- effects is chosen for this regression.

Now that every test has been checked for and fixed, respectively random effects model has been established as the most appropriate, the results can now be presented. Table 6 below highlights the regression results for both dependent variables: ROA, ROE. Looking at the significance of results, all independent variables but GDP growth and bank size present significant results. And of those 4, only CAR is significant at 10% level with other 3 being significant at 5% level. As expected, results of relationship between LLPR and measurements of performance are negative and significant in both models proving that higher provisions for loan losses cause profitability to decrease. This in turn means that sound CRM directly leads to a higher profitability of banks. More concretely, one unit increase in LLPR causes ROA to decrease by 0.68 units and ROE to a reduction of 7.35 units. Being a proxy for nonperforming loans ratio, the results are in accordance with most of the previous literature. For instance, Noman, Pervin and Chowdhury (2015) found the same negative relationship

between NPL and ROA, and NPL and ROA. In terms of strength of the relationship, LLPR seems to have a higher impact on performance measures than NPL when compared to other studies.

Second proxy for CRM called capital adequacy ratio shows mixed results when it comes to different independent variables. First, CAR is found to have positive and significant (at 10% level) effect on ROA. More specifically, one unit increase in capital adequacy ratio leads to a 0.013 increase in ROA. This is in accordance with the study of Kosmidou, Tanna and Pasiouras (2005) who find a positive relationship between CAR and ROA. On the other hand, different scenario has appeared when using ROE as a dependent variable. The relationship between CAR and ROE is proven to be negative and significant (at 5% level). More concretely, one unit increase in CAR causes ROE to decrease by 0.119 units. This may seem as a contradictory result as both ROA and ROE represent profitability of banks. At the same time, as mentioned in the literature review section, results for this specific relationship are contradicting. While Berger (1995) found a positive relationship between CAR and ROE, Noman, Pervin and Chowdhury (2015) prove a negative relationship between these two variables. Berger (1995) addressed this possibility already in his study as his take on sustainability of his results was fairly skeptical due to his anticipation of more regulated banking sector in the future. In other words, our results may not be contradicting after all. Nevertheless, it is worth noting that the effect of CAR is different when comparing to ROA and ROE.

The intuition behind these findings can be decomposed into several arguments. First, higher capital adequacy ratio makes banks more capital constrained which in turn squeezes the room for management to operate. In essence, their investment opportunities and decisions are then affected making a chance to adequately invest capital much smaller. Secondly, these findings can be an indication of Nordic commercial banks being heavily dependent on equity capital as their primary source of funding. As a result management may be too constrained while it cannot profitably use equity with the higher capital ratios being forced by Basel regulations. More importantly, higher regulations may force management of banks being more conservative and risk averse in their decision- making. All these factors may have contributed to our results of CAR being negatively associated with ROE. Nevertheless the true reasons are out of scope of this thesis.

Focusing on the remaining variables, bank size is significant only in the model with ROA and estimates a negative relationship with the performance measure. Although some researchers estimated such relationship to be positive, the likes of Naceur and Kandil (2009) proved the negative impact. At the same time, our results produce a very small coefficient value showing not much impact on profitability. More surprisingly, cost per loan ratio is found to have positive effect on the performance of banks. This seems as a surprising finding as it would indicate that higher costs would lead to higher profitability. Looking at data however, this ratio was stable at around 5% for the entire 16 year sample period. Thus the explanation can be that the data for CLA only changed marginally. GDP growth, on the other hand significantly and positively affects ROE as was expected. Furthermore, the overall satisfying fit measured by R squared shows that 42% of data explaining the relationship with ROA, while 65% with ROE. Compared to other studies, our overall satisfying fit is well above average. For instance Berger's (1995) study of CAR relationship on ROE has a 23 % fit of data while the research by Noman, Pervin and Chowdhury (2015) presents even worse fit with only 20%. Therefore, the choice of variables for our thesis seems to be more adequate than the previous studies.

**Table 6: Regression Results**

This table shows regression results performed for 2 dependent and several independent variables. First number represents the values of the coefficients while second value presented in parentheses represents standard errors of coefficients. Values of R squared are presented to identify overall satisfying fit of the data.

<i>Dependent Variables</i>	<b>ROA</b>	<b>ROE</b>
<b>LLPR</b>	-0.686** (0.070)	-7.352** (0.567)
<b>CAR</b>	0.013* (0.007)	-0.119** (0.054)
<b>CLA</b>	0.075** (0.023)	0.408** (0.185)
<b>Bank Size</b>	-0.007** (0.002)	0.001 (0.007)
<b>GDP Growth</b>	-0.009 (0.015)	0.304** (0.136)
<b>Constant</b>	0.066** (0.018)	0.119** (0.053)
<b>R<sup>2</sup></b>	0.42	0.65

\* (\*\*\*) = significant at 10% (5%) level

## 5.4 Pre- vs. post- crisis comparison

Previous section highlighted the relationship between CRM and banks' performance of Nordic commercial banks. Now the focus turns to differences in this relationship in the respect to pre- crisis and post-crisis period. The results for both dependent variables are summarized in table 7. LLPR is significant in all four instances at the 5% significance level. In line with previous results and our expectations, there is a negative sign of LLPR across both models. On the other hand, the relationship in both instances becomes "less negative", thus the negative effect begins to lose on strength. This may indicate that banks have become more efficient at dealing with defaulted loans. The amount of provisions set aside compared to total loans has increased post-crisis as previously highlighted in table 5. In other words, it is hard to attribute these results to a better management of defaulted loans. Looking at CAR, all values are positive but only two of them are significant at the 10% level. Nevertheless it seems as if CAR had the more stable relationship with profitability measures than LLPR. In addition, looking at the post- crisis results alone, CAR seems to have a very little effect on both profitability measures. Unsurprisingly, macroeconomic situation in Nordic countries may have had a large impact on the decreasing profitability post-crisis. GDP growth already showed us in the descriptive statistics section how it decreased in the post-2009 period. Although not having all coefficients significant, the change in direction of the relationship between GDP growth and profitability of banks is obvious. Most notably, its relationship with ROE has worsened where the relationship reverted from being positive to negative (although post-crisis CAR being insignificant). There is thus suspicion that GDP growth may become more influential in determining profitability of banks after the financial crisis. These arguments cannot be conclusive due to the insignificance of certain coefficients.

### Table 7: Regression Results

This table shows regression results performed for 2 dependent and several independent variables. It also presents values for two sub-periods (before and after crisis). First number represents the values of the coefficients while second value presented in parentheses represents standard errors of coefficients. Values of R squared are presented to identify overall satisfying fit of the data.

Dependent variables	<b>Regression Results</b>			
	ROA		ROE	
	<i>Pre-crisis</i>	<i>Post-crisis</i>	<i>Pre-crisis</i>	<i>Post-crisis</i>
<b>LLPR</b>	-1.123** (0.291)	-0.598** (0.077)	-9.401** (1.948)	-5.498** (0.823)
<b>CAR</b>	0.015 (0.009)	0.018* (0.009)	0.126* (0.066)	0.008 (0.103)
<b>Cost per Loan</b>	0.070** (0.035)	0.006 (0.033)	0.342 (0.157)	-0.246 (0.353)
<b>Bank Size</b>	0.001 (0.001)	-0.000 (0.001)	0.011 (0.008)	0.007 (0.007)
<b>GDP Growth</b>	-0.022 (0.037)	-0.032** (0.014)	0.984** (0.253)	-0.234 (0.153)
<b>Constant</b>	0.010 (0.008)	0.013** (0.006)	0.023 (0.057)	0.069 (0.061)
<b>R<sup>2</sup></b>	0.65	0.74	0.41	0.73

\* (\*\*) = significant at 10% (5%) level



## 6. Conclusion

The aim of this thesis was to determine the relationship between credit risk management and performance of Nordic commercial banks. Based on our results, it can be concluded that credit risk management affects performance of Nordic commercial banks. Nevertheless, direction and significance of this relationship were mixed depending on the CRM proxy used. The methods of arriving to the successful results were twofold. Firstly, the study showed mixed results as two independent variables for the measurement of credit risk were used. In particular, loan loss provision ratio was found negative and significant for both return on assets and return on equity. It is worth to note that relationship with return on equity was stronger. Capital adequacy ratio, on the other hand, differed in results depending on the chosen dependent variable. The effect of CAR on return on assets was positive as other studies have also shown. As estimates on return on equity have varied through the studies, it cannot be concluded that the negative association between CAR and ROE is in accordance to general results. Nevertheless, it can be concluded that credit risk management has significant influence on the profitability of Nordic commercial banks.

Further analysis focused on the Eurozone crisis and its impact on credit risk management. The sample was divided into two subsamples for a pre- and post- crisis period. The biggest finding was that the relationship between loan loss provisions and profitability measures has lost in power after the wake of crisis. Nevertheless, the negative and significant impact was still obvious even in the recession period. As outlined in the descriptive statistics section, profitability of banks has decreased since 2009. In fact, from our regression results it seems as if GDP growth has grown in strength in terms of explaining the dump in profitability measures. Before the crisis arrived, the relationship between GDP growth and ROE was highly positive and significant. This relationship is however different after 2009 as there is a negative and insignificant effect of economic growth in countries on banks' ROE.

One of the drawbacks of this study is inability to access data for NPL which has been the most used proxy for CRM in other studies. While LLPR and CAR serve as very approximate indicators of credit risk, it would be of great advantage to include NPL as well and compare results with other articles and variables. It is then recommended for any future study focusing on this topic to use NPL as another independent variable. Using NPLR or not, there is a problem arising with using NPLR or LLPR as a proxy for credit risk management. Its usability can be skewed as it is a subject to managerial manipulation which in turn can cause

these proxies to misleading based on managements' will (Niinimaki, 2012). It can be done by either postponing the loan maturity or creating a new loan. Therefore there is still a possibility that LLPR may not be the exact proxy for CRM. Further research could also look at the possibility of a comparative study between different areas of Europe due to the disparity of non-performing loans across the Old Continent. Last but not least, including more data post- crisis would be beneficial to show a whole picture of the impact of the crisis on this issue.

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# Appendix

## Table A1: Breusch Pagan test for heteroscedasticity

This table summarizes results performed for both dependent variables. Second row presents the chi square value while the third table shows pi- value of coefficients.

	ROA	ROE
Chi <sup>2</sup>	1.96	0.00
p- value	0.1617	0.9958

## Table A2: Correlation matrix of coefficients

This table summarizes all independent variables and their respective values for correlation of coefficients.

	LLPR	CAR	CLA	Bank Size	GDP Growth
<b>LLPR</b>	1.00				
<b>CAR</b>	-0.33	1.00			
<b>CLA</b>	-0.51	0.43	1.00		
<b>Bank Size</b>	0.47	-0.28	-0.51	1.00	
<b>GDP Growth</b>	0.19	0.11	0.001	-0.01	1.00

## Table A3: Test for multicollinearity

This table summarizes all independent variables and their respective values of variance inflation factors (VIF).

Variable	VIF	1/VIF
CLA	2.38	0.420466
LLPR	2.25	0.445350
Bank Size	1.37	0.727994
CAR	1.26	0.793765
GDP	1.12	0.891799
<b>Mean VIF</b>	<b>1.68</b>	

## Table A4: Hausman Test

This table summarizes Hausman Test results to decide whether random or fixed effects model shall be used. Chi square values and p- values of coefficients are presented for both dependent variables.

	ROA	ROE
Chi <sup>2</sup>	11.16	4.16
p- value	0.0483	0.5270

**Table A5: Pooled Regression, Fixed Effects, Random Effects for ROA**

Coefficient values and their respective p-values are presented for all independent variables. Three tests are provided for the dependent variable (ROA): pooled regression, fixed effects, and random effects.

ROA	Pooled Regression		Fixed Effects		Random Effects	
	Coeff.	p- value	Coeff.	p- value	Coeff.	p- value
<b>LLPR</b>	-0.745	0.000	-0.685	0.000	-0.767	0.000
<b>CAR</b>	0.008	0.240	0.013	0.064	0.004	0.458
<b>CLA</b>	0.047	0.027	0.075	0.002	0.070	0.001
<b>Bank Size</b>	0.000	0.337	-0.007	0.005	-0.000	0.550
<b>GDP</b>	0.003	0.885	-0.009	0.546	-0.001	0.972
<b>Constant</b>	0.011	0.002	0.066	0.001	0.016	0.002

**Table A6: Pooled Regression, Fixed Effects, Random Effects for ROE**

Coefficient values and their respective p-values are presented for all independent variables. Three tests are provided for the dependent variable (ROE): pooled regression, fixed effects, and random effects.

ROE	Pooled Regression		Fixed Effects		Random Effects	
	Coeff.	p- value	Coeff.	p- value	Coeff.	p- value
<b>LLPR</b>	-6.886	0.000	-7.454	0.000	-7.352	0.000
<b>CAR</b>	-0.105	0.077	-0.071	0.266	-0.119	0.027
<b>CLA</b>	0.427	0.016	0.272	0.201	0.408	0.028
<b>Bank Size</b>	0.086	0.204	-0.035	0.125	0.001	0.850
<b>GDP</b>	0.351	0.021	0.219	0.129	0.304	0.025
<b>Constant</b>	0.086	0.002	0.397	0.021	0.119	0.206