Mortgage Lending Institutions in Scandinavia: 
A study of risk for the period 2000-2013

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Abstract

In the last 14 years there has been a major flux in the Scandinavian financial institutions and real estate markets. The increase in size and openness, in both the markets and the institutions allowed the sector to expand phenomenally, raising concerns about the potential rise of risks. Concerns regarding the health and state of the Scandinavian real estate and mortgage markets increased with the surge in residential housing prices between 2000 and 2013. However, during this period popular sentiments and media outcry was not met with sufficient academic inquiry into the subject.

Hence, we conducted this study trying to bridge the gap between popular concern and academic inquiry by addressing the question: How are mortgage lending institutions affected by the risk emanating from residential real estate markets in Scandinavia between 2000 and 2013? In attempting to answer this question we developed a two-tiered approach by addressing two questions: What is the effect of selected factors on the delinquency rate of mortgagors in Scandinavia during the period 2000 to 2013? And does the change in institutional business models and mortgage lending businesses affect their distance to default? These questions give us an insight into the composition of the mortgage market and the effects of the market upon the institutional distress; thereby giving us a comprehensive understanding of the markets and institutions in line with our primary research question.

We employed a deductive approach in line with our epistemological stance of positivism and ontological belief of objectivism. Thereby, we formulated a quantitative explanatory research employing the panel regression analysis tools in order to address our central question.

The results of the research re-affirmed our earlier intuition as we discovered that interest rates, unemployment, outstanding mortgages and mortgage growth were significant predictors of the delinquency rates. Meanwhile risk weighted assets, mortgage revenue and mortgage share of total assets were significant predictors of distance to default. These findings highlighted that while individual delinquencies are affected by macro and mortgage business changes, the distress in institutions is characterized by capital adequacy and the flux in their mortgage businesses.

Hence, the results of our two-tiered analysis confirmed that mortgage lending institutions have been affected by the risks emanating from the residential real estate markets between 2000 and 2013 and this effect has been characterized by changing models and rising influence of the real estate market in institutional portfolios.

Keywords:
Scandinavia, Real estate markets, Mortgage, Delinquency, Firm Default, Distance to default, Credit Risk, Panel regression, Random Effects model, Fixed Effects model
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Abbreviations

BIS: Bank of International Settlements
EBSCO: Elton Bryson Stephens Company
EMF: European Mortgage Federation
FMAC: Freddie Mac
FMAE: Fannie Mae
FSA: Financial Supervisory Authority
IMF: International Monetary Funds
OECD: Organisation for Economic, Co-operation and Development
CHAPTER 1: INTRODUCTION

In this chapter we provide the readers with an introduction to our research topic. The chapter discusses the background of the problem that lead us to the research question followed by the purpose of the research, the research gap, limitations and contributions.

1.1 Problem Background

The Financial crisis of 2008-09 still haunts economists, industry professionals and academics alike, especially in the wake of a slow recovery and the later development of the crisis in Europe. Although a whole host of reasons have been discussed regarding the causes of the financial crisis, the eventual spark that lit up the flame came after the bursting of the property bubble. This leads to defaults on the subprime loans which spelled out disastrous implications for the mortgage backed security markets; hence on the financial markets as a whole (Jickling, 2009, p. 3-7). In light of these events heavy criticism has been aimed towards both private and government backed subprime lending, relaxed credit policies for mortgages, and upon the failure of risk management within corporate lending institutions (Jickling, 2009, p. 6-7).

Large deviations from fundamentals within real estate markets can, hence, spell potentially disastrous systemic effects upon an economy and the entire financial system as a whole (Anson, 2012). This effect is especially pronounced in highly developed markets where bank portfolios have a large exposure towards real estate investments and housing mortgages make up a large part of the bank balance sheets. However, the fundamental problem with real estate stems from the complexity of the real estate market as it eludes notions of semi-strong efficiency present within other asset markets particularly since transactions are mostly private and no liquid trading facilities are present (Anson, 2012, p.45). Furthermore the excess availability of financing, easy availability of credit and openness has made the housing market bubble prone within the recent years, especially in times when crises lead to a flow of liquidity to safer assets.

Given these complications within the real estate market, the advent of the European debt crisis spelled out a surge in the capital into the safer markets, which were relatively well performing (Colliers, 2013). However, this effect was especially pronounced in Scandinavia, which has one of the most transparent real estate markets in the world (Colliers, 2013). Hence, within the last few years housing prices in Scandinavia have increased significantly attracting criticism from the IMF, and noted economists like Nourel Robini and Nobel Prize laureate Robert Schiller (Magnusson, 2013).
While the Scandinavian economies have kept up a good performance posing a relatively stronger GDP growth and lower unemployment than the rest of Europe, the high private indebtedness is a significant cause for concern since household debt relative to disposable income is extremely high within these economies and is primarily composed of residential mortgages (SEB, 2011). Furthermore, what makes the situation unique for these countries is the overuse of interest only loans, which can be a significant problem since these assume the ability of the asset to appreciate in price indefinitely. This can be extremely risky for banks if property market downturns occur (Magnusson, 2013). Hence there seems to be a potential threat to both the Scandinavian mortgage lending business and financial sector from a potential deflation of residential real estate prices or a hike in the interest rate.

However, the composition of the Scandinavian housing markets depicts a slightly different picture with structured products and covered financing displaying an extremely sophisticated outlook. Although all three markets share certain common traits such as the prevalence of covered bonds (bonds issued using mortgage repayments as cash flow) to finance mortgage loans, the prevalence of interest only and fixed interest mortgages (in Sweden and Denmark), and markets concentrated by a few large players, they do have significant differences in terms of structure which is why they require a brief overview before delving deep within the subject.
The Swedish mortgage market is covered by eight large banks Danske Bank, Handelsbanken, Lanzforsakringar Bank, Nordea, SBAB Bank, SEB, Skandiabanken and Swedbank, which control 95% of the market. Nordea, SEB, SwedBank and Handelsbanken control assets 4.5 times the Swedish GDP and pose a strong Tier 1 capital ratio of 18% (Magnusson, 2013). In Sweden owner occupied and tenant owned dwellings make up housing for two thirds of the population and loans pertaining to housing make up almost 85% of household lending. Household debt has soared to 177% of disposable income and housing prices have soared to 11% from 2009 (Magnusson, 2013). The Finans Inspektionen (Financial Service Authority in Sweden) has implemented general guidelines to introduce a cap on the loan to value ratio at 85%. However these make 11% of the total mortgage loans. This is pertaining to the fact that the higher the loan to value ratio the more difficult it is to repay the loans. Sweden has seen a growth in household indebtedness though lending institutions reiterate that they have taken a stance by introducing limits to the indebtedness to 500% of the income. The rate of amortization, however, stands at 140 years hinting signs of concern (FI, 2013).

Denmark, however, has a unique mortgage market, which even according to leading investors such as George Soros (2008) offers a model for developed economies to follow. Firstly only mortgage banks are allowed to offer loans against mortgages on real property by issuing covered bonds on each mortgage. These banks are under strict rules enforced by the Danish mortgage credit Act, which requires banks to match assets with liabilities within their balance sheets. Only Five Large institutions: Nykredit, Realkredit (part of the Danskebank group), Nordea Kredit (part of Nordea Group), BRF Kredit and DLR Kredit control the entire mortgage market in Denmark. Secondly the government
introduces a strict cap on loan to value ratios for different kinds of properties (BIS, 2004). However, the rise in unemployment and increase in household debt to 300% of disposable income alongside the dampening of a property market bubble create significant concern for the market and the financial sector as a whole (Lerving, 2014).

In comparison with those of its neighbours, Norway has a mortgage market in a relatively nascent stage. The mortgage financing market is saturated by 3 large players of whom DNB controls 35%, Sparebank 1 controls 13%, Nordea controls 11%, and 3 small players KLP, Storebrand and Terra which control less than 1% of the market (regjeringen.no, 2012). Financing for mortgages is available mostly via adjustable rate mortgages and mortgages of up to 70% of loan to value have to be covered by a covered bond. Furthermore, banks provide plenty of cheap credit, which has increased household debts considerably and household loans make up more than 85% of banks assets. Government policy and subsidies encourage buying houses and the market has seen a substantial increase during and after the credit crisis. Banks have increasingly funded themselves using short term deposits from money markets which pose a substantial problem since most of the balance sheet is composed of long term assets (residential mortgages) (Gjedrem, 2010). However, Norwegian institutions have also indulged in the distribution of controversial products such as securing credit lines on houses and selling structured products with a derivative component, which have not generated any substantial return for the investors and are potentially risky (Almklov, 2008).

Hence, despite the strengths of the structured and sophisticated Scandinavian mortgage markets and financial institutions, there are some areas of legitimate concern, which serve for an interesting case from a risk investigation perspective.

1.2 Research Question

Rapidly changing house prices, house price to income ratios, high levels of mortgage debt as a share of household debt can be considered as signals towards housing bubbles. A significant concern within such market conditions is the borrowers and institutions’ ability to indulge in speculation given the low interest rate conditions and in expectation of ever increasing house prices (Boverket, 2013). In the event of a market downturn or an interest rate hike this can spell disastrous consequences for financial institutions involved in mortgage lending.

Furthermore, major financial institutions within Scandinavia have increasingly expanded within the last 13 years, significantly changing their business model as well as the risk appetite of their portfolios (FinansInspektionen, 2013, p.4). Hence, facing such a situation we developed the following question, in line with our interest in mortgage and real estate markets:

*How are mortgage lending institutions affected by the risk emanating from the residential real estate market in Scandinavia during the period 2000-2013?*

In order to answer this question, we developed two sub-questions, which guide our approach towards conducting this study. The two questions are:

*What are the effects of selected factors on delinquency rate of mortgagors in Scandinavia during the period 2000-2103?*
Where the factors selected include indicators from established literature on the predictors of delinquency. These include: mortgage interest rate, mortgage growth rate, outstanding mortgage debt, debt to income ratio, unemployment rate, social benefits, risk free rate, GDP growth rate and housing price changes.

Does the change in institutional business models and mortgage lending business affect its distance to default?

Where the changing nature of business models and mortgage lending within institutions is depicted by the following factors: mortgage growth, delinquency rates, derivatives as a share of total assets, risk weighted assets, interbank assets, wholesale funding, net income to total assets, loan to deposit ratio, mortgage revenue to total mortgage assets and the share of mortgages within total assets.

1.3 Purpose

With increasing integration of financial markets and enlarging of the financial sector within developed and developing economies, financial institutions have increasingly acquired an important role within an economic system. Thus, the maintenance of healthy financial markets and financial institutions is the objective of many governments and has led international bodies like Bank for International Settlements, OECD, IMF and World Bank develop regulation and procedures towards achieving this objective. However, with regards to 2008 financial crisis and the later Euro debt crisis concerns about the health of the financial system and institutions have been particularly strong among investors, shareholders, governments and policy makers.

Hence, we attempt to address concerns about the health of major Scandinavian financial institutions and their mortgage lending businesses in light of the tumultuous housing markets via our study. Keeping investors, shareholders, analysts, policy makers and advanced academic researchers as our target audience, we attempt to spread awareness regarding risks posed from the changing bank business models and real estate markets within Large Mortgage Lending Institutions (LMLIs) in the region.

In order to acquire a comprehensive overview of the evolution of the institutions, and to account for a tumultuous period encompassing a rapid expansion followed by two crises and an eventual slow recovery, we have chosen a period from 2000 to 2013 for our study. The extent of this period will further the understanding of risks emanating from the real estate markets, mortgage businesses and bank operations during volatile periods and serve as a model encompassing stressed and expansive periods.

This study tries to develop a two-tiered approach towards the analysis of the primary research question in order to serve as a useful insight for each of the members of the intended audience. The first level involves the study into selected macro and micro factors influencing delinquency. This would serve as an important insight into the characteristics of the borrowers and the mortgage market itself, serving the needs of policy makers, academics and industry analysts. The second level involves investigating the factors affecting distress in large mortgage lending institutions within Scandinavia. This would help display the risk emanating from business models and mortgage businesses of the institutions, which draw them closer to distress thereby serving the needs of investors, regulators and shareholders alike.
1.4 Research Gap

The failure of subprime loans and the financial crisis 2007-09 stimulated extensive research within finance devoted towards bank distress, real estate and housing markets. Within this regard, Hays, Lurgio and Gilbert (2009) published a study on real estate lending activities of community banks in the US. Using a logistic regression analysis, they could detect a positive impact of risk exposure, measured by CAMEL indicators, on the level of bank lending. Additionally, Igan and Pinheiro (2010) studied the exposure of US bank portfolio to real estate markets between 2002 and 2008. The authors specified the determinants of delinquency on real estate loans and then measured the potential impact of delinquency on banks, concluding that most banks were vulnerable within the sample (Igan & Pinheiro, 2010).

In Europe studies have primarily responded to the European sovereign debt crisis by researching the role of government and financial institutions in crises rather than looking into the impact from specific markets. With regards to Scandinavian countries, there are a few studies on the Swedish housing market. One such study is that conducted by Andersson and Wilhelmsson (2008) on Swedish single-family housing markets, detecting the impact of interest rate, price and rent level, income and employment on the regional differences in the risk of foreclosure. Another such study on Sweden is conducted by Sorensen (2013) who studied the trends and risks in the housing market. In Denmark the direction of research has focused on defining and explaining the unique Danish market, Frankel et al. (2004) follows such a trend by outlining the specifics of the Danish mortgage market and Soros (2010) proposes it as a model for developed markets to follow. Meanwhile, in Norway studies have focused on the presence of a property bubble. Miles and Pillonca (2008), and Bourassa et al. (2010) both conclude that a large deviation from fundamentals exists within the Norwegian mortgage market.

A number of academic studies have depicted a relation between bank distress, interest rates, housing prices and underlying factors within the housing market. However despite the media speculation and concern, few studies have aimed at capturing the impact of real estate markets on institutions therein. Possible reasons for this could be the complexity of the real estate markets and the lack of availability of data for analysis in line with the relatively recent improvement in reporting standards. Hence we believe our research will help in a thorough understanding of the exposure of institutions to the volatile real estate market in Scandinavia bridging the much needed gap between popular concern and academic research.

1.5 Contributions & Limitations

In line with our alarmist approach towards developing this research, our desire is towards raising awareness and potential red flags. We have done this in order to stimulate the discussion, further the research, strengthen the regulation and/or even to hint towards the re-modification of the investment portfolios in order to hedge against any impending crises in the future.

From a theoretical perspective this research attempts to shine an academic light on the topic, being hotly debated and argued within the financial news media. However, considering the fact that we have included the largest institutions, which cover almost 80-95 percent of mortgage lending within their respective regions, our study serves as a
good proxy towards understanding the risks inherent within the entire market to the institutions present therein. Thus, for potential investors or academic researchers this serves as good stepping-stone towards understanding the markets and the risks within them.

Furthermore, with regards to policy makers and regulators this might serve as an early warning, which raises a few flags and attempts to steer a discussion into the present models and mortgage businesses within the large institutions. The factors identified within the study, both bank specific and on the wider macroeconomic level, allow a careful observation into the concerns which could be addressed via policy or practices which could be curbed via regulation enabling a safer financial environment.

Finally for analysts and established investors the study provides an overview of the strengths and risks within the large lending businesses emanating from real estate markets, which would help develop analysis and strategies to hedge against potential downsides losses in portfolios with large exposure to such investments.

In studying a fairly complex market such as mortgage markets, there were a number of limitations, which restricted our approach towards studying the markets in the manner we would have liked to. The first of these limitations came from difference in reporting regimes and the quality of reporting within the earlier parts of our time series. The lack of an availability of concrete data within the financial reports in the earlier part of our time series restricted us to fewer ratios and the use of proxies for various factors.

Furthermore, in the absence of a combined mortgage database such as the FMAC & FMAE database for mortgages in the US, we were lead into assuming delinquencies from the balance sheets of financial institutions and were constrained by a lack of data available for analysis. Secondly, the availability of reports itself was a contentious issue restricting our time period and giving us fewer data points for a more comprehensive analysis. Finally, the presence of a single group such as Nordea and Danske bank within multiple markets where they commanded a large market share and the presence of non traded companies such as SBAB and Lansforsakringar AB as major players within the markets constrained our ability to conduct a more market oriented rather than book oriented value analysis whilst considering models for default.

Hence, the study adds another large contribution as it constructs an in-depth analysis keeping in line with the research requirements and taking into consideration the various limitations any researcher might have while studying this field.

1.6 Disposition

In chapter 2 we elaborate the theoretical methodology, which guide our research process. Thereafter in chapter 3 we review the fundamental literature regarding the real estate market, bank distress in each country and risk measurement and management. Chapter 4 is the inclusion of hypotheses deduced from the discussed theories, data and data collection and statistical tests involved in the study. Chapter 5 discusses the descriptions of data and the statistical findings. Follow these is the analysis of data in chapter 6. The paper ends with a discussion on the quality of the study, the conclusion and last but not least suggestions for further research.
CHAPTER 2: METHODOLOGY OF THE RESEARCH

This chapter entails theoretical considerations, which guide our research process. The chapter starts with the choice, preconception of the research topic and the perspectives the authors had in mind while conducting the research. The chapter also specifies the philosophical underpinnings guiding the research and leads to the structure of the research. Finally the chapter ends with a clarification of literature review, data sources and the ethical, legal and social aspects of the thesis.

2.1 Choice of Topic & Preconceptions

The proposal of this research topic can be viewed as a combination of our knowledge and interest within the subject. After gaining enough knowledge in Business Administration and especially in finance, risk management and financial statistics, we chose to conduct a study in line with our interests and relevant to the current affairs in Scandinavia. Studying as foreign students in Sweden, we both were interested in reconciling our concepts by studying a local issue and shining a light upon it from a neutral’s perspective. Additionally, this research comes just in time when Scandinavia is in a possible residential real estate bubble yet there is not enough corresponding academic research within addressing this situation. Hence, we are very excited with the prospects of our outcomes to fill the possible gaps within research.

However, our motivation for conducting research within this subject area should not be assumed to generate subjectivity and influence our results. This stems primarily from our training and education within both finance and research. As students who have had the pleasure of studying and researching within different prestigious universities in Europe, we believe we have acquired a necessary insight into both the subject matter of finance and risk management, and a rigorous training in research projects which would help us maintain objectivity within our research area. Furthermore, our different backgrounds, analytical skills would increase the objectivity of the study process. Moreover, we base our hypothesis on peer-reviewed theories/models. The data is established as it is represented in public domains, and statistical testing is in line with credible input data. Finally, important critique and advice from our supervisor and colleagues has increased the neutralist approach towards the research thereby enhancing the validity of the thesis.

2.2 Perspective

Adhering to the purpose of our study, we will write our thesis in the perspective of financial analysts attempting to understand the exposure of the real estate and mortgage markets upon the financial market in Scandinavia. Our findings aim towards benefiting a number of actors, namely banks, specialised investors, regulators, industry analysts and advanced students of finance, the intended audience for this study. Therefore the research employs specialised terminology and advanced financial concepts. Given the soaring prices within the housing market, we expect our findings will reveal how LMLIs have been affected by residential real estate market in Scandinavia. Thereby helping investors hedge their risks, institutions gain an insight into and regulators to plan appropriate policy responses for risks stemming from this market.
2.3 Research Philosophy

Research philosophy determines what reality is. Its importance is not only for the development of knowledge but also for the nature of that knowledge (Saunders et al., 2009, p. 107, 108). The choice of one’s research philosophy helps one to define a good research proposal and acquire useful guidelines throughout the course of research. Epistemology and Ontology are the major orientations.

2.3.1 Epistemology

The epistemological stance concerns how to study a social entity. It asks whether a social entity should be explained by ‘the same principles, procedures and ethos as natural science’ or should it reflect the complexity of human behaviour and its institutions (Bryman & Bell, 2011, p. 15, 16). Positivism and Interpretivism are the two aspects of epistemology.

Positivism according to Crossman affirms the importance of imitating the natural science given the use of appropriate methods (2003, p.50). Natural science implies working with an observable social reality, which in turn leads to the production of measurable data while appropriate methods refer to the use of ‘maths and formal logic’ to provide analytical statements about the observable world using the process of deduction as the means of establishing generalisations and laws (2003, p.50). Carrying the features of natural science, a positivist approach asserted by Saunders et al. (2009, p. 114) should be undertaken in a value-free way which has to be assured by no bias preferences of researchers in the collection of data and there should leave no room for altering them. As Bryman and Bell (2011, p. 15) stresses that the true domain of a positivist researcher should be scientific statements instead of normative statements.

Interpretivism opposes positivism, as it requires researchers to understand the differences between objects and humans the latter of whom are social actors (Bryman & Bell, 2011, p. 18; Saunders et al., 2009, p.116). According to this philosophical stance, social science would become too rigid and limited if it only relied upon on hard facts and observable reality since reality is not always observable or verifiable but multiple and subjective. Crossman (2003, p.51, 52) stresses that reality is the creation of the individual involved in the research and that humans are not objects but are subjects with feelings, perceptions, behaviours and attitudes. Therefore, Saunders et al. agrees that conducting research upon people is different from doing research on objects (2009, p. 115). Hence, the interpretive philosophy should adopt an empathetic stance, which challenges researchers to enter the social world of the research subjects in order to understand their point of views (2009, p. 116). Due to this feature Saunders et al. (2009, p. 116) claims the interpretive perspective is more appropriate for studies on organisational behaviour, marketing and human resource management.

A comparison of these features leads us to the conclusion that our study stands for positivism. Adopting this view, we aimed to explain a reality in which possible causal effects between social actors exist. We did not try to interpret human behaviour nor did we try to understand in-depth phenomena beyond the observed reality since we believe that knowledge is accepted only when it is logical and empirically verified (McKeinzie, 2011, p.535). Our research question “How are mortgage lending institutions affected by the risk emanating from the residential real estate market in Scandinavia during the period 2000-2013?” reflects this standpoint. First of all, there are no value judgements in this question regarding the risk arising from the residential real estate market. The
question simply affirms the fact that mortgage lending institutions are exposed to residential real estate market and initiates an inquiry into this affect. Then, acting like natural scientists we believe knowledge originates from what we observe. In other words, we based our research on observable social reality, namely LMLIs, banks as institutions, mortgagors as individuals and the real estate market in Scandinavia from where measurable data are collected. Lastly, following a deductive process we draw our conclusions about the exposure of these institutions from the outcomes of the input data and statistical tests leaving no rooms for subjective judgments as explained in the interpretive position.

2.3.2 Ontology
The ontological stance deals with the nature of social entity – whether a social entity exists independent of social actors or are social actors ones who build up social entities (Saunders et al., 2009, p. 111). Responding to this question there are two orientations objectivism and constructionism.

Objectivism implies that social phenomena confront us as external facts, which are beyond our reach or influence (Bryman & Bell, 2011, p. 21). For the purpose of convenience, both Bryman and Bell (2011, p. 21) and Saunders et al. (2009, p. 110,111) develop the concept under an organisational set up. Every organisation has its own well-defined structures, rules and missions. People living within this organisation simply have to comply and fulfil their duties without any individual inputs upon how they are to perform their jobs. In other words, the social entity is a constraining force of social actors (Bryman & Bell, 2011, p.21).

On the other hand, a constructionist position asserts that ‘social phenomena and its meaning is created from the perceptions and consequent actions of social actors’ (2009, p. 21). Therefore, the researcher role is to try to understand the motives, actions and intentions of social actors (Saunders et al., 2009). This goes in line with the interpretivist philosophy, which stresses the importance of understanding the complexity of human.

In this study a volatile real estate market is considered as a large organisation with LMLIs, banks and mortgagors as individuals in this market. This organisation most likely has a large impact on the individual participants in this set-up. The volatile market condition within the period 2000-2013, there are potential issues which create problems for mortgagors which consequently spread onto LMLIs. This impact is the consequence of a causal effect. Delinquency rate and other market factors such as housing prices and interest rate can be seen as mechanisms of the market, which objectively affect mortgagors and LMLIs. Overall mortgagors and institutions bear all possible impact from the real estate market, which will be revealed later in our analysis. Hence for these reasons, we stand for the objectivist ontological position.

2.4 Research Approach
Having clarified our philosophical stance we can analyze our research approach in conducting this study. This determines the relation of theory with our research and leads to our research design (Bryman & Bell, 2011, p.11). The main consideration here is testing and building theory. The two contrasting approaches are induction and deduction. These have been illustrated in the following table.
The deductive approach is akin to scientific research, common in natural science experiments (Collis & Hussey, 2003). Researchers adopt this approach by deducing a hypothesis from a theory, indicating how data are collected, testing the hypothesis given a certain strategy and confirming or modifying the theory in light of the findings (Robson 2002; Bryman & Bell, 2011, p. 11).

However, the criticism of the deductive approach is that it is rigid and therefore limits alternative explanations (Saunders et al., 2009, p.126). Therefore an alternative choice is offered by the inductive approach. Within the inductive approach the research process begins with data collection and concludes by drawing generalizations in the form of inferences from the data creating a tentative hypotheses upon which conclusions are drawn (Adams et al., 2007, p.29; Cresswell, 2009, p.63).

The difference of the two approaches can be observed from not only the research process but also from the choice of data and research strategies, a discussion we will conduct in the next section. However, before we continue, it is useful to associate the different research philosophies with the research approaches. Deduction likely belongs to positivism and induction to interpretivism (Saunders et al., 2009, p. 124; Bryman & Bell, 2011, p.27).

In line with the philosophical stances clarified before and the sequence of the research described above, our study adopted a deductive approach. As mentioned in the previous part, with the understanding of fundamental theories, we can create hypotheses on the predicted relationship of the delinquency rate and selected factors. We can also create hypotheses on the impact of market factors and banks’ lending businesses on bank distress. Thereafter collecting quantitative data and conducting subtle statistical tests, we can confirm or reject the hypotheses to reinforce or negate the validity of the theories. Therefore adhering to scientific method, we answer our research question based on the outcome of the test built on initial theories.

### 2.5 Research Design

Research design is considered to be a general plan for the research (Saunders et al., 2009, p. 136). In order to achieve a good plan, researchers need to be clear about the purpose of their research since this will guide how the research is designed (Bryman & Bell, 2011, p.40). According to Saunders et al. (2009, p.138) the purpose of a research can be exploratory, descriptive and explanatory.

An exploratory study usually involves the exploration of new ideas, new insights or a clarification of an ambiguous concept (2009, p. 139). This can be achieved by searching literature, or conducting in-depth interviews such as those with an expert in field of

<table>
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<th>Table 1 Summary of Main Procedure of Research Approach</th>
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<td><strong>DEDUCTION</strong></td>
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<td><strong>INDUCTION</strong></td>
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Source: Bryman and Bell (2012)
study or a focus group (2009, p. 139; Sreejesh et al. 2014, p.29, 30). Explanatory studies according to Saunders et al. (2009, p.140) establish causal relationships between variables. Researchers need to have good knowledge of the situation or phenomena in order to infer or detect pertinent causal relationship (Zikmund et al., 2012, p.55). According to Zikmund et al. (2012, p.55) researchers want to study how a change in one event will change another event of interest.

In contrast with exploratory studies, design descriptive research emphasises upon the description of a group of people or entities (Robson, 2002, p.59; Sreejesh et al., 2014, p.33). Design descriptive research is further described by Sreejesh et al. (2014, p.33) who discusses that it should describe the characteristics of certain groups in order to figure out certain behaviour, to make specific prediction and to examine difference between groups.

Hence based on the discussion above we can establish that our research design is explanatory, since we emphasize on the relationship of the variables and seek to detect a causal effect between them. We therefore believe that a possible causal relationship between delinquency rate and other explanatory variables, such as disposable income, employment, unemployment benefit, housing price etc exists. Furthermore, we also believe the causal relationship between bank distress and the bank business model will be examined in line with the objectives of an exploratory study.

2.6 Research Strategy

Having established the design of our research we progress towards our strategy. The literature outlines numerous approaches towards conducting exploratory studies (Hair et al., 2007; Robson, 2002; Saunders et al., 2009). Our choice however was in line with our research philosophy and best suited towards addressing our research question (Saunders et al., 2009, p. 141). The different strategies commonly used in social sciences are:

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<table>
<thead>
<tr>
<th>Method</th>
<th>Explanation</th>
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<tr>
<td>Experiments</td>
<td>Derived from a natural science approach of varying independent and dependent variables</td>
</tr>
<tr>
<td>Survey</td>
<td>Strategy focused on feedback from individuals via questionnaires or structured interviews</td>
</tr>
<tr>
<td>Archival</td>
<td>Strategy using administrative or published records for research</td>
</tr>
<tr>
<td>Case Study</td>
<td>Explores a topic or a phenomenon under a certain context</td>
</tr>
<tr>
<td>Ethnography</td>
<td>Observes behaviour of certain groups</td>
</tr>
<tr>
<td>Action</td>
<td>A process within which a collaboration and participation solves a real issue</td>
</tr>
<tr>
<td>Grounded Theory</td>
<td>Developing a theoretical framework for social actions or interactions</td>
</tr>
<tr>
<td>Narrative Inquiry</td>
<td>Compiling oral accounts of personal interpretations of certain events</td>
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Source: Saunders et al., 2012, p. 171-188

When observing our research needs and philosophy alongside our questions, a research strategy based on experimentation could not be implemented for the obvious lack of control we possess on the independent variables. Archival data that we employed within
our study cannot be changed within the context of the study; hence, our research cannot be described as experimentation borrowing from a natural science context. The principle for such studies as described in Bryman and Bell is establishing a control group and an experimentation group upon whom individual tests are conducted by changing the independent variables and observing the influence on the dependent variables (2012, p.45). However, we have included a certain aspect of experimentation within our study as we will be conducting an individual stress test upon the individual institutions by changing the independent variables to assess the impact of a potential impact of an unexpected negative stress event.

The study relies on secondary sources of information that are derived from established reports and proxy variables constructed from established research, hence, surveys, ethnographies, action research, case study, grounded theory or narrative inquiries can all be ruled out as possible descriptions of our research. This is as all these are methods, which rely on feedback from the research subjects and are the wider part of the inductive approach towards research, which we have not pursued due to either the complications involved within the collection procedures, the insufficient time and resources to do so.

Hence, archival research as described before is the best description of the orientation of our research strategy. This is as archival research described by Saunders is ‘research that uses administrative data from the principle sources of data’ (Saunders et al., 2009, p. 150). Archival research is also described as one that makes use of data from the principle sources and interprets it in order to derive conclusions not established before by Hakim (1987, p.38-39). Since we employ data from secondary sources which has been collected and organized this can reflect the reality embedded within statistics being studied rather than being a poor reflection of data that might have been collected within a different manner (Hakim et al., 1987, p. 21-24). Such an approach is best suited towards answering our research question within the time frame in the most efficient manner, as it uses established facts in the form statistical data to base conclusions upon. We construct our macro-economic function of delinquency and default based on macro-economic variables collected from the statistical bureaus of Sweden, Denmark and Norway, while the model for distance to default is based on information from company annual reports. This data has been used to derive our conclusions regarding our hypothesis.

**2.7 Time Horizon**

Time horizons vary depending upon the purpose of a research question. If a researcher is interested in a snapshot of a particular event at one given point in time, he/she fares a cross-sectional study (Saunders et al., 2009, p.155). The purpose of this type of study is to identify and understand differences between the various members of the study population (Renmenyi et al., 1998, p.47). On the other hand, if the development or changes of certain events are in concern, a longitudinal study is an alternative choice (2009, p. 155).

Within our research, we are concerned with both types of studies. The reason is that we are interested in both the differences between the exposure of mortgagors and LMLIs in Sweden, Norway and Denmark and the credit risk evolving during the period of 2000-2013. By just observing a snapshot of the credit conditions of the three countries at one given time, we would be able to compare the differences in the rate of delinquency and
the impact of the mortgage lending business on bank distress in each country, but we would not be able to see the development of particular variables for example the interest rates or the credit risk throughout the economic cycle. By accounting for periods when the economy was relatively healthy, onto a crash and into a recession our study contributes a more in-depth understanding of delinquency and bank distress face from credit risk ensuing from the real estate market.

2.8 Research Method

Research method provides us the framework of the data collection and data analysis. A research can follow two widespread approaches - quantitative or qualitative approach. The choice depends primarily on the purpose of the research question, whether the emphasis is on generalisation or in-depth understanding (Bryman & Bell, 2011, p. 410). Thereby, quantitative or qualitative data and deductive or inductive approach will be matched respectively. Certainly these decisions need to follow after the choice of researchers’ philosophical point of view.

According to a number of researchers there are common contrasts between the two methods, which help them to determine the appropriate method. For instance, qualitative research relies on contextual understanding of humans as social actors. This requires the collection of qualitative data, which is rich and complex in meaning and therefore requires the analysis of the words collected. In line with these characteristics, theory and concepts in qualitative research emerge from data, which make the study unstructured since it leaves room for subjective interpretations. On the other hand, quantitative studies rely on generalisation, which needs the support of hard and reliable data. This goes in line with the purpose of theoretical testing which follows a certain static, pre-determined structure prescribed by researchers. Therefore quantitative studies reflect a researchers’ point of view better than the views of participants in the research.

In this study we follow a quantitative method, which harmonises the purpose of our research question and the choice of research philosophy, research approach and design. This is as firstly the aim is to determine factors that lead to the delinquency by mortgagors; for this we employ macro and micro factors in each country. The second aim is to acquire the determinants of bank distress; for this we employ a number of accounting ratios and fundamental theories on credit risk and risk management. The statistics is collected from LMLI balance sheets, the statistical authorities in each country and allow us to generate hypotheses that can be tested by statistical programming software. Lastly, the confirmation or rejection of the stated hypotheses is based on present theory and can only be made in the light of the outcomes without our own interpretation.

2.9 Literature and Data Sources

In an attempt to ‘refine and map the already established theoretical framework’ (Tranfield et al., 2003, p.208) we utilized the literature and data from secondary sources. Since this was in line with our deductive approach, literature review for which is done for the purposes of establishing the theoretical framework for testing data (Saunders et al., 2012, p.61). Secondary source analysis for the purposes of research is defined as the analysis of sources, which have not been collected by the researchers themselves but come from data collected by other researcher or by other organizations in the course of their business (Bryman & Bell, 2011, p.325). This secondary data we have collected is
composed of data from reports, annual/quarterly statistics, scientific articles and books. The literature primarily consists of material collected from Emerald and Business Source Premier (EBSCO) and Science Direct available from Umea University library and Reports from the individual financial authorities and central banks in the three countries (Sweden, Norway and Denmark). The use of EBSCO and Science Direct databases is a natural result of the fact that they consist of the largest source of economics and business scholarly journals. The key words employed while conducting our search were: residential real estate, credit risk exposure, banks, delinquency, default, and distance to default, bank stress, Scandinavia, Sweden, Norway, Denmark, single family house, mortgages, mortgage market, financial performance and risk report. In gathering the literature we ensured that the articles were peer reviewed. This process ensures the objectivity of the research.

After reviewing a sufficient number of articles and establishing a sound basis for our research, we started gathering data for our models on defaults and distance to default from Thomson DataStream, annual reports of individual banks and macro, micro economic data from the European Mortgage Federation (EMF), OECD and Eurostat. The choice of EMF, OECD and Eurostat database stem from their wide scope of compiled data of different countries and in particular the specialised data on housing and mortgage market from the EMF fit perfectly our research question. The choice of Thomson DataStream stems from the acceptance and respect within the financial community, it is regarded as a premier data source for businesses, academics and industry analysts alike. Overall these databases underscore our utilization of globally accepted, legitimate and verifiable data sources, which spells out the possibility of incorrect data. However, in order to develop our model we had to create a new database with micro and marco-economic variables alongside the financial statistics we collected.

2.10 Summary of Methodology of our Research

Figure 3 Summary of Methodology of the Research
2.11 Ethical, Legal and Social Considerations

Social science research is guided by ethical and legal considerations in order to ensure a fair and justified approach towards research. A number of different schools argue the different basis upon which to judge ethical and legal considerations within social research. Two of the most prominent of these are **universalism** which argues that certain universal ethics should not be broken by researchers in going about their research and **situation ethics** which argue that ethics are defined by the situation faced by researchers (Bryman & Bell, 2011, p.129). Since our research consists of a deductive approach with descriptive/archival research we can associate with the universalism school of by ensuring we have respected the specified ‘universal’ ethics and legal considerations of research.

In discussing research ethics Diener & Crandall specify four specific parts of research ethics. These concern the following whether there is harm to participants, whether there is an invasion of privacy, whether there is a lack of informed consent and whether deception is involved (1978, p. 17-96). In our research we employed data from secondary sources where no individual participants were involved and large organizations had disclosed information themselves, hence harm due to invasion of privacy, lack of informed consent and harm to participants could not have been involved in the data collection process as it was already a matter of public record without any discrepancy and with full authority. Diener & Crandell elaborate on this issue by mentioning that the fact that the disclosed information is a matter of public records represents ‘informed consent’ by the companies involved (1978, p.38-39).

We addressed the concern regarding deception, which is explained as the ‘deliberate misrepresentation of a scientific study’ (Diener & Crandell, 1978, p.72) by ensuring that the sources were cited in the right context as per our understanding and it is correctly cited with the corresponding author. However, deception also includes the process of data processing and gathering. While conducting the econometric analysis, we have ensured that this process is thoroughly elucidated with transparency. Furthermore, we ensured a strict adherence towards presenting results as they occurred and have not indulged in data mining in order to produce results. This can also be understood from the fact that we have no gain in doing so nor do we have any established preconceptions regarding the outcomes of our research.

Questions of ethical behaviour aside, we have also considered the legal aspects which might afflict a research of this nature. The first of these refers to deception or misrepresentation which we dealt with in the paragraph above by explaining the fact that we have reproduced our research model, statistics and results with transparency in the incoming chapters hence spelling out possibility of ‘data-mining’ or misrepresentation of data. The second aspect concerns the issue of privacy and rights to information. This aspect is covered by the fact that we have employed Thomson Reuters DataStream and statistics from the Central Statistics Bureaus of Scandinavian countries. Hence, all information used within this research is disclosed publicly and can be used by anyone and does not create any privacy issues. We have, therefore, adhered to the strictest provisions of ethics and legality while conducting this study.

In line with the legal and ethical aspects, we would also consider social or societal impact of our research. Throughout our university studies we have constantly focused on societal impact within our subject areas in order to become concerned and active
citizens within the wider community and in accordance with this spirit we continue this trend within this research as well.

Adhering to the recent catastrophic events in the financial sector on the back of a property market crash which left millions in financial turmoil particularly due to the large exposure of the financial sector, we believe our study is a small attempt towards a greater transparency and understanding of the risks facing the financial sector within Scandinavia. We, via our study, have attempted to give a fair representation of the exposure and consequent stress that could occur in a negative tail event. However, we should elucidate that the purpose of our study is not to predict turmoil or to give reasons for which would occur but merely understand what financial turmoil, if it occurs, could do. This we believe is an extremely vital for not just investors, finance students and institutions but ultimately also to the larger community involved in buying property and taking mortgages. Thus adhering to our belief in greater transparency for the financial services we believe our research has a potential to provide insights to buyers (via mortgages) or their advisors and result in more awareness and understanding of risks before the proverbial ‘rainy day’ occurs. Hence, essentially the societal impact of our study is an attempt to increase the awareness and understanding of risks stemming from the mortgage markets, which constitute a fairly large percentage of the credit markets within Scandinavia.
CHAPTER 3: THEORETICAL FRAMEWORK

In this chapter we provide the theoretical framework on real estate and mortgage markets. We then present the debate on real estate bubbles before going over the market outlook for each Scandinavian country individually. Next we present the theoretical underpinnings for the various concepts of financial risk and discuss the different methods of risk measurements and risk management. The chapter ends by presenting our selected measures and an illustration of our research model.

3.1 Real Estate Markets, Real Estate Bubbles and Mortgage Markets

3.1.1 The Real Estate Markets

In the recent financial history of the world few asset classes have created as much controversy because of their potential role in financial crises as real estate. Despite receiving a significant attention by academics and industry specialists alike, the property or the real estate market remains a rather grey area, with researchers still struggling to explain bubbles and mispricing within the market. A part of this problem as argued by Anson (2012) lies in the fact that the real estate asset is fundamentally illiquid in nature. This stems from a number of different factors such as the unique nature of each property, the lack of a publicly traded market, appraisal valuing of each asset and the ‘chunky’ size of this asset (Anson, 2012, p.45). The problem hence is that there is no notion of efficiency within real estate markets where the price would essentially reflect all publicly available information. Therefore essentially the problem with real estate stems from the unique nature of the asset. Hence, in order to understand real estate and consequently the mortgage market we will attempt to break down the analysis to the very basics, by understanding the determinants of the real estate pricing leading on to a discussion on the presence of large deviations or bubbles within the market, before going over the analysis of the individual markets within the three countries.

A great deal of research has gone into understanding the determinants of the cycles in real estate prices from both the demand and supply side. Tsatsaronis and Zhu (2004) try to summarize the main findings of prior research by explaining both the determinants from the demand and supply side, including factors, which entail distortions within the market. According to their research factors stemming from the demand side include fundamentals such as nominal interest rate on bank loans (+), tax rate of first ownership of house (+), cost of detention related amortization and maintenance (+) and earnings and capital losses on housing (-). All of these factors are combined within one main determinant, the user cost of housing which along with factors such as population size, growth, disposable incomes (real/nominal) is used in composing the demand function. Tsatsaronis and Zhu (2004) elaborate that factors, which determine supply are availability of land, existence of transport infrastructure and regulation. Meanwhile the factors, which introduce distortions within the real estate market, include the innovation within the financial market making credit available for cheap and for general populace rather than just the upper middle class families. Furthermore, the introduction of tax breaks for first time buying and a highly regulated rental market with presence of subsidies and tax incentives for tenants have introduced even larger distortions within the market making them prone to large deviations from fundamentals.
To understand deviations within the real estate market Sorensen (2013, p. 8-18) evaluates whether real housing prices trend upwards. In constructing his analysis he concurs with the argument from Shiller (2007), who conducting a study on long term housing prices in the United States using his specially constructed index and concluded that housing prices do not tend upwards in the long term. This view is endorsed by many economists and by Sorensen (2013, p. 8-18) who goes to elaborate the relationship between the long run housing supply curve which is the total stock of housing is assumed to be horizontal whilst the marginal cost of building a house is supposed to be constant. As long as the price of existing houses is greater than the marginal cost of building a new house, each profit-maximizing firm will keep adding to the total stock of housing. However if the price of housing falls the building firms will see a fall in profit and need compensation for depreciation in housing prices thereby reducing the stock of housing. Consumers however demand a flow of housing services, which are assumed as proportional to the housing stock. The annual cost of housing services is given by the price of the house and the user cost, which we defined in the paragraph above. Hence, the demand of housing is defined by user costs and prices, as prices move upwards-citrus paribus the demand decreases, whereas when user costs move upwards ceteris paribus the demand decreases. Based on this view Sorensen (2013) says that we can deduce how housing prices keep in line with construction costs.

In the long run equilibrium housing demand meets the housing supply and where costs of acquiring a house and building one of a same type are the same. In such equilibrium the construction of new homes is just sufficient to make up for the depreciation of current housing stock ensuring the aggregate stock remains constant.

Sorensen (2013) also introduces a possible contention within this view by citing an argument made by some critics of Shiller (2007) who argues that changing two important components of the cost of supplying the house rather than assuming them fixed does not lead to a long term return to fundamentals. The first of these components is the price of the land on which the building is made. This is as a building company can counter the increasing prices by building a different building structure on the land for eg. an apartment instead of a house rather therefore avoiding the depreciation of the housing stock. The second of these is the productivity of labor, as labor productivity increase so does the price paid to labour as wages increases thereby increasing costs of construction in the future distorting the idea of a horizontal long run supply curve for housing.

3.1.2 Real estate bubbles

The prevailing view among economists tends to favour the view that housing prices do not tend upwards ad infinitum in the future. Pertaining to this view and in line with the difficulty inherent within pricing the real estate asset, the housing market is prone to the ‘bubble’ phenomenon. A bubble however is a rather vaguely defined term and is contaminated by its overuse by media sources. While a lot of work has gone into its identification, its definition and understanding remain ambiguous at best. Case and Schiller (2003, p.1) attempt to define bubbles as situations where excessive public future expectations of asset prices leads to an elevation in the price of the assets. Hence, they take a more behavioralist approach towards bubbles. Claussen, Jonsson and Lagerwall (2011, p.81) provide an opposing view, from a rationalist perspective by stating that bubbles can be interpreted in three different ways:
i) Housing Prices are above their long-term trend level
ii) House Prices cannot be explained by fundamental factors
iii) Models of the housing predict falling future real house prices

The first interpretation is rather ambiguous since it is dependent upon the time period in question and thereby the definition of long term could be interpreted in different ways, which would affect one’s view of housing prices. The second interpretation uses ‘fundamental prices’ which are based on fundamental economic variables such as interest rates, disposables incomes, household wealth, property taxes etc. This approach is again dependent upon the time period in question as housing prices adjust to short run equilibrium where housing demand equates the housing stock and it takes an even longer period of time for prices to adjust to the long term equilibrium where prices equate the cost of providing the house as explained in the last section. However there is hardly any difference between the second and third interpretation as both emphasize that overvaluation is where prices are above short or long run equilibrium which is established with accuracy (Sorenson, 2013, p.19). The only difference between the two interpretations occurs where one assumes the pricing in the short run is not an overvaluation hence there by the second definition would assume no overvaluation while the third one will retain that overvaluation maybe there since prices will depreciate in the future (Sorenson, 2013, p.19-20).

Sorenson (2013, p.19-20) elaborates that confusion when considering a housing bubble is not only limited to its definition but also to the nature of its occurrence. The rationalist approach to housing bubbles considers that a part of the price of an asset reflects an expectation of the price the next day, which is based on expected capital gain. While house prices should reflect the discounted valued of future housing services it produces, given that the rate of increase in house prices is lower than the discount rate, Market might believe for some reasons that the rate of increase of prices is greater than the discount rates which would produce current house prices exceeding the fundamental price by a component described as the ‘bubble’. This component grows in line with the expectations of future gain. Hence this situation describes when a housing price could be in rational expectation equilibrium and prices are confirmed by anticipations of further increases (Sorenson, 2013, p.20). This effect is demonstrated by Arce and Lopex (2011) in their study of bubbles rising up under rational expectations when there is a minimum collateral requirement combining the borrowing capacity of homeowners with the value of their houses.

However, those economists obtaining a behavioralist approach take a different view towards how bubbles arise in a market as explained by Case and Shiller (2003, p.321) who elaborate that “A tendency to view housing as an investment is a defining characteristic of a housing bubble’. Expectations of future appreciation of homes is the motivation for buying that deflects consideration from how much one is paying for housing services. That is what a bubble is all about: buying for the future price increases, rather than simply for the pleasure of occupying the home. And it is this motive that is thought to lend instability to bubbles, a tendency to crash when the investment motive weakens”. The emphasis of Shiller’s argument is that bubbles are characterized by unreasonable assumptions, widespread beliefs, and storytelling. This means bubbles are grounded in ‘irrational exuberance’. Lux (1995) attempted to formalize Shiller’s argument by using a model where some agents have a fundamental asset values while others do not. The uninformed investors either practice herding or
follow imitation strategies. Lux used his research to show how the uninformed investors by following an imitation strategy drove prices far away from the fundamentals but after sufficient deviation the asset returns to the fundamentals. Similarly researches by Hong and Stien (1999), Daniel et al. (1998) and Barberis et al. (1998) attempted to study bubbles from a behaviorist perspective of Shiller and concluded that prices in the short term tends to under react to fundamentals but gradually moves or overreacts to fundamentals in the long run.

Despite the confusions surrounding real estate bubbles there has been a significantly high correlation between bursting of property bubbles and financial/banking crisis in the world (Herring and Wachter.1998, p.2). Hence a period characterized by real estate bubbles or a that hinting a potential bubble in the future require a greater understanding in order to avoid the potentially disastrous effects after the bubble bursts.

3.1.3 Mortgage Markets
Bursting bubbles can impact financial institutions and banks in two different ways as argued by Herrying and Wachter (1998, p.3-5). The first of these as explained before is that real estate assets on balance sheets can lose value really fast in an event of a bust, hence affecting portfolios. The second of these impacts concerns the mortgage market as the value of loans collateralized by real estate would depreciate leading to defaults that reduce capital. This can also increase the perceived risk in real estate lending and therefore affect the supply of credit in an economy. However, Miles and Pillonca (2008, p.145-147) argue that the mortgage lending market plays more than just the role implied earlier within the calculation of user costs for determining the demand of housing as it can worsen the effects of contagion after a bubble bursts by affecting both the lender and the debtor as explained in the earlier sentence. Furthermore, since mortgage lending constitutes a central tenant of this study we will first give these markets a cursory look before going over to individual mortgage and real estate markets of the three countries we would be studying in this research.

In order to understand the magnitude of the mortgage markets one can observe the facts that the total outstanding residential mortgage loans in the EU 27 and Norway stand at a staggering €6.9 trillion, the residential loans to GDP ratio is at a 52% for the EU27 and 69.7% for Norway, and the total residential debt to GDP ratio stands at 81.4 % in EU 27 and 156.4 % in Norway (EMF, 2013, p.87-90). However, the significance of the mortgage market does not just stem from its sheer size but also because homeowners within the economy depend on them, because they fuel the economy and because they serve a wider ideological purpose in the neoliberal age (Aalbers, 2009, p.290). The liberalization of these markets have provided a wider access to homeownership and goes hand in hand with the neoliberal agenda of providing private property, firm ownership and risk taking for any willing to do so. This process had enabled more freedom for households (and ultimately individuals) in the sense that they are able to make decisions regarding risk taking, homeownership etc. without adhering to the income bracket they pertain to. However, it has increasingly made households dependent upon the financial markets for their long-term security, which is why housing risks stem primarily from the financial sector, and contagion within one quickly spreads to another. This phenomenon was evident in the financial crises of 2007 where contagion from the mortgage market spread into the financial markets (Aalbers, 2009, p.290).
Hence as Bergeson & Greibrok (2012, p.1-2) emphasize, developed economies within recent times have seen a phenomenal increase in mortgage lending due to innovation within products and easy credit policies allowing mortgage borrowing, once strictly upper middle income family activity, to lower middle and low income families. This has led to the expansion in both the size of the market and the scope of any potential threats imitating from it. This increase has reshaped bank balance sheets giving a large share to mortgages on bank assets. It has led to the development of large independent or state run mortgage institutions and therefore increased the mortgage debt to GDP burden. Furthermore, low mortgage rates, high loan to value ratios, lowering of down payment schedules, and flexible payment schedules have all played a crucial role in the appreciation of housing prices and increasing risks.

Mortgage and real estate markets today control a significant place within the realms of both academic and industry research due to both their sheer size and the eventual impact they have upon both financial institutions and individuals. Therefore before proceeding to our formal assessment of risks and risk management, we would now assess the outlook on the three individual markets within Scandinavia, Sweden, Norway and Denmark, to establish a framework for understanding the situation with reference to the latest reports available 2013 within these three economies.

3.1.4 The Countries’ Insights

Sweden
The overview of the Swedish market from the EMF (2013, p.70) report elaborates that Sweden witnessed stagnated economic growth at +0.8% and the National Institute of Economic research elaborated that after the sharp drop in demand for housing after the financial crisis the economy has not reached full utilization despite the quick recovery. However, the Euro debt crisis prolonged the Swedish recession and exports have not recovered substantially. Unemployment increased to 8% from 7.8% in 2012, while inflation remained at the 2% target. Gross government debt stands at 40% of GDP and residential housing loans to disposable income stands at 156.5% in 2012 (EMF, 2013, p.70).

The FinansInspektionen (Swedish Mortgage Markets, 2013) elaborates that housing completions have increase in 2012 to 26000 dwellings from 20100 in 2011 but these figures remain lower than the demand. Housing starts are lower from 2011 at 20100. The transactions declined by 4% in 2012 while the prices for single-family homes fell by 1.3% in 2012 it started rising phenomenally from the beginning of 2013 due to the raising of the loan to value ratio cap at 85% by FinansInspektionen (FSA). According to FinansInspektionen (Swedish Mortgage Markets, 2013) housing price increase is primarily driven by large cities like Stockholm, Gothenburg, and has prevailed throughout the mid 1990s. University towns and other cities have seen mild or even negative increases in prices while Malmo has seen a slight decline influenced by happenings in Copenhagen. Construction figures have seen an increase by 2.5% in 2012 over 2011, residential mortgages have grown by 4.5% over 2011, the variable interest rate on mortgages decreased to 2.90% in 2012 from 4.20% in 2011 and this has continued to decrease in 2013. Both net credit losses and doubtful loans have increased slightly by 0.01% and 0.03% respectively in 2012. Funding for the mortgages is via covered bonds primarily and Swedish institutions have managed to raise the stock of these by 1.6 % in 2012 to Euro 220 billion despite the chaotic market. The reason for
this increase stems from Basel III requirements favoring long term funding and from the increase in real estate lending (EMF, 2013, p.70).

There is quite a lot of research on the Swedish market though it seems to be rather contradictory. While some research including that from leading economists like Robert Shiller and Noriel Robini point towards bubble like conditions with property prices soaring, others contend such a position. This is visible in Peter Sorensen’s (2013) report on the trends and risks in Swedish housing market where he takes a multifaceted approach by establishing different definitions of housing bubbles and assesses the Swedish market in terms of these definitions. He concludes that while the Swedish market does not seem to be in a bubble like environment if assessed from a user cost model, it does seem to have had a +12% deviation from fundamental house price (price reflected by fundamental factors like borrowing costs, interest rates etc). Furthermore, Sorensen (2013) reiterates that the housing prices will gradually return to the fundamentals rather than a sudden drop unless a negative shock appears. This view is shared by Finansinspektionen Sweden (FSA) who in their report (Swedish mortgage market, 2013) express a similar view saying that only 1 in 10 Swedish borrowers use an unsecured loan, the amortization schedule is 140 years, and that banks are fairly resistant to this risk. However, Boverket (2013), the Swedish housing association takes a rather cautious approach towards the housing market by elaborating that the housing prices are 11% over fundamental values. Increased incomes and the falling costs of borrowing are fuelling a price hike in the property market (Boveket, 2013). Furthermore, they emphasize that the debt burden of households is increasing because of mortgage lending and that a negative shock can be extremely disastrous for the economy.

**Denmark**

The EMF (2013, p.38-39) writing on the Danish economy states that it went into a recession in 2012 as GDP contracted by -0.4% over the year. This deterioration was caused by slow growth in consumption and falling exports. Imports rose by 1% while exports rose by 0.2%. Private consumption remained low increasing 0.5% over 2012; gross capital formation and residential construction fell by 0.1% and 8.6% respectively. The interest rates remained low at 0.42% and 30-year mortgage rates were at 3% coupon. Negative real growth in wages, falling exports, job losses and uncertainty about the housing prices all have been depressing consumer spending in Denmark. Unemployment rate remained constant at 6.2% in 2012 while the labor market saw a decrease in employment by 0.7% and consumer prices rose by 2.4%. This negative outlook is further worsened by Denmark’s extremely high residential debt to disposable income ratio at staggering 205.7% given that house prices are falling 2012 by 3.2% underscores a potential trouble (EMF, 2013, p.38-39).

The Danish FSA (Risk Report, 2013) mentions that the Danish housing market retains a divided outlook, as developments within Copenhagen area are certainly different from those in the rest of the country. Copenhagen has witnessed a larger price drop than other areas in the aftermath of the crisis. The owner occupation rate fell by 1.1% from 2011 to 2012; this rate has been falling at 1.8% since 2007. The construction costs are increasing. The total outstanding mortgage loans increase by 2.1% in 2012 and stand at 2457 billion out of which 75% are residential. Fixed rate mortgages accounted for 47% of gross lending and are the highest share of gross lending since 2007. The adjustable mortgages stood at 51% of gross lending while mortgages with an interest cap made 2% of the total lending. Mortgage loans are entirely funded by issuance of covered bonds
and mortgage banks can apply extra collateral on loan-to-loan basis. The funding mix for the bonds includes a short term and a convertible component, which adjusts to a borrower’s demands (EMF, 2013, p.38-39).

Danish Mortgage market has had many supporters as reflected by opinions from not only the Bank of International Settlements (2004) but also from investment moguls like George Soros who emphasizes in his opinion to the Wall Street Journal (Oct, 10, 2008) that American regulatory and financial authorizes should learn from the Danish mortgage market and its various strengths such the presence of open pools, no quasi-monopolistic conditions and the conversion of mortgages into securities by issuance of a covered bond. Hence, Bank for International Settlements and major investors support the current Danish model of mortgage issuance and coverage. Furthermore, Admunsen and Arnt (2005) discover that the risk of contagion within banks in Denmark at loss given default of 100% is fairly limited with only a couple of small banks exposed and no knock on effects possible. Hence, studies have been indicating a fairly safe Danish market.

Sorensen (2013) however elaborates that Denmark saw a housing bubble in 2005-2006, which led to massive increases in prices, which could not be explained by the present models. However, the economists at the National Bank of Denmark overhauled the models and produced a new model based on a user cost model. The Danish market saw a downturn with the fall in housing prices and consumer confidence and net exports collapsed both of which have been trying to recover since then yet have not. These conditions led to a fall in investor confidence and it made it difficult for Denmark to obtain international funding during the financial crisis. This has resulted in the anaemic growth in Denmark and furthers the seriousness of housing bubbles, which despite strong mortgage industry in Denmark produced grave consequences for the economy.

**Norway**

EMF (2013, p.77) mentions that Norway outpaced the OECD growth rate by growing at 3.5% in 2012 an increase over 2011. However, exports remained weak and just grew by 2.2% in 2012 while petroleum investments increased by 10% in 2012. Inflation remained low as indicated by the CPI at +0.8%, which was result of a strong krona and low and falling interest rates. This has reduced financial costs, house renting prices and margins. The interest rate in the 2 month money market was 2.2% a decrease of -0.7% of 2011. Unemployment decreased by 0.1% to 3.2% in 2012. The outstanding residential mortgage lending per capita increased in 2012 to €70114 per person from €62000 in 2011 and outstanding residential mortgage lending to disposable income ratio has now become 156.4% while the house prices growth is at 6.6% indicating a bubble like conditions (EMF, 2013, p.77).

Furthermore, EMF (2013, p.77) also elaborates that the rapid increase in housing prices by Q4 of 2012, which had hit +7% was a result of increase in population and declining interest rates. The housing starts rose to 30200 in 2012 from 27000 in 2011 triggered by population growth. A lot of the increase is due to an influx of immigrants from eastern European EU-Countries. However, building costs have increase by 3.1% in 2012 which is a lesser increase than 2011’s 3.7%. The total mortgage lending has increased by 14% in 2012 where in mostly traditional mortgages are being sought after. Mortgages account for 84% of the total debt of households while the household debt itself has increased now becoming 1.6 times the household income. The increase in mortgages
and debt has thrown in speculation about possible financial instability as increasingly loans with higher LTV ratios are being issued. The Norwegian FSA has recommended lowering the mortgage LTV ratios. The Funding for mortgages via bonds increased by 33% in 2012 to NOK 82.3 bn. Furthermore unlike Sweden and Denmark where covered bonds make most or all of the mortgage lending, Norway allows mortgages to be covered by interbank loans, bond debt, short term debt and customer deposits which exposes its banks to risks emanating from the mortgage market (EMF, 2013, p.77).

Most of the academic research concluding with regards to housing prices and existence of bubbles hints at the possibility of a bubble or at the very least bubble like conditions in Norway. Miles and Pillonca (2008), Bourassa, Hendershott & Murphy (2010), Svenska BoVerket (2013), all conclude that the real estate prices as well as the percentage of mortgage debt as compared to disposable income is high for Norway as compared to other economies. Furthermore, to highlight the concern of probable financial distress Almklov (2008) argues that the use of controversial products by Norwegian banks in the forms of structured financial securities with bond and option components, and credit lines secured on dwellings has been widespread. These products while giving no significant return are an increasingly risk venture for the banks.

3.2 Financial Risks in Banks and Financial Institutions

Financial risk is a broad term encompassing risks involved in all kinds of transactions in banks and financial institutions’ daily businesses (Hull, 2012, p. 37). It is the risk of loss, which stems from both counterparty creditworthiness and shocks that change market conditions or states of the economy (Hull, 2012, p.347-367). Increasingly global markets have improved the efficiency and integration, which has led to problem that risk contingent within the system once shocks occur threatens the global financial system. The financial crisis of 2007 is a representative of this problem. Hence, partly due to the large exposure of risks from the financial system and the important role banks and financial institutions, it is worth having a brief review on types of risks these institutions bear before going towards risk management and measurement. Within this discussion we would emphasize on credit risk since it appears to be one of the primary causes of the last financial crisis and is the primary field of study for our research.

In the works of Santomero, 1997; Vyas and Singh, 2011; Duffie and Singh, 2012; Hull, 2012 risks are discussed in different scopes. However they seem to converge into four main types - operational, liquidity, market and credit risk.

3.2.1 Operational risk

This risk can be seen as a broad term including internal and external risks. BIS (2001) defines it as ‘loss resulting from inadequate or failed internal processes, people and systems or from an exposure to an external event’. Internally, operational risk implies all the risks associated with the institution’s daily operations. For instance, trade entry mistakes, failed process of trade settlements, inaccurate models, and actions of ‘rogue traders’. Externally operational risk accounts for political, legal issues and catastrophic events. Due to the wide scope of the risks involved, operational risk is hard to quantify and manage (Gregory, 2010, p.2).

3.2.2 Liquidity risk

‘Liquidity risk of a financial firm is its ability to meet its debt obligations without incurring unacceptably large losses’ (Lopez, 2008). Hull (2012, p. 469) puts it more
simplistically – ‘the risk that an asset or security cannot be traded quickly enough in the market to prevent a loss’. The idea is that it is required for firms to have sufficient liquid assets to meet short term debt obligations and small shocks. Brunnermeier and Perdersen (2009, p. 91,94) characterized these two requirements by the concept of funding liquidity and market liquidity, which is the availability of cash and the transformability into cash respectively. Liquidity risk is amplified in stressed market conditions when traders become “irrational exuberance”, overexposed themselves to particular risks (Alan Greenspan’s speech, December 1996; Shiller, 2005).

3.2.3 Market risk
Market risk is defined by BIS (2003, p.30) as the ‘risk to institution resulting from movements in market prices’. Vyas & Singh (2011, p.16) classified this by risk of changes in interest rates, foreign exchange rates, equity and commodity prices. Market risk is at a certain extent identical to systemic risk, which is the risk of a ’ripple effect of a trouble’, a default by one financial institution leads to defaults of other financial institutions threatening the stability of the financial system (Hull, 2012, p.258). Once these risks arise, they hit the performance of the entire financial markets. Therefore market risk is considered to be a non-diversifiable risk against which banks can only hedge.

The LMLIs in our study are exposed to the risk of losses due to possible surging interest rates and declining housing prices. This results in the deterioration of the value of a house and the credit conditions of mortgagors, which in turn creates losses to respective mortgage institutions.

3.2.4 Credit Risk
‘The potential loss that a bank borrower or counterparty will fail to meet its obligations in accordance with agreed terms’ (BIS, 2000, p.1). Duffie and Singleton (2003, p.3) add that credit risk is a deterioration of counterparties’ creditworthiness, which implies the perceived credit quality of borrowers or counterparties might deteriorate, without default being a certainty (Bruyere. et al. 2006, p. 8). In other words the former case implies a more severe actual loss whereas in the later case future loss is more likely leading to a mark-to-market impact. According to Gregory (2010, p.2) to characterize credit risk it is important to take into account not just probability of default but also exposure at defaults and associated recovery values.

Credit risk exists in loans and other types of assets, such as bonds, short-term debt securities, derivatives, unused credit lines, guarantees and documentary credit (esrb. 2004, p. 10). Loans, however, are the largest elements of credit risk as banks face the default risk from loan borrowers (BIS 2000, p.1). In this case, Santomero argued that borrowers either have inability or unwillingness to perform their loans’ obligations (1997, p. 9). Consequently financial institutions or lenders of the issued loans will be in trouble with their loan portfolios and their debt creditors as well.

In this study we delve into LMLIs, their exposure to the residential real estate mortgage in Scandinavia. Due to the exclusive business in granting mortgages to mortgagors, these institutions bear substantial credit risk which is specifically the default risk of the borrowers. Credit risk in loan portfolios can be diversified through the combination of for example different homogenous group of borrowers, although the diversification effect is limited since default risk can be triggered by the market risk, which is not fully under financial institutions’ control. This is the main motivation of our study since we
will investigate factors that trigger default risk of mortgagors and then examine the extent that a mortgage lending institutions can be exposed to.

3.3 Risk Management and Measurements

3.3.1 An Overview
The idea regarding risk management stems from one of the primary functions of firms, which is the provision of adequate reward for bearing a certain risk. This risk reward framework, however, is not the only reason why firms specifically financial manage there risks. Costs in the wake of bankruptcy and the reluctance of governments to grant bailouts, as seen in the case of Lehman Brothers, are other reasons why firms might want to manage risks. Furthermore, specifically in the case of financial firms governments have established strict regulatory requirements in order to ensure financial firms manage their risks.

While the subject of risk management in financial institutions is an idea which has been floating around the industry for quite some time, the marked beginning of the importance of risk management came with the BIS Accord in 1988 where the 12 members of the Basel committee set down making the first regulatory requirements for banks. After phenomenal changes by the addition of VaR and Back-testing procedures, netting and marked to market accounting in 1996, the Basel committee published the new Basel II requirements in 2005, which were adopted in 2007. These requirements had a three tier structure which required banks to have minimum capital requirements, conduct a supervisory review and work towards maintaining market discipline. Along with this the rules within risk management were also revamped and made more stringent. However after the financial meltdown of 2008, there was an outcry by authorities across the world regarding the malpractices within the financial sector and this paved way for the Basel III, which follows a 6 parts structure as follows:

1. Capital Definition and Requirement
2. Capital Conservation Buffer
3. Countercyclical Buffer
4. Leverage Ratio
5. Liquidity Risk
6. Counterparty Credit Risk.

Hence the entire structure of the Basel II was shaken up and made more stringent. While the deadline for the adoption of Basel III is set in 2015 it has already been adopted by a large number of financial institutions. The start of the credit crisis in 2008 therefore also brought back risk management into the limelight making it the ever growing and researched field within international finance (Hull et al 2009, p. 257-288).

Risk management within financial institutions follows two distinct methodologies. The first of these uses risk decomposition where in each individual trader is responsible for the trades he makes, while the second is aggregation whereby all risks are pooled together in order to assess their impact on the institution as a whole (Hull et al 2009, p.17).
3.3.2 Risk Aggregation
The Basel committee specifies risk aggregation as one of the most important sections within its report on the ‘The principles of effective risk reporting’ (2013). Risk aggregation is impressed on by not only regulatory bodies but also by investors and board members who require a basis to make decisions regarding risks, which are easier to do if aggregation is done to provide hard numbers. Risk aggregation is done in principle by combining the various risks stemming from a number of different channels and even within each channel. Hence, not only figures from operational, credit, market, reputational and liquidity risks are combined but also figures within each channel, such as those stemming from different products creating credit risks are combined in order to calculate aggregate credit risk statistics.

Skoglund (2013) elaborates that risk aggregation is carried forward via two distinct approaches the top down approach where the risk measurement at individual levels, the market risk in the trading book, the credit risk in the trading and banking book, the operational risk in the management systems are combined into a figure for risk using the established models. The other method is the bottoms up approach wherein the sub-risks are combined at different levels using correlations or copula models. He goes on further by explaining the various models involved and concludes that while the top down approach is easier and faster the bottoms up is more explanatory and that the type of risk determines the approach used to aggregate it.

3.3.3 Risk Decomposition
The concept of Risk Decomposition itself is an idea that stems from the very beginning of the research on risk and return when Harry Markowitz (1952) composed his influential insights into what has now shaped up to be the modern portfolio theory. The central tenet of modern portfolio theory is that the total risk from a portfolio is lower than the sum of the individual parts. The idea of risk decomposition basically aims to compute the risk stemming from each constituent part of a portfolio or a firm for that matter. Models used within this regard range from standard volatility measures of standard deviation, mean, kurtosis and skewness of the returns distributions (Marchiorio, 2010, p.1-2).

3.4 Methods for Risk Management and Measurements
The task of risk management does not only include measures for their identification but also methods for protection against the risks. The tools at the disposal of the firm management depend on the type of risk faced by the firm as well as its risk management appetite. Trading risks are protected against by using individual tools available for the disposal of the firm such as derivatives, bond insurance also known as credit default swaps, or other indexes, swaps or futures. However for firm wide risks the firm needs to use measures such as allocating risk or economic capital, which is basically a capital buffer to protect against downside risks stemming from credit, market, operational, model, reputational or other forms of risk.

As discussed in the types of risk section, market and credit risks have large impacts on mortgage lending institutions, and credit risk is triggered by market risk, meaning that possible fluctuations of market factors lead to potential defaults. However credit risk has more direct impact on the bank mortgage portfolio, which is exposed to the risk of defaults of mortgagors, we focus more on discussing methods for credit risk management and measurements.
Credit risk management has remained as one of the more dynamic ideas within the domain of risk management as measures within it have evolved from simple assumptive models to increasingly complicate and robust models, which have a strong exploratory power. In their paper Altman and Saunders (1998) tried to summarize the major developments within credit risk measurement in the last twenty years. They begin by defining the forces, which have led to such a dynamic approach towards credit risk management. These are as follows:

(i) increase in bankruptcies worldwide
(ii) trend towards disintermediation
(iii) competitive margins on loans
(iv) falling values of real assets
(v) increase in off balance sheet instruments.

These factors have resulted in the development of sophisticated tools and a move towards measures for other fixed income and entire portfolios. We will now discuss the credit risk measurement models in parallel with proxies used to measure them. These models are widely used within both academia and industry.

3.4.1 Expert Systems and Subject Analysis

The early analysis of credit risk relied on ‘experts’ (experts being bankers) subjective analysis of borrower characteristics. This analysis introduced a number of biases within the credit risk management process as it relied on a subjective view rather than an objective analysis (Altman & Saunders, 1998, p.1722-1723). Probability of default entailing a number of measuring proxies is an example of this analysis.

Probability of Default

The risk of credit comes from a possibility of counterparties in derivative transactions, borrowers; bond issuers may default on their obligations (Hull, 2012, p. 347). In acquiring information regarding the possibility of an event happening we switch to the domain of statistics dealing with probability theory. Hence, probability of default is estimated by a number of different methods including: credit ratings, historical data, internal ratings, recovery rates, spreads on credit default swaps, delinquency rate, value at risk and expected loss (Hull, 2012, p. 347-367). A number of these proxies are discussed in the following.

- Credit Ratings

Credit Ratings are ratings of creditworthiness of a corporate bond granted by a rating agency (Hull, 2012, p. 347). Moody’s, S&P and Fitch are popular rating agencies. Ratings can be granted into four classes from A- to D- with increasing probability of default. Each agency designs its own rating standards. Methods used for assigning credit quality of a corporate usually consider ‘through the cycle rating’ meaning that rating agencies take into account long-term perspectives of relevant factors and thereby smooth out the performance (Hull, 2012, p. 347). Credit ratings from these agencies can also applied into calculating of hazard rate based on the historical values of the ratings (Hull, 2012, p. 347-348).

- Credit Default Swaps (CDS)

A credit spread considered as an average rate of loss for a given time period wherein the time period is the maturity date of the CDS (Hull, 2012, p.351). With a given recovery rate, the average hazard rate between time zero and time to maturity can be calculated.
Hazard Rate = Credit Spread given a certain time to maturity 
1 – Recovery Rate

Hazard rate from CDS Swap Rate (Hull, 2012, p.361)

This process can be repeated using the bootstrap method using different credit spreads for different maturities. In order to calculate the expected loss we first deduce the loss on a bond by using computing the default free values of the bond given by the forward risk free interest rates and subtracting these by the recovery amount in order to produce the loss amount. This loss is multiplied by default probabilities calculated using the Hazard rate to produce the expected loss (Hull, 2012, p.361).

- **Delinquency Rates**

Delinquency rate is an indicator for the quality of a bank loan portfolios computed by the number of past due loans divided by total number of current loans (Investopedia). Delinquent loans need to last for a certain length of time until the lender would affirm it delinquent. Delinquency rates on loan are affected by the borrower’s credit quality, like disposable income or macroeconomic factors, such as employment, housing prices (Igan & Pinheiro, 2010, p.11). Delinquency does not necessary lead to a default although it tends to be the precursor of default; therefore most of literature focuses on the probability of default to measure the risk banks exposed to mortgages (Diaz-Serrano, 2005). However, at a certain extent delinquency rate influence the final mortgage default. According to Diaz-Serrano (2005), shock in income, financial resilience of mortgagors, and amount of equity invested in the mortgage are factors that determine mortgage delinquency.

- **Value at Risk (VaR)**

VaR is a measure for the potential loss in value of a risky asset or portfolio over a defined period for a given confidence interval (Gregory, 1996, p. 20). Simply put, VaR attempts to make this statement ‘We are X% certain that we will not lose more than V dollars in time T’ (Hull, 2011, p. 471). VaR is used as a standard summary of market risk exposure, which has become popular among financial firms, banks and regulators during the last two decades due to its simplicity and convenience (Hull, 2012). Several approaches have been developed to compute VaR. Among these there are three popular ones, namely Historical Simulation, Monte Carlo and Variance Covariance (Jorion, 1996; Duffie & Pan, 1997; Linsmeier & Pearson, 2000; Dowd 2002; Hull, 2011). In contrast to Historical Simulation, which employs historical data on loss and profit to guide future outcomes, the other two methods demand estimates of standard deviations and correlations of the portfolio assets with the assumption of normal distribution of these variables.

Although VaR is a popular measure, there is criticism against the measure. For instance, Beder (1995) criticises that VaR is ‘dangerous’ because of the reliance on input parameters and data assumptions; Yami and Yoshiba (2012, p. 2216) and Hull & White (1998) criticise on the disregarding of fat-tailed of actual returns and lack of subadditivity property; and Crouhy, Galai & Mark (1998) criticise on the computation of VaR is substantially exposed to misspecification and model risk especially in the case of firms with large portfolios.
- **Expected Loss**

Expected loss is defined as the expected amount of a loan that will be lost within one year in the case of a default (Hlawatsch & Ostrowski, 2009, p.133). Expected loss is indeed a credit risk measure regulated in Basel II by BIS (2010). From this measure Basel II can implement regulatory capital requirements on banks. In order to adapt the legal qualification and also to signal the banks’ healthy financial conditions, most large banks adopt this method to measure total risk of their loan portfolios. Detail measurements are usually disclosed in the bank capital adequacy risk management report. Expected loss (EL) is computed by the three multiples, Loss Given Default (LGD), Exposure at Default (EAD) and Probability of Default (PD). Here is the formula:

$$\text{EL} = \text{LGD} \times \text{EAD} \times \text{PD}$$

BIS (2010) clarified the terms as the following: PD provides the average percentage of obligors that default in a rating grade in the course of one year, EAD offers an estimate of the outstanding amount in case the borrower’s defaults and LGD is the percentage of exposure the bank might lose if the borrower defaults. In the context of mortgage lending institutions, LGD is understood as the collateral value. Assented by Basel II, these risk components are computed by banks’ Internal Ratings-based model (IRB). This model allows banks to incorporate their own estimated risk parameters for calculating the regulatory capital requirements. Hence the method reflects the credit risk sensitivity of individual bank portfolios and incentivizes compatibility for better risk management to minimize the regulatory capital (BIS, 2001).

### 3.4.2 Accounting based Credit Scoring Systems

Accounting based credit scoring systems rely on credit ratings given based on certain variables or factors. Earlier univariate credit based scoring systems were used in order to compare key accounting ratios with accounting group norms. However, later this developed into multivariate models where key accounting variables were combined with weightings to give credit scores or probability of default measures. The primary models used for multivariate approach include the linear, the logit, the probit and the discriminant analysis model. Later developments focused on developing models similar to Altman (1977) and CAMEL models (Altman & Saunders, p.1998, 1724).

- **Altman Z-score**

Altman Z-score is a measure to predict default. The method was name after Edward Altman who pioneered the use of financial ratios and developed a Z-score through a discriminant analysis to predict defaults of industrial firms (Altman, 1967). By analyzing financial ratios within a multivariate framework, the test becomes more significant comparing to common technique of sequential ratio comparisons (Hull, 2012, p. 349). Below is the discriminant function developed by Altman is as follow:

$$Z = \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + \beta_5X_5$$

Here $X_1$ stands for working capital/ total assets, $X_2$ for retained earnings/ total assets, $X_3$ for EBIT/ total assets, $X_4$ for market value of equity/ book value of total liabilities and $X_5$ for sales/ total assets. According to Altman (1967) default can be accurately predicted up to 2 years prior to actual failure. Specifically, firms having a Z score greater than 2.99 belong to the ‘non-bankrupt groups while those below 1.81 are bankrupt and firms in between the range of 1.81 and 2.99 classified as in ‘grey area’ implied for alerting case of default.
• **CAMEL**
The abbreviation stands for capital adequacy, asset quality, management, earnings and liquidity, which represent financial performance, financial condition, operating soundness and regulatory compliance of the banking institution (BIS, 2000). Each of the components is rated on the scale of 1 (best) to 5 (worst). CAMEL is said to be a highly significant indicator to predict default risk due to a thorough assessments of each indicator (a more detailed measurement is in BIS, 2000). For instance factors used for rating ‘Management’ of the firm, such as technical competence, leadership, level of compliance with banking laws and regulations, etc are all qualitative indicators, which only regulatory agencies have the authority to assess. Due to this restriction, CAMEL is widely used by supervisory authorities. However there are a few studies that come up with financial ratios providing approximations for CAMEL (Van der Ploeg, 2010; Hays et al., 2009).

3.4.3 **Risk of ruin models**
With the problems inherent within discriminant analysis models of risk as those developed by Altman (1969) or early warning systems developed by Sinkey (1975; 1977) there has been an increasing move towards understanding how bankruptcies and risk of ruin plays into the valuation of firms. A lot of research has now started using more stochastic models in order to see how risk to ruin plays into the valuation of companies. The method for estimating risk to ruin derives inspiration from models such as those based on Merton (1974), Black and Scholes (1973), and Hull and White (1995). The idea behind these models is to calculate the distance to default or observe how default ties into valuation procedures. (Altman & Saunders, 1998, p.1724) We will observe some of the most popular models used within academia and industry for the estimation of risk stemming from credit and employ this within our analysis.

• **Merton’s default model**
This model predicts default probabilities and was developed by Merton in 1974 based on the option-pricing model of Black and Scholes (1974). Applying the same approach of pricing options, Merton developed a model to price a ‘firm equity’ thereby estimate probabilities of defaults. Merton (1974) assumes a firm equity is a call on the assets of the firm with the debt outstanding as a strike (illustrated in the figure 4) and that the firm defaults if assets are less than debt at maturity.

![Figure 4 Equity as an Option of Asset](image)

Given the assumptions of firm’s assets ($V_0$, $V_T$) and equity ($E_0$, $E_T$) today and at time T when the debt dues, of volatility of assets ($\sigma_A$) and equity ($\sigma_E$) and of debt interest and principal due to be repaid at time T (D), Merton’s model yields the probability of default, loss given default (i.e. $1 - \text{recovery rate}$) and the resulting spread over risk free that a corporate has to pay on its liabilities.

• **Distance to Default (DTD)**
DTD is a measure of credit risk and is an output of Merton’s model. Hull (2012, 370) explained DTD as the number of standard deviations the asset price must change for default to be triggered T year in the
future. DTD has to large enough; the more DTD reduces the more likely the company becomes default. The formula is as follows:

$$\frac{\ln V_0 - \ln D + (r - \frac{\sigma^2}{2})T}{\sigma \sqrt{T}}$$

A challenge in implementing Merton model and its output Merton’s DTD model is the importance it places in the estimation of the asset market value and asset market volatility since a firm as a going concern presumably possesses intangible assets and volatility involves a time series of observed asset values which are hard to determine. Hence, Merton’s model cannot be applied directly (like Black & Scholes model) without other methods to estimate the unknown variables. However, literature has revealed a number of methodologies to estimate these parameters. A few of these methods are: the volatility restriction method proposed by Rone and Verma (1986), Jones et al. (1984); the market value proxy method used in Brockman and Turtle (2003), Eom et al. (2004), the KMV iterative method described in Crosbie and Bohn (2003) and the Maximum Likelihood Estimate (MLE) developed by Duan (1994). The propositions have their strengths and weaknesses depending on the underlying assumptions and been criticized by other researchers. Despite all these, KMV appears to be commercially a common credit risk assessment (BIS, 2005), moreover, the MLE method according to Duan and Wang (2012) prevails over other existing methods.

### 3.4.4 Our chosen measure: Distance to Default

Out of the numerous methods for risk measurement, we chose distance to default. The reason for doing so depended upon both the ease of implementation in light of data constraints and the exploratory power of the method. Measurements relying on the probability of default approximated by different proxies are not our choice because of data constraints. Methods relying on credit ratings, available via rating agencies could be used yet they were too general a measure for our analysis and the ratings generally are subjective to the respective ratings agencies. Among other measures; Altman Z-score is more applicable to non-financial firms and CAMEL covers a wide range of quantitative as well as qualitative indicators, which we cannot obtain. If we were to use proxies to approximate the CAMEL we would need to analyse them in combination with other risk measures such as credit ratings in order to assure that they reflect the appropriate risks. Moreover these risk measurements are associated with models having intrinsic problems such as data measured on discreet intervals or ‘the world not being linear’. Hence, these reasons lead us to the choice of distance to default. However, we had to adjust our approach towards the distance to default in order suit our data and this we discuss in the next chapter.

### 3.4.5 Factors influencing bank / institutional distress

In conducting this research we employed various ratios as variables to address the question regarding institutional business models and real estate businesses by observing their impact upon the distance to default measure we selected. The variables employed capture various aspects of business model changes and real estate businesses within the modern financial institutions. Furthermore, these are motivated by the theoretical framework, which we would address in the following discussion.

The interest in firm distress or default has been hotly investigated throughout time. This is particularly pronounced with regards to the financial firms, where distress has had wider systemic effects on the overall economy. However, the work by Beaver (1966) and Altman (1968) gave this field a proper structure for analysis and has guided
research so far. Both Beaver and Altman’s approach towards understanding various variables associated with bank distress carries on until now despite the changing nature of models and variables associated with the consequent studies. The literature about influences on bank distress has evolved by building upon the earlier studies by Altman and Beaver into even more complex and explanatory variables. The research evolved by incorporating ratios and measures which address the changing nature of institutions and businesses. Van Der Ploeg (2010) in his study of the literature on bank defaults gives a thorough understanding of the framework established by researchers wherein he indentifies the following risk factors: capital adequacy, asset quality, management quality, earnings and liquidity, within which the variables studied, could be clustered into.

The table below taken from Van Der Ploeg (2010) explains the various ratios used within the context of the factors emphasized above within some of the most prominent literature from 1977-2008.

Table 3 Summary of Factors influencing distress in previous studies

<table>
<thead>
<tr>
<th>Study</th>
<th>Model</th>
<th>Significant Variables</th>
<th>Capital Adequacy</th>
<th>Asset Quality</th>
<th>Management Quality</th>
<th>Earnings</th>
<th>Liquidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Martin (1977)</td>
<td>Logit</td>
<td>4</td>
<td>GCARA</td>
<td>GCONI</td>
<td>NITA</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bath et al. (1985)</td>
<td>Logit</td>
<td>5</td>
<td>NWTA</td>
<td>ISFTP</td>
<td>NITA</td>
<td>LATA</td>
<td></td>
</tr>
<tr>
<td>Thomson (1991)</td>
<td>Logit</td>
<td>7</td>
<td>NCAFTA</td>
<td>NCOTA</td>
<td>ROA</td>
<td>LIQ</td>
<td></td>
</tr>
<tr>
<td>Wheelock &amp; Wilson</td>
<td>Hazard</td>
<td>8</td>
<td>TETA</td>
<td>TLTA</td>
<td>CFIN</td>
<td>NITA</td>
<td>LIQ</td>
</tr>
<tr>
<td>Arena (2008)</td>
<td>Hazard</td>
<td>8</td>
<td>TETA</td>
<td>TETL</td>
<td>ROA</td>
<td></td>
<td>LATL</td>
</tr>
<tr>
<td>Anderson (2008)</td>
<td>Hazard</td>
<td>6</td>
<td>CAR</td>
<td>RMGL</td>
<td>ROA</td>
<td></td>
<td>NBLI</td>
</tr>
</tbody>
</table>

GCARA = Gross Capital / Adjusted Risk Assets, GCONI = Charge-Offs / (Net Operating Income + Loss Provision), CILLN = (Commercial and Industrial Loans + Loans to REITs and Mortgage Bankers + Construction Loans + Commercial Real Estate Loans) / Total Assets, NITA = Net Income / Total Assets, NWTA = Net Worth / Total Assets, ISFTP = Interest Sensitive Funds / Total Funds, LATL = Liquid Assets / Total Assets, NCAFTA = (Book Equity + Loan Loss Reserves – Loans 90 Days Past Due - Non-Accruing Loans) / Total Assets, NCOTA = Net Charge-Offs / Total Assets, OVRHDTA = Overhead / Total Assets, CFIN = Loans to Insiders / Total Assets, ROA = Return On Assets, LIQ = (Federal Funds Purchased – Federal Funds Sold) / Total Assets, CAR = Capital Adequacy Ratio, RMGL = Residential Mortgages / Gross Lending, ELOSS = Expected Loss based on PD / Gross Lending, CONS = Herfindahl Index for Loan Portfolio, NBLI = Norges Bank’s Liquidity Indicator, OEIQ = Operating Expense / Operating Income, TLJD = Total Loans / Total Deposits, CDR = Total Domestic Time Deposits / Total Assets, NPCR = (Primary Capital – Nonperforming Loans) / Average Total Assets, TLTA = Total Loans / Total Assets, OHR = Operating Expenses / Average Total Assets, TETA = Total Equity / Total Liabilities, OROTA = Other Real Estate Owned / Total Assets, NPLTA = Nonperforming Loans / Total Assets, CSTIN = Cost Inefficiency, TETL = Total Equity / Total Liabilities, LATL = Liquid Assets / Total Liabilities

Source: Van Der Ploeg, 2010. p.10

The table above depicts that most of the studies within this time period had significant results for the ratios, which formed a proxy for the risk factors identified as the CAMEL risk factors.
However, aside from the more prominent literature within bank distress/default which focuses on CAMEL ratios, Blundell-Wignall & Roulet (2013) and Igan & Pinheiro (2009) take a different approach towards the factors determining default as they focus on business models and impacts from the real estate markets. Blundell-Wignall & Roulet (2013) in their study of large OECD lending institutions use macro ratios to observe the presence of systemic influences in bank defaults and balance sheet ratios which express the core business model of banks which include wholesale funding, gross market value of derivatives, trading assets, interbank asset ratios. They also account for the diversity of banking operations by accounting for cross-border revenues and number of subsidiaries. Hence, their approach towards determinants of default is rather expansive covering a wider dimension of ratios in line with the global nature of the financial institutions today. Igan & Pinheiro (2009) do not take such an expansive approach; however, their focus is more towards ratios gauging the impact of mortgage lending businesses and real estate markets which is why they include ratios such as outstanding mortgages, mortgage loan to total assets and non-performing loan ratios. Hence, our research takes inspiration from these two studies as we study a cross country market and emphasize on the mortgage lending businesses of financial institutions therein.

### 3.5 Research Model

**Figure 5 The Research Model**

In light of the theoretical framework surrounding Scandinavian mortgage markets and conditions for bank default, we developed a two-tiered analysis of our primary question.
The two-tiered system is inspired by the approach taken by Igan & Pinheiro (2009) in conducting their analysis of commercial bank exposure to real estate markets within the United States prior to the financial meltdown of 2008. Our approach, however, looks at this question with an increase in depth and complexity as compared to Igan & Pinheiro (2009). This pertains to the fact that we have included specific variables in compliance with the Scandinavian markets and we have used a more sophisticated approach towards studying the question with our use of Merton’s Distance to Default model for estimation of default and wide-range of ratios capturing effects from the mortgage businesses of the institutions.

The two-tiered approach itself allows us to acquire a profound understanding at both the individual and the economy-wide level to understand the exposure of real estate markets. The first tier of analysis involves the determination of factors, which affect the delinquency rate within bank portfolios. This analysis tries to understand macro and micro factors behind delinquency within the context of Scandinavian markets over a chaotic period of 2000-2013. The analysis attempts to provide an understanding on a wider policy level of the various economic factors affecting delinquency rates.

The second tier concerns the large financial institutions within the three economies and tries to observe the impact stemming from various balance sheet factors and from their mortgage businesses. In this tier, we attempt to understand the factors within financial institution books along with two macro economic factors, housing price and interest rates, which can lead to distress within the institutions. We measure distress by the using a distance-to-default measure inspired by Merton (1977) model and in line with Bottazzi et al. (2011) model for measuring distance to default relying on book values. This analysis completes our outlook from a risk management perspective as it delves into specific factors from individual banking books and from mortgage business segments which can affect an institution. Hence it provides an in-depth understanding of the risks stemming within the banks credit portfolios from the real estate markets.

The two-tiered analysis, therefore, tries to understand the risks from real estate markets from both a macro and micro perspective as it attempts to understand macro influences into the delinquency rates and the impact within institutions of risks to the credit portfolios from the market.
CHAPTER 4: PRACTICAL METHOD

This chapter explains the practical method used in conducting this study. First of all we draw hypothesises deduced from relevant theories presented in the previous chapter. Then we present the data collection method along with the computation of proxies. The chapter ends by a clarification of statistical tests used to analyse the data.

4.1 Hypotheses

The objective of this study is to discover how a volatile real estate market impacts LMLIs in Scandinavia during the period 2004-2013. In order to do this, two sub-questions need to be answered:

What are the effects of selected factors on delinquency rate of mortgagors in Scandinavia during the period 2000-2103?

Does the change in institutional business models and mortgage lending business affect its distance to default?

4.1.1 Delinquency rate of mortgagors

Our main argument on the possibility of a delinquency among borrowers stems from the low declining interest rates under a long period and the surge of housing prices throughout these years. As discussed in the problem background and theoretical framework, the moves in housing prices does not always match the changes in other prudential economic factors such as disposable income, household wealth or interest rates. Therefore the borrower’s probability of delinquency on mortgages becomes more likely when he/she encounters an income shock or unfavourable changes in loan terms making it troublesome for keeping up with regular interest payments. Moreover, macroeconomic shocks, such as rising interest rates or stagnant economies are likely to have strong impacts on defaults by mortgagors as well. With these arguments we model the aggregate delinquency rate as a function of the following explanatory variables aggregate mortgage rate, household debt to disposable income ratio and unemployment rate while controlling for variables indicating the position of the housing market such as housing prices, mortgage credit growth outstanding mortgage and the business cycle – GDP growth, interest rate changes and social benefits. Hence we expect these factors lead to delinquency of mortgagors noticing that some factors carry a more significant impact than the others. Stated below are the assumptions and hypotheses with regards to individual variables.

The first model is:

\[
\text{Delit} = \beta_0 + \beta_1 \cdot \text{RFit} + \beta_2 \cdot \text{HPIChngit} + \beta_3 \cdot \text{Unempit} + \beta_4 \cdot \text{DebtIncomeit} + \beta_5 \cdot \text{SocialBenefitit} + \beta_6 \cdot \text{GDPgrowthit} + \beta_7 \cdot \text{MortRateit} + \beta_8 \cdot \text{OutMortgtit} + \beta_9 \cdot \text{Mortgrowthit} + \text{Vit}
\]

**H1-Risk free rate (RF).** The risk free rate reflects the monetary policy of the central bank. A change in risk free rate affects a number of other factors such as mortgage rate, household income and housing prices. Delinquency is expected to have positive relation with RF (+). Based on this assumption the first hypothesis is:

Ho: $\beta_{\text{RF}} = 0$
Ha: $\beta_{RF} \neq 0$

Here the $\beta_{RF}$ indicates the relationship between risk free rate and delinquency rate. The null hypothesis states that risk free rate does not have an impact on delinquency and the alternative hypothesis would state the opposite.

**H2- House price change (HPIchng).** An increase in house price goes together with an increase in the market value of the house, in our argument this phenomena implies speculation in the increased value of the property in real estate market and thus we expect this to have positive impact on delinquency (+). Based on this assumption our second hypothesis is:

Ho: $\beta_{HPIChng} = 0$
Ha: $\beta_{HPIChng} \neq 0$

Here $\beta_{HPIChng}$ indicates the relationship between the change in house price and delinquency rate. The null hypothesis states that change in house price does not have an impact on delinquency and the alternative hypothesis would state the opposite.

**H3-Unemployment (Unemp).** Unemployment cuts down the income source of borrowers, which affects their creditworthiness. A high unemployment rate goes in line with high delinquency rate since more borrowers cannot afford to pay the interests (+). Based on this assumption our third hypothesis is:

Ho: $\beta_{Unemp} = 0$
Ha: $\beta_{Unemp} \neq 0$

Here $\beta_{Unemp}$ indicates the relationship between unemployment rate and delinquency rate. The null hypothesis states that unemployment rate does not have an impact on delinquency and the alternative hypothesis would state the opposite.

**H4-Debt/Income ratio (DebtIncome).** Household debt to disposable income ratio is supposed to have a positive relation with delinquency, since the higher the debt burden is the more economic constraints mortgagors have to bear and thus the chance to fail the interest payment are significant (+). Based on this assumption our forth hypothesis is:

Ho: $\beta_{DebtIncome} = 0$
Ha: $\beta_{DebtIncome} \neq 0$

Here $\beta_{DebtIncome}$ indicates the relationship between debt and income ratio and delinquency rate. The null hypothesis states that debt and income ratio does not have an impact on delinquency and the alternative hypothesis would state the opposite.

**H5-Social Benefit (SocialBenefit).** A high rate of unemployment benefit might lessen the debt burden of mortgagors at a certain time, however this implies a high number of unemployed people, thus this should be positively related to delinquency (+). Based on this assumption our fifth hypothesis is:

Ho: $\beta_{SocialBenefit} = 0$
Ha: $\beta_{SocialBenefit} \neq 0$
Here $\beta_{\text{SocialBenefit}}$ indicates the relationship between social benefit and delinquency rate. The null hypothesis states that social benefit does not have an impact on delinquency and the alternative hypothesis would state the opposite.

**H6-GDP growth (GDPgrowth).** GDP growth reflects the healthiness of an economy overall which places less burden on the household economy and thus less problem of delinquent loans to the banks. GDP growth expects to be negatively related to delinquency (-). Based on this assumption our sixth hypothesis is:

$H_6:$

\begin{align*}
\text{Ho: } & \beta_{\text{GDPgrowth}} = 0 \\
\text{Ha: } & \beta_{\text{GDPgrowth}} \neq 0
\end{align*}

Here $\beta_{\text{GDPgrowth}}$ indicates the relationship between GDP growth and delinquency rate. The null hypothesis states that GDP growth does not have an impact on delinquency and the alternative hypothesis would state the opposite.

**H7-Mortgage rate (MortRate).** Mortgage rate is the premium the bank charges its mortgagors. The higher the mortgage rates the harder for mortgagors to fulfil the interest payments. Thus, mortgage rate is expected to be positively related to delinquency (+). Based on this assumption our seventh hypothesis is:

$H_7:$

\begin{align*}
\text{Ho: } & \beta_{\text{MortRate}} = 0 \\
\text{Ha: } & \beta_{\text{MortRate}} \neq 0
\end{align*}

Here $\beta_{\text{MortRate}}$ indicates the relationship between mortgage rate and delinquency rate. The null hypothesis states that mortgage rate does not have an impact on delinquency and the alternative hypothesis would state the opposite.

**H8-Outstanding mortgages (OutMort).** This variable is inline with the mortgage growth. The more outstanding mortgage in the market the more risks involve, hence this should be positively correlated to DTD (+). Based on this assumption our eighth hypothesis is:

$H_8:$

\begin{align*}
\text{Ho: } & \beta_{\text{OutMortg}} = 0 \\
\text{Ha: } & \beta_{\text{OutMortg}} \neq 0
\end{align*}

Here $\beta_{\text{OutMortg}}$ indicates the relationship between outstanding mortgages and delinquency rate. The null hypothesis states that outstanding mortgages do not have an impact on delinquency and the alternative hypothesis would state the opposite.

**H9-Mortgage growth (Mortgrowth).** This variable corresponds to the change in house prices, the higher the house price gets the more mortgage grows, hence mortgage growth should have positive impact on delinquency (+). Based on this assumption our ninth hypothesis is:

$H_9:$

\begin{align*}
\text{Ho: } & \beta_{\text{Mortgrowth}} = 0 \\
\text{Ha: } & \beta_{\text{Mortgrowth}} \neq 0
\end{align*}
Here $\beta_{\text{Mortgrowth}}$ indicates the relationship between mortgage growth and delinquency rate. The null hypothesis states that mortgage growth does not have an impact on delinquency and the alternative hypothesis would state the opposite.

### 4.1.2 Distance to default of banks

DTD is used as a proxy for bank distress. To detect banks exposure we model the bank DTD as a function of these explanatory variables, macro factors, such as default rate, change in house prices, and interbank interest rate while controlling for factors indicating the banks business model and their business activities, such as, capital adequacy liquidity, whole sale funding, interbank assets, net income, derivatives; and variables accounting for the proportion of mortgage lending institutions in the banks, such as the proportions of mortgages and revenue. Stated below are the hypotheses with regards to individual variables.

The second model is:

$$\text{DTD}_t = \beta_0 + \beta_1\text{HPIChng}_t + \beta_2\text{Mort2TA}_t + \beta_3\text{RWA}_t + \beta_4\text{INTTA}_t + \beta_5\text{WSFDTL}_t + \beta_6\text{NITA}_t + \beta_7\text{L2D}_t + \beta_8\text{Der}_t + \beta_9\text{MortGit}_t + \beta_10\text{Del}_t + \beta_11\text{RevTA}_t + \nu_t$$

**H1-House prices change (HPIChng).** The variable captures at a certain extent monetary policy of a country and the credit cycle of asset prices. An increase in house prices implies gains in the increased value of the house, which leads to a high DTD, thus DTD is expected to be positively related to $\Delta\text{HPI}$ (+). Based on this assumption the first hypothesis is:

- $\text{Ho: } \beta_{\text{HPIChng}} = 0$
- $\text{Ha: } \beta_{\text{HPIChng}} \neq 0$

Here $\beta_{\text{HPIChng}}$ indicates the relationship between change in house price and DTD. The null hypothesis states that change in house price does not have an impact on DTD and the alternative hypothesis would state the opposite.

**H2-Mortgage/Total assets (Mort2TA)** Total mortgages of a mortgage company over total assets of the group represent the proportion of mortgages in the portfolio of the bank. The larger the mortgage portion is the more vulnerable the bank become, thus DTD is positively correlated to Mort2TA (+). Based on this assumption the second hypothesis is:

- $\text{Ho: } \beta_{\text{Mort2TA}} = 0$
- $\text{Ha: } \beta_{\text{Mort2TA}} \neq 0$

Here $\beta_{\text{Mort2TA}}$ indicates the relationship between the share of mortgages in the group asset and DTD. The null hypothesis states that the share of mortgage in the group asset does not have an impact on DTD and the alternative hypothesis would state the opposite.

**H3-RWA.** The capital available for risk-weighted assets is a good estimation for the capacity to absorb risks of banks. A high capital ratio is a good predictor for a far DTD, thus should have positive relation with DTD (+). Based on this assumption the third hypothesis is:
Here $\beta_{\text{RWA}}$ indicates the relationship between risk weighted asset and DTD. The null hypothesis states that risk weighted asset does not have an impact on DTD and the alternative hypothesis would state the opposite.

**H4-Interbank Assets/Total assets (INTTA).** Banks hold each other’s assets in the interbank market and can sell these liquid assets in case of liquidity crunch. The ratio is expected to be positively related to DTD (+). Based on this assumption the forth hypothesis is:

Ho: $\beta_{\text{INTTA}} = 0$
Ha: $\beta_{\text{INTTA}} \neq 0$

Here $\beta_{\text{INTTA}}$ indicates the relationship between interbank assets and DTD. The null hypothesis states that interbank assets do not have an impact on DTD and the alternative hypothesis would state the opposite.

**H5-Whole sale funding/Total Liability (WSFTL).** This reflects the sources banks use to finance their liabilities besides deposits from the public. Wholesale funding is short-term funds and more vulnerable than retail funds in stressed market. DTD is negatively related to a high level of wholesale funding (-). Based on this assumption the fifth hypothesis is:

Ho: $\beta_{\text{WSFTL}} = 0$
Ha: $\beta_{\text{WSFTL}} \neq 0$

Here $\beta_{\text{WSFTL}}$ indicates the relationship between wholesale funding and DTD. The null hypothesis states that wholesale funding does not have an impact on DTD and the alternative hypothesis would state the opposite.

**H6-Net income/Total assets (NITA).** The profitability of the banks reflects the ability to cover losses. Hence DTD is expected to have a positive relation with profitability (+). Based on this assumption the sixth hypothesis is:

Ho: $\beta_{\text{NITA}} = 0$
Ha: $\beta_{\text{NITA}} \neq 0$

Here $\beta_{\text{NITA}}$ indicates the relationship between net income and DTD. The null hypothesis states that net income does not have an impact on DTD and the alternative hypothesis would state the opposite.

**H7-Loan to deposit ratio (L2D).** The proportion of loans as assets as compared to deposits as liabilities reflects a sound funding of the banks through retail funds, which is liquid. A high proportion implies the reliance on wholesale funding of the banks. Hence, this ratio should have positive relation with DTD (+). Based on this assumption the seventh hypothesis is:
Ho: βL2D = 0
Ha: βL2D ≠ 0

Here βL2D indicates the relationship between loan to deposit ratio and DTD. The null hypothesis states that loan to deposit ratio does not have an impact on DTD and the alternative hypothesis would state the opposite.

**H8-Derivatives/Total assets (Der).** Derivatives represent the risk of margin calls in volatile market, the more derivatives banks hold; the larger the call on capital or the more the assets become liquid. This ratio is expected to have negative impact on DTD (-). Based on this assumption the eighth hypothesis is:

Ho: βDer = 0
Ha: βDer ≠ 0

Here βDer indicates the relationship between derivatives and DTD. The null hypothesis states that derivatives do not have an impact on DTD and the alternative hypothesis would state the opposite.

**H9-Mortgage growth (MortG).** The more the mortgages grow, the more the exposure of banks to these risky assets, therefore mortgage growth is expected to have negative relation with DTD. Based on this assumption the ninth hypothesis is:

Ho: βMortG = 0
Ha: βMortG ≠ 0

Here βMortG indicates the relationship between mortgage growth and DTD. The null hypothesis states that mortgage growth does not have an impact on DTD and the alternative hypothesis would state the opposite.

**H10-Delinquency (Del).** A high number of impaired loans in comparison to the total mortgages represent a high risk of defaults. DTD is expected to have negative relation with impaired loans (-). Based on this assumption the tenth hypothesis is:

Ho: βDel = 0
Ha: βDel ≠ 0

Here βDel indicates the relationship between delinquency rate and DTD. The null hypothesis states that delinquency rate does not have an impact on DTD and the alternative hypothesis would state the opposite.

**H11-Revenue/Total Mortgage (RevMort).** The more profitable the mortgage company is the less financial burden it places on the group or in other words the more financial funds it contributes to the group, hence this ratio should have positive relationship with DTD (+). Based on this assumption the eleventh hypothesis is:

Ho: βRevMort = 0
Ha: βRevMort ≠ 0
Here \( \beta \)RevMort indicates the relationship between the share of mortgage revenue and DTD. The null hypothesis states that the share of mortgage revenue does not have an impact on DTD and the alternative hypothesis would state the opposite.

### 4.2 Data collection

In this study we utilise micro and macro datasets along with institutional financial reports from the three countries with yearly frequency. As discussed throughout the text, our sample includes LMLIs in Sweden, Norway and Denmark representing for the whole population in Scandinavia. Thirteen banks and LMLIs are selected based on the market share they capture in each country, which we have discussed in the background and the countries’ insights. Although the sample is not large, we expect the large market share pertaining to 90% or above of the institutions within respective markets is sufficient to reflect the exposure of the mortgage-lending sector to the real estate market. Table 4 and 5 depict the samples and specific data and data sources used respectively.

<table>
<thead>
<tr>
<th>Country</th>
<th>Group</th>
<th>Mortgage Lending Institution</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sweden</strong></td>
<td>Swedbank AB</td>
<td>Swedbank Mortgage AB</td>
</tr>
<tr>
<td></td>
<td>Svenska Handelsbanken AB</td>
<td>Stadshypotek AB</td>
</tr>
<tr>
<td></td>
<td>Nordea Bank AB</td>
<td>Nordea Hypotek AB</td>
</tr>
<tr>
<td></td>
<td>Svenska Enskilda Bank AB (SEB)</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>SBAB Bank AB</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Länsförsäkringar AB</td>
<td>-</td>
</tr>
<tr>
<td><strong>Denmark</strong></td>
<td>Danske bank AS</td>
<td>Realkredit Danmark AS</td>
</tr>
<tr>
<td></td>
<td>Nordea Bank Denmark AS</td>
<td>Nordea Kredit Realkreditaktieselskab</td>
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<tr>
<td></td>
<td>Nykredit Realkredit AS</td>
<td>Totalkredit AS</td>
</tr>
<tr>
<td></td>
<td>BRFkredit Bank AS</td>
<td>-</td>
</tr>
<tr>
<td><strong>Norway</strong></td>
<td>DNB Bank ASA</td>
<td>DNB Boligkredit AS</td>
</tr>
<tr>
<td></td>
<td>Nordea Bank Norge ASA</td>
<td>Nordea Eiensusomkredit AS</td>
</tr>
<tr>
<td></td>
<td>Sparebank 1 AS</td>
<td>Sparebank 1 Boligkredit AS</td>
</tr>
</tbody>
</table>

**Table 4 Banks and LMLIS covered in the study**

<table>
<thead>
<tr>
<th>Sources</th>
<th>Specific Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>European Mortgage Federation (EMF)</td>
<td>representative mortgage rates, change in house prices, unemployment rates, GDP</td>
</tr>
<tr>
<td>Eurostat</td>
<td>growth rate, house price index (2000=100)</td>
</tr>
<tr>
<td>OECD</td>
<td>gross debt-to-income ratio of household</td>
</tr>
<tr>
<td>Thomson DataStream</td>
<td>1 year rate of Stibor, Oibor, Cibor</td>
</tr>
<tr>
<td>Financial Annual Reports</td>
<td>TL_RWA, total assets, total liabilities, derivatives, loans to the public, loans to</td>
</tr>
<tr>
<td></td>
<td>credit institutions, debt securities, net income, revenue, impaired loans, loan losses, deposits from public, deposit from credit institutions</td>
</tr>
</tbody>
</table>

**Table 5 Data and data sources used in the study**

43
Proxies
The choice of variables and ratios was based on the relevant theories. Among others, the research by Blundell-Wignall and Roulet (2013) and Igan and Pinheiro (2010) were our main guides in conducting this research. The variables and ratios we used came from the bank annual statements including the notes section. However, since not all variables and ratios were given, we needed to derive and approximate some of them:

Wholesale funding = Liability – Deposits from public – Debt securities issued
Interbank assets = Loans to credit institutions
Delinquency rate = (Impaired loans + Loan losses)/ Total mortgages
Mortgage rate = Representative rates
Interbank rate = Stibor, Oibor, Cibor
RWA = Tier 1 capital ratio

4.3 Computation of DTD

The Merton’s (1977) distance to default model was developed as one of the dynamic models in order to assess the question of bank contagion. Overall it assumes the bank equity as a call option on the banks debt holder, whereupon default the equity holder does not get any pay off where as the entire pay off goes to the writer of the call which in this case is represented by the debt holder. Furthermore the model involves the assumption of Brownian motion with a constant drift frequency represented by the volatility of the assets as described in the earlier chapter.

However within the case of our research we had to modify our approach towards measuring distance to default since we considered regional subsidiaries of the Nordea Banking group within Sweden, Norway and Denmark. Along with these subsidiaries we also considered mortgage companies, which are not actively traded on the financial markets these include public owned firms such as Lansforsakringar AB, SBAB and mortgage companies such as Nykredit and BRF. Hence we applied the approach used by Bottazzi et al. (2011), which is based on a method to find the naïve DD by Bharath & Shumway (2008).

Bharath and Shumway (2008) explained distance to default as:

$$\text{Naïve DD} = \frac{\ln\left(\frac{E+F}{F}\right) + (rt-1 - 0.5 \text{ naïve } \sigma^2 \nu)T}{\text{ naïve } \sigma \nu T}$$

Where E is the equity market value, F is the face value of debt, T is the time to maturity assuming that every firm has just a single bond maturing over the T period, rt-1 is the firm’s stock return over the previous year, and naïve \(\sigma_v\) represents the volatility of firm assets which will be computed as follows:

$$\text{Naïve } \sigma_v = \frac{E}{E+F} \sigma_e + \frac{F}{E+F} (0.05 + 0.25\sigma_e)$$

In this equation the volatility of debt is assumed to be the term in the parenthesis composed of the volatility of equity (\(\sigma_e\)), which is an estimate of the Black-Scholes Merton’s volatility of debt as predicted by Bharath & Shumway (2008, p. 9). However, Bottazzi et al. (2011) modified this approach by making it suitable to those firms that were not publicly traded, which we have adopted within our distance to default.
calculations. The first of these is the assumption for the time period, which for us corresponds with 2000-2014 as explained in earlier sections. Secondly, an approximation for the equity value was required which was calculated as the sum of the carried forward income, net income after tax for the year and the share capital (face value of outstanding shares). This measure is defined as Book Equity (BE). Thirdly, we use the sum of BE and Debt as the total value of assets. Fourthly, we employ the time series average of Book Equity μ be instead of rt-1. We, hence, employ a smoothing assumption whereby the naïve DTD is thought to be captured by the previous year stock returns due to an efficient stock market. Finally, we calculate the volatility of equity and debt as the standard deviation of the respective growth rates over the time period 2000-2014. Hence, our book version of naïve DTD is:

$$\text{Book DTD} = \ln\left(\frac{\text{BE} + \text{DE}}{\text{BE}}\right) + \frac{\sigma^2_{\text{BE}} - 0.5\sigma_{\text{ND}}}{\sigma_{\text{ND}}}$$

And

$$\sigma_{\text{ND}} = \frac{\text{BE}}{\text{BE} + \text{D}} \sigma_{\text{S}} + \frac{\text{D}}{\text{BE} + \text{D}} \sigma_{\text{D}}$$

This model assumes that the maturity of debt is in one year’s time, which is why the time value has been set at 1. Hence, using this proxy we are able to ensure a consistency within our distance to default figures for all institutions within our sample group.

### 4.4 Panel data and statistical test for the analysis of panel data

In conducting our research we used panel data analysis wherein the widely popular 95% confidence level was used for evaluating the various hypotheses. Here we would reflect on the nature and present arguments for the tests conducted within our research.

#### 4.4.1 Panel data

Panel data combine time series and cross sectional data allowing researchers to get more insights into the research matter and the development of the samples throughout a given period of time which the use of time series and cross sectional data alone cannot achieve (Hsiao, 2007, p.1-2). Studenmund (2011, p.526) clarifies that panel data includes observations on the same variables from the same cross sectional sample from two or more time periods. The advantages of using panel data is that it allows researchers to control for heterogeneity, the unobserved variables such as variables that change over time but not across entities, say national characteristics (Frees, 2004, p.4-9). Another advantage of using panel data is that researchers can obtain a large number of data points increasing the degree of freedom and reducing the collinearity among explanatory variables, thus enhance the efficiency of econometric estimates (Hsiao, 2003, p.3).

In this study we use panel data to adapt to the nature of our data, which varies across both identities and time series. By observing the changes of the same factors cross the countries through 14 years, we can get a more insights into the development of residential real estate market and the exposure of mortgage lending institutions. Moreover, panel data allow us to control for variables that we cannot observe, which reduces the problem of omitted variables in our regressions.
4.4.2 Fixed and Random Effects Models

Among others models, fixed and random models are the two common ones that have been proposed by a number of econometricians such as Baltagi (2008) or Wooldridge (2010) as appropriate for panel data analysis.

Fixed effects model

Fixed effect model explores the relationship between a predictor and independent variables within an entity, such as a country or a company. The model assumes that the characteristics of an individual entity may cause bias in estimating the predictor and the independent variables compelling a researcher to control for this. The fixed effects model works in the way that it allows each cross sectional unit to have a different intercept to account for the differences between an individual unit and one or more dummy variables. It also does this in order to account for possible omitted variables that do not change over time, which might cause bias in estimating the variables coefficients (Hsiao, 2003, p. 30-33). Using the term ‘fixed effects’ the model assumes the variation across entities is fixed and correlated with the regressors in the models, which reflect the correlation between the error term and other variables (2003, p.31). When such a correlation exists, the researcher would have chosen the wrong model and should apply random effect model instead.

We chose the fixed effects model for our first question because we were interested in analyzing the impact of variables that vary over time, such as changes in interest rates, housing prices, household debt to income ratios, or unemployment rates and the impact these variables have on the delinquency rates of mortgagors. Furthermore, using the fixed effect model helps us to explore the relationship between delinquency rate and other explanatory variables while controlling for possible differences that might exist within the country, which is in line with our premise regarding the relative similarity within Scandinavian markets. Moreover, we can disregard the probable correlation of time-invariant variables since in the model of delinquency rate we have no time invariant variables.

Random effects model

Another option for panel data analysis is using the random effect model. While the fixed effect model assumes different intercept for each cross sectional unit, the random effect model assumes the intercept of each cross sectional unit is drawn from a distribution that is centered around a mean intercept (Wooldridge, 2008, p. 489). By this the model assumes the variation across entities to be random and uncorrelated with the predictors. Since the model disregards the possible variations between cross sectional units that can repeat over time, there is a possibility of omitted variable bias. An advantage of random effects model researcher can include time invariant variables while in the fixed effects model, these variables are absorbed by the intercept.

We use the random effects model for our second question since we believe that variation between entities is significant since the structure of the institutions vary and because there is correlation between error terms, which we can control via random effect models.
### 4.4.3 Diagnostics tests

**Hausman test**
Haumans test (1978) is the only recommended test that can prioritize the choice of fixed or random effects model. The application of this test is to check whether there is significant correlation between the error terms or the unobserved specific random effects and the regressors. The test is simply a comparison of the covariance matrix of the regressors in the fixed effect model with those in the random effect model given the null hypothesis that there is no correlation. If there is no statistical significant difference between the covariance matrixes of the two models, then the correlations of the random effects with the regressors are statistically insignificant and the fixed effect model prevails and vice versa.

**Testing for time fixed effects**
As earlier mentioned fixed effects model control for all time invariant differences between individuals, researcher needs to double check if this is the case. This can be done by a normal fixed effects regression with the inclusion of all the year dummies to see if the dummies for all years combined are equal to 0, if they are then no time effect are needed.

**Breusch-Pagan Lagrange Multiple and Pesaran test for cross-section dependence**
As discussed earlier the random effects model assumes there is no correlation between the cross sectional unit and the predictors, we need to test if this is the case and if it is then heteroskedasticity arising from group-wise differences is the issue at hand. This happens when the observations of the error term are drawn from a distribution that has different variance, which causes biased standard errors and leads to biased inference of the results (Wooldridge, 2008, p. 264). To justify this problem Breusch-Pagan LM test, which is based on the average squared pairwise correlation coefficients was introduced. The method behind the test is to first obtain the residuals of the estimated regression equation, then to run a linear regression with the squared residuals from the original equation as a function of all the independent variables in that equation (Wooldridge, 2008, p. 273). The null hypothesis is that residual across entities are not correlated. If the p-value of the test is sufficiently small at significant level, we can reject the null hypothesis and thus the researcher need to control for heteroskedasticity problem.

Another powerful test to diagnose for random effects is the Pesaran test for cross-section dependence. The test is based on a simple average of all pairwise correlation coefficients of the OLS residuals from the individual regressions in the panel (Pesaran, 2004, p.2). The null hypothesis is the residuals are not correlated. The strength of Pesaran is that it is applicable independent small sample bias of the parameter estimate, the fixed or random effect residuals will have mean zero provided the disturbances are symmetrically distributed (Pesaran, 2004, p.6).

**Wooldridge test for autocorrelation**
Serial correlation or autocorrelation refers to correlations among observations taken over time (Studenmund, 2011, p. 305). Informally it exists when we expect there is an effect of an independent variable on a dependent variable after a time lag or there are repeating trends through a certain time span. Serial correlation causes bias standard errors of the coefficient and R-squared leading to unreliable hypothesis testing
(Studenmund, 2011, p. 312-314). To improve this problem we used Wooldridge (2002) test for autocorrelation in panel data. The method is to analyze how well the lagged residuals explain the residuals of the original equation. The null hypothesis is that there is no autocorrelation. If the lagged residuals significantly explain the time’s residuals, then the null hypothesis of no serial correlation can be rejected.

Hence having discussed the tools, estimators and tests for empirical analysis we can provide an overview of our empirical model. The first model consists of 3 group (country) variables of which we set dummy 0 for Sweden, 1 for Norway and 2 for Denmark and time variable of 14 years from 2000-2013. The second model entails 13 group (banks) variables of which six belong to Sweden, 3 to Norway and 4 to Denmark and time variable of 10 years from 2004-2013. The time spans in two models are different due to a lack of data of Sparebank 1 and Lansfosa Kringar in the first four years. Below are the two models (for the variable abbreviations, review the hypothesis section).

Model for delinquency of mortgagors:

$$\text{Delit} = \beta_0 + \beta_1*RFit + \beta_2*HPICngit + \beta_3*Unempit + \beta_4*DebtIncomeit + \beta_5*SocialBenefitit + \beta_6*GDPgrowthit + \beta_7*MortRateit + \beta_8*OutMortgtit + \beta_9*Mortgrowthit + V_{it}$$

(Where Vit is the error term, and i, t are indexes for cross sectional unit and time)

Model for distance to default:

$$\text{DTDit} = \beta_0 + \beta_1*HPICngit + \beta_2*Mort2TAtit + \beta_3*RWAtit + \beta_4*INTTAtit + \beta_5*WSFDTLtit + \beta_6*NITAtit + \beta_7*L2Dit + \beta_8*Derit + \beta_9*MortGit + \beta_{10}*Delit + \beta_{11}*RevTAtit + V_{it}$$

(Where Vit is the error term, and i, t are indexes for cross sectional unit and time)
CHAPTER 5: EMPIRICAL RESEARCH

In conducting our research we used the panel data analysis, which suited the cross-sectional and time-series nature of our data. This chapter summarizes the descriptive statistics regarding our data sets for the two sub-questions we answered in order to produce a conclusion for our primary research question. The chapter is organized in the step form adhering to our research model with the first summary statistics for question 1 and then for question 2 followed by the regression results for the questions accordingly.

5.1 Descriptive Statistics and Summary Statistics

Consistent with the method of panel data analysis as specified by chapter 4, our data was organized with the identity variable (panel variable) being country for the dataset for the first question and banks for the second question. The time variable for both the datasets was years. However, the difference in the data sets is the length of time series, which for the second dataset is shorter in line with the lack of availability of concrete data for years before 2004 for a few banks while it is from 2000-2013 for the first question. The shorter time series for the second dataset was necessary in order to preserve the comparability of the banks in question.

5.1.1 Research Question 1

What are the effects of selected factors on delinquency rate of mortgagors in Scandinavia during the period 2000-2013?

As mentioned in chapter 4 the composition of the dataset on influences on delinquency relies on data on delinquencies acquired via the dataset on Scandinavian banks studied for the second question. The individual macro factor influences are estimated from the three other large changes occurred in debt to income ratio for households, outstanding mortgages and rate of mortgage growth by standard deviations of 22.5%, 73717.29 Euros and 7% respectively, in the EMF or OECD databases. Here we will observe the summary statistics on an individual country level before proceeding to the summary statistics for the panel so that a better understanding of our results could be developed before proceeding.

Table 6 Descriptive Statistics of Swedish Delinquency Model Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Del</td>
<td>14</td>
<td>0.2776</td>
<td>0.1424</td>
<td>0.1622</td>
<td>0.6498</td>
</tr>
<tr>
<td>RF</td>
<td>14</td>
<td>3.1315</td>
<td>1.3216</td>
<td>1.15</td>
<td>5.085</td>
</tr>
<tr>
<td>HPIchng</td>
<td>14</td>
<td>6.3085</td>
<td>4.1221</td>
<td>-1.3</td>
<td>11.4</td>
</tr>
<tr>
<td>Unemp</td>
<td>14</td>
<td>6.7857</td>
<td>1.2672</td>
<td>4.9</td>
<td>8.6</td>
</tr>
<tr>
<td>MortRate</td>
<td>14</td>
<td>3.6157</td>
<td>1.1420</td>
<td>1.89</td>
<td>5.18</td>
</tr>
<tr>
<td>GDPgrowth</td>
<td>14</td>
<td>2.6</td>
<td>1.9949</td>
<td>-0.6</td>
<td>6.6</td>
</tr>
<tr>
<td>DebtIncome</td>
<td>14</td>
<td>128.2743</td>
<td>22.5407</td>
<td>96.19</td>
<td>170</td>
</tr>
<tr>
<td>SocialBenefit</td>
<td>14</td>
<td>28.6143</td>
<td>.8574</td>
<td>27.3</td>
<td>30.1</td>
</tr>
<tr>
<td>OurMort</td>
<td>14</td>
<td>213285.6</td>
<td>75717.29</td>
<td>118828</td>
<td>334922</td>
</tr>
<tr>
<td>Mortgrowth</td>
<td>14</td>
<td>7.2120</td>
<td>7.5417</td>
<td>-8.7032</td>
<td>26.5380</td>
</tr>
</tbody>
</table>

49
The table above shows the summary statistics for Sweden. As observable from the dataset delinquency in Sweden averaged a 0.28% which is considerably lower for the tumultuous period in consideration and delinquencies did not increase 0.65% of the total mortgages given out and the change was not substantial considering the low standard deviation of 0.14%. The risk free interest rate averages 3.13% with a low standard deviation of 1.32%. Housing prices changes remains at 6.3% over time period with a higher standard deviation of 4.12% and a maximum value of 11.4% which highlight a considerably heated market since this is the change in the average index prices wherein the base was elevated in 2000. Unemployment in Sweden remains lower than the European Union average with an average of 6.78% over the time period and hitting a maximum of 8.6%. Mortgage rate, GDP growth and social benefit as a percentage of GDP all have a low standard deviation over the time series. The high debt to income ratio and increase of mortgages highlight the high indebtedness and the heated property markets within the country.

Table 7 Descriptive Statistics of Norwegian Delinquency Model Variables

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Del</td>
<td>14</td>
<td>0.7617</td>
<td>0.8350</td>
<td>0.0148</td>
<td>2.1037</td>
</tr>
<tr>
<td>RF</td>
<td>14</td>
<td>4.28</td>
<td>1.9783</td>
<td>2.02</td>
<td>7.45</td>
</tr>
<tr>
<td>HP1chng</td>
<td>14</td>
<td>7.5571</td>
<td>4.6977</td>
<td>-1.1</td>
<td>15.7</td>
</tr>
<tr>
<td>Unemp</td>
<td>14</td>
<td>3.5857</td>
<td>0.6136</td>
<td>2.5</td>
<td>4.55</td>
</tr>
<tr>
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<td>5.3692</td>
<td>1.8963</td>
<td>3.53</td>
<td>8.64</td>
</tr>
<tr>
<td>GDPgrowth</td>
<td>14</td>
<td>1.6571</td>
<td>1.4781</td>
<td>-1.6</td>
<td>4</td>
</tr>
<tr>
<td>DebtIncome</td>
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<td>154.395</td>
<td>27.2787</td>
<td>11.9</td>
<td>200</td>
</tr>
<tr>
<td>SocialBenefit</td>
<td>14</td>
<td>22.2285</td>
<td>1.3952</td>
<td>19.8</td>
<td>24.7</td>
</tr>
<tr>
<td>OurMort</td>
<td>14</td>
<td>162702.9</td>
<td>67465.25</td>
<td>71416</td>
<td>275754</td>
</tr>
<tr>
<td>Mortgrowth</td>
<td>14</td>
<td>28.7714</td>
<td>51.7574</td>
<td>-66.8663</td>
<td>141.6991</td>
</tr>
</tbody>
</table>

The table above shows the summary statistics for Norway. Delinquency remains at an average of 0.76% with a standard deviation of 0.83%, however the range is quite large compared to other two countries with a maximum value of 2.1% of total mortgages. Other important highlights are the high spread between house prices changes of 16.8%, the high indebtedness at 154% with a huge standard deviation of 27% and the large standard deviation in mortgage growth of 51.75%, which reflects a severely heated market.
In Denmark the delinquencies remain at an average of 0.23%, which have a standard deviation 0.165%. Housing price changes had a considerably large spread of 34% which includes a drop of -12.9% which signifies the crash of the property market. Other important highlights are the extremely high indebtedness at an average of 236% with an average deviation of 38% and high mortgage growth average of 6.7%.

**Figure 6 Panel Summary Statistics**
The graph above gives as a picture of the evolution of delinquency rates within the three countries over time. While Sweden retains a rather stable trend, Norway has seen a remarkable fall in delinquency rates from a high of above 2% while Denmark sees a rising trend.

Table 9 Summary of Panel Data set

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Del-y</td>
<td></td>
<td></td>
<td>GDPgrowth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>overall</td>
<td>0.4246</td>
<td>0.5429</td>
<td>overall</td>
<td>1.6762</td>
<td>2.0367</td>
</tr>
<tr>
<td>between</td>
<td>0.2928</td>
<td>0.4860</td>
<td>between</td>
<td>0.9144</td>
<td>1.8913</td>
</tr>
<tr>
<td>within</td>
<td>1.5839</td>
<td>1.6762</td>
<td>within</td>
<td>1.5839</td>
<td>1.6762</td>
</tr>
<tr>
<td>RF</td>
<td></td>
<td></td>
<td>Debtincome</td>
<td></td>
<td></td>
</tr>
<tr>
<td>overall</td>
<td>3.5131</td>
<td>1.6762</td>
<td>overall</td>
<td>173.1276</td>
<td>55.2863</td>
</tr>
<tr>
<td>between</td>
<td>0.6641</td>
<td>1.5839</td>
<td>between</td>
<td>56.5946</td>
<td>29.4824</td>
</tr>
<tr>
<td>within</td>
<td>1.5839</td>
<td>1.6762</td>
<td>within</td>
<td>1.5839</td>
<td>1.6762</td>
</tr>
<tr>
<td>HPlchng</td>
<td></td>
<td></td>
<td>SocialBenefit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>overall</td>
<td>5.8683</td>
<td>6.2138</td>
<td>overall</td>
<td>26.4285</td>
<td>3.2968</td>
</tr>
<tr>
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<td>6.0020</td>
<td>between</td>
<td>3.6383</td>
<td>1.3523</td>
</tr>
<tr>
<td>within</td>
<td>6.2138</td>
<td>1.9466</td>
<td>within</td>
<td>6.2138</td>
<td>1.9466</td>
</tr>
<tr>
<td>Unemp</td>
<td></td>
<td></td>
<td>OutMort</td>
<td></td>
<td></td>
</tr>
<tr>
<td>overall</td>
<td>5.2309</td>
<td>1.7239</td>
<td>overall</td>
<td>189433.8</td>
<td>66464.88</td>
</tr>
<tr>
<td>between</td>
<td>1.6019</td>
<td>1.1042</td>
<td>between</td>
<td>25413.95</td>
<td>63059.49</td>
</tr>
<tr>
<td>within</td>
<td>1.1042</td>
<td>1.6019</td>
<td>within</td>
<td>1.1042</td>
<td>1.6019</td>
</tr>
<tr>
<td>MortRate</td>
<td></td>
<td></td>
<td>Mortgrowth</td>
<td></td>
<td></td>
</tr>
<tr>
<td>overall</td>
<td>4.7852</td>
<td>1.6159</td>
<td>overall</td>
<td>14.2558</td>
<td>31.4174</td>
</tr>
<tr>
<td>between</td>
<td>1.0128</td>
<td>1.3822</td>
<td>between</td>
<td>12.5727</td>
<td>29.6496</td>
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<tr>
<td>within</td>
<td>1.3822</td>
<td>1.0128</td>
<td>within</td>
<td>1.3822</td>
<td>1.0128</td>
</tr>
</tbody>
</table>

The table above gives the summary of the panel dataset. The table is unique in the sense that not only does it provide with the summary of the mean and standard deviation of the change in the overall variation in the variables but also the respective changes between, implying within individual countries, and within, implying change between individual countries over time, variables. This basically provides us with a good summary of which effects to expect within our regression results. As observable from the variations most variation is within variables except for unemployment, debt to income ratio and social benefits where the variation seems to lie within individual countries. This however is expected since these variables have a wider difference between the countries as it is comparatively harder for them to change phenomenally within a small time frame than for them to vary across countries. This trend however explains our choice of model later.

5.1.2 Research Question 2

*Does the change in institutional business models and mortgage lending business affect its distance to default?*

The second question used a dataset composed entirely of data from annual accounts along with a macro indicator of housing price, which was acquired from the EMF reports and interbank offered rates from respective countries. Hence, the database is composed of ratios from 14 different large lending institutions in Scandinavia all of which combined make up more than 90% of total mortgage and banking operations in
the market. Here the analysis will be presented briefly for banks individually before proceeding to summary statistics for the panel.

**The Banks**
The tables below summarize the main bank balance sheet measures including book distance to default.

**Table 10 Summary of Statistics of the Banks Variables**

<table>
<thead>
<tr>
<th>Bank</th>
<th>DD</th>
<th>RWA</th>
<th>INTTA</th>
<th>WSFTL</th>
<th>NITA</th>
<th>L2D</th>
<th>Der</th>
<th>Del</th>
<th>RevMort</th>
<th>Mort2TA</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SWE</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>2.97</td>
<td>0.12</td>
<td>0.0823</td>
<td>0.4510</td>
<td>0.0082</td>
<td>1.4433</td>
<td>0.0426</td>
<td>0.0005</td>
<td>0.0067</td>
<td>0.3874</td>
</tr>
<tr>
<td>St.Dev</td>
<td>0.20</td>
<td>0.05</td>
<td>0.0324</td>
<td>0.0580</td>
<td>0.0051</td>
<td>0.5128</td>
<td>0.0149</td>
<td>0.0003</td>
<td>0.0019</td>
<td>0.0268</td>
</tr>
<tr>
<td>Min</td>
<td>2.46</td>
<td>0.07</td>
<td>0.0452</td>
<td>0.3621</td>
<td>-0.0053</td>
<td>0.9612</td>
<td>0.0248</td>
<td>0.0002</td>
<td>0.0045</td>
<td>0.3441</td>
</tr>
<tr>
<td>Max</td>
<td>3.23</td>
<td>0.20</td>
<td>0.1272</td>
<td>0.5716</td>
<td>0.0125</td>
<td>2.1712</td>
<td>0.0730</td>
<td>0.1092</td>
<td>0.0097</td>
<td>0.4223</td>
</tr>
<tr>
<td><strong>Hand</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>2.41</td>
<td>0.12</td>
<td>0.0687</td>
<td>0.5084</td>
<td>0.0079</td>
<td>1.8154</td>
<td>0.1018</td>
<td>0.0016</td>
<td>0.0088</td>
<td>0.9631</td>
</tr>
<tr>
<td>St.Dev</td>
<td>0.15</td>
<td>0.05</td>
<td>0.0262</td>
<td>0.0570</td>
<td>0.0014</td>
<td>0.1945</td>
<td>0.0406</td>
<td>0.0016</td>
<td>0.0022</td>
<td>0.0155</td>
</tr>
<tr>
<td>Min</td>
<td>2.01</td>
<td>0.07</td>
<td>0.0253</td>
<td>0.4122</td>
<td>0.0065</td>
<td>1.4955</td>
<td>0.0577</td>
<td>0.0006</td>
<td>0.0058</td>
<td>0.9329</td>
</tr>
<tr>
<td>Max</td>
<td>2.55</td>
<td>0.07</td>
<td>0.0996</td>
<td>0.5965</td>
<td>0.0099</td>
<td>2.0489</td>
<td>0.1771</td>
<td>0.0060</td>
<td>0.0126</td>
<td>0.9813</td>
</tr>
<tr>
<td><strong>Nors</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>1.23</td>
<td>0.10</td>
<td>0.0474</td>
<td>0.2606</td>
<td>0.0080</td>
<td>1.4535</td>
<td>0.2762</td>
<td>0.0004</td>
<td>0.0078</td>
<td>0.0928</td>
</tr>
<tr>
<td>St.Dev</td>
<td>0.12</td>
<td>0.03</td>
<td>0.0294</td>
<td>0.1258</td>
<td>0.0019</td>
<td>0.0734</td>
<td>0.1077</td>
<td>0.0005</td>
<td>0.0013</td>
<td>0.0316</td>
</tr>
<tr>
<td>Min</td>
<td>0.93</td>
<td>0.07</td>
<td>0.0158</td>
<td>0.1038</td>
<td>0.0060</td>
<td>1.3478</td>
<td>0.1417</td>
<td>0.0001</td>
<td>0.0061</td>
<td>0.0719</td>
</tr>
<tr>
<td>Max</td>
<td>1.35</td>
<td>0.16</td>
<td>0.0970</td>
<td>0.5558</td>
<td>0.0110</td>
<td>1.5599</td>
<td>0.4840</td>
<td>0.0012</td>
<td>0.0097</td>
<td>0.1799</td>
</tr>
<tr>
<td><strong>Seb</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>1.63</td>
<td>0.09</td>
<td>0.1943</td>
<td>0.5601</td>
<td>0.0044</td>
<td>1.2236</td>
<td>0.1706</td>
<td>0.0117</td>
<td>0.0213</td>
<td>0.1602</td>
</tr>
<tr>
<td>St.Dev</td>
<td>0.17</td>
<td>0.02</td>
<td>0.0689</td>
<td>0.0638</td>
<td>0.0018</td>
<td>0.2142</td>
<td>0.0502</td>
<td>0.0053</td>
<td>0.0051</td>
<td>0.0918</td>
</tr>
<tr>
<td>Min</td>
<td>1.37</td>
<td>0.07</td>
<td>0.0870</td>
<td>0.4875</td>
<td>0.0023</td>
<td>0.9033</td>
<td>0.1045</td>
<td>0.0060</td>
<td>0.0082</td>
<td>0.0272</td>
</tr>
<tr>
<td>Max</td>
<td>1.83</td>
<td>0.11</td>
<td>0.2678</td>
<td>0.6823</td>
<td>0.0089</td>
<td>1.4906</td>
<td>0.2842</td>
<td>0.0233</td>
<td>0.0265</td>
<td>0.2460</td>
</tr>
<tr>
<td><strong>Lans</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>3.58</td>
<td>0.12</td>
<td>0.0267</td>
<td>0.5473</td>
<td>0.0048</td>
<td>2.0843</td>
<td>0.0338</td>
<td>0.0014</td>
<td>0.0029</td>
<td>0.3880</td>
</tr>
<tr>
<td>St.Dev</td>
<td>0.02</td>
<td>0.01</td>
<td>0.0283</td>
<td>0.1179</td>
<td>0.0131</td>
<td>0.2894</td>
<td>0.0212</td>
<td>0.0006</td>
<td>0.0014</td>
<td>0.0402</td>
</tr>
<tr>
<td>Min</td>
<td>3.56</td>
<td>0.11</td>
<td>0.0002</td>
<td>0.3733</td>
<td>-0.0260</td>
<td>1.7106</td>
<td>0.0067</td>
<td>0.0006</td>
<td>0.0018</td>
<td>0.3421</td>
</tr>
<tr>
<td>Max</td>
<td>3.62</td>
<td>0.15</td>
<td>0.0745</td>
<td>0.6999</td>
<td>0.0261</td>
<td>2.5329</td>
<td>0.0787</td>
<td>0.0023</td>
<td>0.0066</td>
<td>0.4582</td>
</tr>
</tbody>
</table>
These tables have been provided for a comprehensive insight into the institutions’ current business models and their mortgage businesses along with the risk of default captured by the distance to default (book). Distance to default here should be interpreted as the number of standard deviations away from a potential default an institution is.
Apart from Lansforsakringar AB none of the institutions are more than 3 standard deviations away from default, which means the default probability for most of them according to this book distance to default measure is not a tail or extremely unlikely an event. Some banks have notable concern for example Nordea in Sweden and Denmark has a low distance to default at average of 1.23 and 1.47 deviations with standard deviation of change being at 12 and 13% respectively. Danish institutions: Danske, Nordea, Nykredit and BRF have a higher risk of default with their extremely low distance to default measures. However BRF has extremely risky assets within its portfolio the portfolio of institutions with a average deviation of only 0.18. A cursory look over the statistics also shows that a very high loan to deposit ratio is related with bank riskiness as BRF also has the highest loan to deposit ratio. However, with regards to the prior discussion presented in chapters 1 and 3, Danish institutions indulging in mortgage lending generally have mortgage lending and property management as their core business where as in Sweden and Norway institutions are large banking conglomerates.

The charts below display the panel summaries for the dataset. Here we can observe a considerable difference within the macro dataset since most of the variation seems to be randomly distributed between the individual institutions and within institutions over time. While some variables like DDBE, INTTA, WSFTL and NITA show a heavy presence of variation between individual institutions, other variables like delinquency and housing prices show a considerably higher variation across time. This simple summary statistics give a precursor to the type of model used for estimation, which we will analyze in detail in the next section.

**Table 11 Panel Data**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
</tr>
</thead>
<tbody>
<tr>
<td>DDBE</td>
<td>1.7698</td>
<td>0.914</td>
<td>Der</td>
<td>0.0823</td>
<td>0.0966</td>
</tr>
<tr>
<td></td>
<td>between</td>
<td>0.9325</td>
<td>between</td>
<td>0.9001</td>
<td></td>
</tr>
<tr>
<td></td>
<td>within</td>
<td>0.1625</td>
<td>within</td>
<td>0.0424</td>
<td></td>
</tr>
<tr>
<td>RWA</td>
<td>0.1093</td>
<td>0.0332</td>
<td>Del</td>
<td>0.0028</td>
<td>0.0042</td>
</tr>
<tr>
<td></td>
<td>between</td>
<td>0.0182</td>
<td>between</td>
<td>0.0031</td>
<td></td>
</tr>
<tr>
<td></td>
<td>within</td>
<td>0.0282</td>
<td>within</td>
<td>0.0030</td>
<td></td>
</tr>
<tr>
<td>INTTA</td>
<td>0.0663</td>
<td>0.0578</td>
<td>RevMort</td>
<td>0.0102</td>
<td>0.0159</td>
</tr>
<tr>
<td></td>
<td>between</td>
<td>0.4838</td>
<td>between</td>
<td>0.0088</td>
<td></td>
</tr>
<tr>
<td></td>
<td>within</td>
<td>0.3275</td>
<td>within</td>
<td>0.0146</td>
<td></td>
</tr>
<tr>
<td>WSFTL</td>
<td>0.4406</td>
<td>0.20167</td>
<td>Mort2TA</td>
<td>0.4456</td>
<td>0.3156</td>
</tr>
<tr>
<td></td>
<td>between</td>
<td>0.19043</td>
<td>between</td>
<td>0.3100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>within</td>
<td>0.08328</td>
<td>within</td>
<td>0.1011</td>
<td></td>
</tr>
<tr>
<td>NITA</td>
<td>0.0065</td>
<td>0.00660</td>
<td>HPChng</td>
<td>0.0545</td>
<td>0.0670</td>
</tr>
<tr>
<td></td>
<td>between</td>
<td>0.00414</td>
<td>between</td>
<td>0.0155</td>
<td></td>
</tr>
<tr>
<td></td>
<td>within</td>
<td>1.00525</td>
<td>within</td>
<td>0.0653</td>
<td></td>
</tr>
<tr>
<td>L2D</td>
<td>3.8669</td>
<td>5.43231</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>between</td>
<td>4.92271</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>within</td>
<td>2.63186</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.2 Regressions and Tests

The regression tests were carried within the context of individual specific effects in panel data analysis. In the following explanation we will go through the pre-modelling diagnostic tests, the model and the selection process.

5.2.1 Regression 1: Delinquency rate of mortgagors

The dataset used for conducting tests in order to answer this question included the macro-micro dataset explained in the section above. The first test regarding the dataset was for possible auto-correlation and serial correlations within the set itself. For conducting this test we used the Lagrange Multiplier test approximating a Wooldridge test for auto-correlation in panel data, as expressed in the earlier chapter.

### Table 12 Wooldridge test for Regression 1

<table>
<thead>
<tr>
<th>Wooldridge test for autocorrelation</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>H0: no first-order autocorrelation</td>
<td></td>
</tr>
<tr>
<td>F(1, 2)</td>
<td>48.214</td>
</tr>
<tr>
<td>Prob&gt;F</td>
<td>0.0201</td>
</tr>
</tbody>
</table>

As displayed by the test H0 was rejected at 5% level and therefore we have some autocorrelation in the panel data. This clearly implied that we would have to change our approach towards the models and embrace robust regression models with clustering in order to address this cross-sectional dependence among the variables. However, this was not the only problem as the second test for heteroskedasticity, which was conducted by the modified Wald test for group-wise heteroskedasticity on the simple models predicted the presence of heteroskedasticity in the simple fixed and random effects models.

### Table 13 Heteroskedasticity for Regression 1

<table>
<thead>
<tr>
<th>Modified heteroskedasticity in fixed effect regression model</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>H0: sigma(i)^2 = sigma^2 for all i</td>
<td></td>
</tr>
<tr>
<td>chi2 (3)</td>
<td>7.9</td>
</tr>
<tr>
<td>Prob&gt;chi2</td>
<td>0.048</td>
</tr>
</tbody>
</table>

As displayed above the H0 implied that the sigma of all errors squared was equal to the sigma of all independent variables however at 5% level the H0 was rejected and therefore hinting the presence of heteroskedasticity within the simple models.

### Models and Model Selection

As emphasized by the pre-modelling tests the data sets contained heteroskedasticity and autocorrelation therefore the use of simple models for evaluation was faulty. In considering alternate tests we had to conduct a robust regression based on the approach by Newly & West (1987) who developed estimators, which were lag consistent and therefore usable under the presence of heteroskedasticity and autocorrelation. The approach we used within the robust regression in this set is loosely depended on Newly
& West (1987) approach and was developed by Driscoll & Kay (1998). They relied on large T asymptotics in order to produce standard errors, which were robust to temporal and cross-sectional correlation. Hence, we conducted our modelling using this approach towards standard errors in fixed effects modelling.

Before establishing our selected model we will go over the tests conducted in order to confirm a robust model, which could be used to draw conclusions about the population. The first of these tests was the Hausman fixed effects versus random effects test in order to establish whether a fixed effects model or a random effects model is appropriate for modelling purposes. The test conducted was a chi square test in-order to establish whether the difference between coefficients was systematic or not.

**Table 14 Hausman test for Regression 1**

![Table 14 Hausman test for Regression 1](image)

As observable from the low p value at 0.0001 the null hypothesis could be rejected therefore establishing that the difference between the coefficients is systematic and therefore we could use a fixed effects model instead of a random effects model.

The next test was post estimation for the fixed effects model established. This test tried to observe the cross sectional dependence within the residuals which could seriously affect the model if present. The test was a Breusch-Pagan LM test of independence of residuals. The test conducted was as follows:

**Table 15 Breusch-Pagan test for Regression 1**

![Table 15 Breusch-Pagan test for Regression 1](image)

The test displays that the null that there is independence among the residuals cannot be rejected at the 95% confidence level since the p value is 0.706. This therefore concludes that the model is robust and free from errors due to cross-sectional dependence. The final test conducted was to observe the effect of time fixed effects, which concluded that there is no need for time fixed effect dummies in the model as the matrix of all time dummies is equal to zero.
Hence, after the tests the final model is presented below.

Table 16 Fixed Effect Model for Regression 1

| Drisc/Kraay Delinquency | Coef. | Std. Err. | t | P>|t| | [95% Conf. Interval] |
|-------------------------|-------|-----------|---|-----|-----------------|
| RF                      | 0.2083045 | 0.0915212 | 2.28 | 0.04 | 0.010585 - 0.406024 |
| HPitchng                | -0.000651 | 0.011578 | -0.06 | 0.956 | -0.025664 - 0.024362 |
| Unemp                   | 0.2787624 | 0.0585598 | 4.76 | 0.0001 | 0.1522516 - 0.405273 |
| MortRate                | -0.0737779 | 0.1115241 | -0.66 | 0.52 | -0.314711 - 0.167155 |
| GDPgrowth               | 0.0062143 | 0.0234598 | 0.26 | 0.795 | -0.044467 - 0.056896 |
| DebtIncome              | 0.0039393 | 0.0020828 | 1.89 | 0.082 | -0.000572 - 0.008451 |
| SocialBenefit           | 0.0345114 | 0.0446383 | 0.77 | 0.453 | -0.061924 - 0.130947 |
| OutMorg                 | -5.816-06 | 1.34E-06 | -4.33 | 0.001 | -8.70E-06 - -2.91E-06 |
| Mortgrowth              | -0.005637 | 0.0017484 | -3.22 | 0.007 | -0.009414 - -0.00186 |
| cons                    | -1.832355 | 1.294661 | -1.42 | 0.18 | -4.629299 - 0.964589 |

As observable from the model it rejects the hypothesis for the F test that the combined model is equal to zero, which is given by the F statistic showing a probability of lower than 5% alpha. Thereby there is no problem within this model as it stands and it is robust. The R-squared is significantly high explaining that the model explains most of the variation within the variables; therefore further cementing the view that model is correct. Having established the strength of this robust regression fixed effects model we would now look at the various hypothesis being tested within the context of this test for the individual independent variables influencing the delinquency rates in Scandinavia.

The first hypothesis tested was regarding the influence of risk free or interest rates upon the delinquency rates. At 95% confidence we can reject the null hypothesis that risk free interest rates do not have an effect on delinquency rates as the p value is 0.04. We can hence accept the alternate hypothesis as the results show that risk free rates are positively related to delinquency rates and 1 unit changes in risk free/interest rates increases delinquency rates by 0.208 units.

The second hypothesis tested within this question was the effect of change in real estate prices captured by the respective changes in housing price indexes within the countries. At 95% level of confidence the null hypothesis that the housing price has no effect on the delinquency rate cannot be rejected therefore implying that the change in housing prices do not effect delinquency rates as evidenced from the sample where the p value is high at 0.956.
The third hypothesis was regarding the effect of unemployment rates and their effect on delinquency rates. At the 95% confidence we can conclude that the null hypothesis, which was that unemployment rates do not have an impact on the delinquency rates, is rejected as the p value is almost zero. Thus the alternate hypothesis is accepted as unemployment rates are positively related with delinquency rates as a 1 unit change in unemployment rates increase the delinquency rates by 0.2788 units.

The forth hypothesis was regarding the impact of debt to income ratios on delinquency rates. As evidenced from the test we fail to reject the null hypothesis at the 95% confidence that the ratio has no effect on the delinquency. However, we should note that the probability is extremely close to significance with a p value of 0.082 and the effect debt to income ratios would have on delinquency rates would be a positive increase of 0.0345 units.

The fifth hypothesis tested by the model was the effect of social benefits to GDP ratio on delinquency rates. As evidenced from the p value of 0.453 the null hypothesis that social benefits have no impact on delinquency rates cannot be rejected.

The sixth and seventh hypotheses tested by the model were the relations between GDP growth rates and mortgage interest rates and delinquency rates respectively. The null hypotheses with regards to these two having no effect on the delinquency rates could not be rejected at the 95% level as both of these had high p values of 0.795 for GDP growth rates and 0.520 for mortgage rate. Hence both these factors have little or no impact on delinquency rates as evidenced by the sample.

The eighth hypothesis was regarding the effects of outstanding mortgages on delinquency rates. At 95% confidence we can reject the null as the p value is 0.001 and accept the alternate hypothesis. Therefore we can conclude that the level of outstanding mortgages do have an impact on the delinquency rates however this effect is marginal as an increase in outstanding mortgages by 1 unit effects the delinquency rates by a decrease of $5.81 \times 10^{-6}$ units.

Finally the ninth hypothesis was the impact of mortgage growth rates on delinquencies. As observable from the low p value of 0.07 we can reject the null hypothesis that mortgage growth rates do not have an impact on delinquency rates and accept the alternate. The impact as estimated by the coefficient is a decrease of 0.0056 units in delinquency rates upon a 1 unit increase in mortgage growth rates.

5.2.2 Regression 2: Bank distress

Pre-modelling diagnostics

The dataset used for assessing this question was the bank dataset as expressed in the prior section on descriptive statistics. The data was first tested for the presence of serial correlations by using the Lagrange Multiplier test.

<table>
<thead>
<tr>
<th>Wooldridge test for autocorrelation</th>
<th>H0: no first-order autocorrelation</th>
</tr>
</thead>
<tbody>
<tr>
<td>F(1, 12) 8.557</td>
<td>Prob &gt; F 0.0127</td>
</tr>
</tbody>
</table>

Table 17 Wooldridge Test for Regression 2
The test displays that we reject the null hypothesis that there is no first order autocorrelations in the dataset. Furthermore, conducting the Wald test for group-wise heteroskedasticity we could observe that the data included heteroskedasticity for which we would have to control by conducting a robust regression analysis using clustering.

**Table 18 Wald Test for Regression 2**

<table>
<thead>
<tr>
<th>Test</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>chi2 (13)</td>
<td>4456.42</td>
</tr>
<tr>
<td>Prob&gt;chi2</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

**Model and Model Selection**

Model selection in light of the pre estimation tests required the use of robust regression in order to avoid heteroskedasticity and autocorrelation. However, as explained by the summary statistics the data set displayed a largely random variation where in there was a presence of less temporal effects and more cross-sectional effects. A Hausman test confirmed this as the H0 could not be rejected due to the high p value. Thus the difference between the coefficients was not systematic ruling out a fixed effects model.

**Table 19 Hausman Test for Regression 2**

<table>
<thead>
<tr>
<th>Test</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>chi2 (11)</td>
<td>0.34</td>
</tr>
<tr>
<td>Prob&gt;chi2</td>
<td>1.0000</td>
</tr>
</tbody>
</table>

Hence we used a robust random effects model with clustering in order to control for heteroskedasticity and autocorrelation. The model we used relied on the assumptions that the entity’s error terms are not correlated with those of the predictors (Green, 2008, p.183). Furthermore in order to diagnose whether a random effects model is more explanatory than a pooled OLS model we conducted the Breusch-Pagan Lagrange multiplier test. The test measures whether or not there is an effect across panels.

**Table 20 Breusch-Pagan LM Test for Regression 2**

<table>
<thead>
<tr>
<th>Test</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>chi2 (01)</td>
<td>338.73</td>
</tr>
<tr>
<td>Prob &gt; chi2</td>
<td>0.0000</td>
</tr>
</tbody>
</table>
The results show that the ‘H0: no significance across panels’ can be rejected safely at the 95% confidence level. Thus a random effects model is appropriate for analysis as significant difference exists across panels.

Hence we used the random effects model estimated with robust standard errors and clustering which is presented on the next page. The model was diagnosed for possible cross-sectional interdependence of residuals via the Pesaran cross-sectional dependence in residuals in order to make sure there was no contemporaneous correlation causing bias within results. The model depicted no cross-sectional dependence, as the H0 for the test could not be rejected at 95% confidence level.

Table 21 Pesaran Test for Regression 2

| Pesaran's test of cross sectional independence | -0.670, Pr = 0.5028 |
| Avg absolute value of the off-diagonal elements | 0.346 |

The final model is depicted in table below and has an R-squared of 0.4409 and it passes the F test by rejecting the null that all the variation within the model is not related to the variable having a very low probability against the F statistic. The error statistics sigma_u shows the variation between entities and sigma_e shows the variation within entities across time series. When evaluating the model in line with answering our research question we have to take care that in the random effects model since one is accounting for both within and between entity effects, the change in a unit of a predictor implies an average change across both within and between entity effects (the entities being the predictor variables in each case). Hence with this mind we can now evaluate our model.

The first hypothesis tested was regarding the change in housing price and its effect upon the distance to default. The null hypothesis in this case could not be rejected at the 95% confidence level as the p value was 0.2370. Thus we can conclude that this variable has no statistically significant effect on the distance to default.

The second hypothesis was regarding mortgage share of total assets and its effects on DTD. The null hypothesis was rejected at 95% confidence level, with p value of 0.0090. The alternative accepted imply that mortgage to total assets shares a positive relation with distance to default and 1 unit increase in it leads to an average increase of 0.590 units in distance to default within and between entities.

The third hypothesis tested was regarding the impact of the risk weighted assets upon the distance to default. The null in this case could be rejected as the p value is 0.0020, which is significant at the 95% confidence level. Thus we can accept the alternative and predict that the variable is positively related to the distance to default implying that a 1 unit change in risk weighted assets results in an average increase in 1.3 units of distance to default between and within entities.
The forth to tenth hypothesis, which include the impact of interbank trading assets, whole sale funding, net income to total assets, loan to deposits, derivatives, mortgage growth and delinquency rate, have the same results since all their respective null hypothesis are accepted at 95% confidence level, as they have p values above 0.05. In all these cases the respective variables do not depict any statistically significant influence upon the distance to default. However, within these predictors only mortgage growth is close to significance with a p value of 0.0990 and has a negative relation with the distance to default. Among other variables, only loan to deposits and delinquency rates had an unexpected relation with the distance to default.

The eleventh hypothesis was regarding revenue from mortgages and its effects on the distance to default. The null hypotheses are rejected at 95% confidence level, with p 0.0010. The alternative accepted imply that mortgage revenue shares a positive relation as well with 1 unit increase in it leading to an average increase of 0.795 units in the distance to default within and between entities.
5.3 Summary of hypotheses tested in the two models

Table 23 Summary of Hypotheses Tested in the Two Models

The text colored in red shows the factors statistically significant within either of the models.
CHAPTER 6: DATA ANALYSIS

We would now tie in our empirical findings with the theoretical framework established in chapters 2-4 in order to present a discussion and an eventual answer towards our primary research question. This chapter also discusses the results from the previous chapter in light of the prior literature. The chapter first goes over the two sub-questions and hypotheses developed within these two questions, and then it concludes with a discussion on the primary research question.

6.1. Research Question 1

What are the effects of selected factors on delinquency rate of mortgagors in Scandinavia during the period 2000-2103?

In answering this question we used a fixed effects model where in we assessed the impact of individual entities over time controlling for within entity effects. The model used was a robust fixed effects regression with Driscoll & Kraay standard errors to control for heteroskedasticity and autocorrelation. The final model developed was:

\[ \text{Delit} = \beta_0 + \beta_1*RF_{it} + \beta_2*HPI\text{Chng}_{it} + \beta_3*Unempit + \beta_4*DebtIncome_{it} + \beta_5*SocialBenefit_{it} + \beta_6*GDP\text{growth}_{it} + \beta_7*MortRate_{it} + \beta_8*OutMortg_{it} + \beta_9*Mortgrowth_{it} + \text{Vit} \]

The equation was robust with a high R-squared of 0.7865 and the non model related variation in the model is fairly low as displayed below in the predicted alphas, which indicate non model related variation:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>alphahat</td>
<td>3.513119</td>
<td>1.974601</td>
<td>-0.20939</td>
<td>7.575332</td>
</tr>
</tbody>
</table>

Hence having established the strengths of the model we can now analyze the predictors and the individual hypotheses.

6.1.1 Interpretations of individual hypotheses

H1: Risk free interest rate

Our results indicated that the risk free interest rate shares a fairly strong positive relation with the delinquency rates as an increase in 1 unit of the risk free rate results in increasing delinquency by 0.208 units and this result is significant at the 95% confidence level with a p value of 0.04. This result is in line with our expectations as established in chapter 4 since the risk free rate is the basis rate upon which banks at their interest rates and it also is the standard upon which changes are made on other lending rates on loans and mortgages. Therefore as displayed by the results and our intuition the rate increases the interest burden on individuals thereby increasing the rate of delinquency on mortgage loans. This is in contrast to Igan & Pinhero (2009) who established a surprisingly negative relation between delinquency rates and interest rates. Hence, we believe our results reflect a fairly appropriate picture in line with our
intuitions and the grounded theory behind interest rates and paybacks on mortgages. However, the results are in line with Andersson & Wilhelmsson’s (2009) inquiry into Swedish housing markets as they discovered a significant positive relation between delinquencies and interest rate increases. Therefore, we believe the Scandinavian market shows difference from the one in the US within this regard.

**H2: Change in Housing Prices**
Our results displayed a negative yet not a significant relation between the housing price changes and delinquency rates this is in line with Igan & Pinhero (2009) who also were not able to establish any significant relation between housing price changes and delinquencies. Possible reasons for a lack of significance of housing prices maybe as explained by the research conducted by Sorenson (2013), Browne et al. (2013) and Diaz & Prado (2011). Sorenson (2013) elaborated that in order to calculate the risk or the potential effects from changes in housing prices the use of user cost of housing should be employed rather than simple changes within the housing prices. Browne et al (2013) argued a similar case when they used the user cost of housing rather than the changing housing prices in order to study the effects on delinquency and default rates in Ireland. Diaz & Prado (2011) made a case in their study for the US Federal Reserve using the user cost measure rather than change in housing prices as they argued the need to use the utility derived from the housing asset rather than just a market price change reflecting expectations.

**H3: Unemployment Rate**
Unemployment rates have a fairly significant relation between delinquency rates, which is large and positive. This is displayed by the low p value at 0.0001 and a high coefficient of 0.279, which implies a fairly strong impact of this predictor on the response. This result is in line with our intuition and with the ability to pay hypothesis and confirms the findings from Igan & Pinhero (2009) and Serrano (2005) that the ability to pay hypothesis confirms that delinquency rates would rise in the case of rising unemployment as mortgagors’ ability to payback mortgages is restricted. Andersson & Wilhemsson (2009) also discovered a significant positive relation between the unemployment rate and delinquency rates in Sweden. This further cements the ability to pay hypothesis that despite differences across economies with regards to welfare payments unemployment is a strong predictor of delinquencies.

**H4: Debt to Income ratio**
This predictor had a positive relation with the delinquency rates yet it was not significant on the 95% level. However, with a p value of 0.08 we expect that a larger time series might have given a more significant relationship between this predictor but within our sample it does not predict a significant influence on the delinquency rates. Bhutta (2012) and Sorenson (2013) both depict that debt to income ratios indeed influence delinquencies positively as they reduce the mortgagors’ ability to make good on his debts. Thus, we believe that our results are just a reflection of our smaller time series.

**H5: Social Benefits**
The predictor was established keeping in line with Finansinspektionen’s (Swedish Mortgage Market, 2013) concern regarding the impact of decreasing welfare payments upon possible rising delinquency rates in the future. However our results indicate no significant relationship between social benefits payments and delinquency rates. The
reason for this might be assumption errors as the only available proxy we could find for welfare payments was the OECD average social benefit as a percentage of GDP, which might be a fairly weak predictor of welfare payments.

**H6: GDP growth**
The GDP growth is an indicator of economic progress within a country and therefore establishes the total consumption; production, imports, government expenditure and exports in an economy hence can be a good proxy for the wealth of the individuals or the expectations of rise of income and wealth. However within our tests as in those conducted by Igan & Pinhero (2009) on residential mortgages we find no significant relation between GDP growth and delinquency rate on mortgages.

**H7: Mortgage Rate**
The test results for mortgage rates were surprising in the sense that it did not have any significance at 95% confidence level and had a negative relation with delinquency rates. This however is similar to the findings of Igan & Pinhero (2009) who could not establish a significant impact of mortgages rates upon delinquency rates. A reason for this might reflect from the fact that there is a major difference in fixed and variable rates. Finansinspektion (2013) and Allen et al. (2004) emphasize in the studies of Swedish and Danish mortgage markets about the change in the popularity of fixed and variable mortgage rates with then last decade. Thus, in recent times both types of rates have been used although fixed rates have dominated within Denmark and Sweden; in Norway variable rates still dominate therefore making this average mortgage rate a rather weak proxy for the prevailing rates in the market.

**H 8 & H9: Outstanding mortgages and mortgage growth**
These two predictors concerned more the institutions and the types of individuals increasing their share in the mortgage market than an individuals’ influence on delinquency. Both have a statistically significant impact on delinquency rates as displayed by the p values 0.001 and 0.007 on outstanding mortgages and mortgage growth rates respectively. This establishes a rather surprising result as both have depicted a negative relation with respect to delinquency. This is in conflict with the study conducted by Igan & Pinhero who did not find any significant relationship between outstanding real estate mortgages and delinquencies on residential real estate mortgages. The possible reason for a negative relation between both these indicators might be an indication of the increasing protections being offered in case of delinquencies and defaults whereby in Denmark the financial supervision authority takes over the mortgages and in Sweden delinquencies are secured by the government guarantees as expressed by Finansinspektionen (Swedish Mortgage Market, 2013) and Admunsen & Art (2005).

**6.1.2 Conclusion on Sub Question 1**

*What are the effects of selected factors on delinquency rate of mortgagors in Scandinavia during the period 2000-2103?*

In trying to establish the answer to this question we looked at possible predictors of delinquency rates, as specified by literature, across the time series from 2000 to 2013 in the three Scandinavian economies. The results depicted that the interest rates, unemployment rates, outstanding mortgages and mortgage growth rates are fairly strong determinants of delinquency rates. Debt to income, however, is also closely related to
the delinquencies however housing prices, GDP growth rates, social benefits and house prices are not significant determinants of delinquency rates. Thus, we can establish that the labour markets and central bank actions have significant influence on the delinquency rates within the mortgage markets, and that the strength of the Scandinavian mortgage markets as depicted by the outstanding mortgages and mortgage growth rates seem to be fairly strong during this tumultuous period. Furthermore, we find that Sorenson’s (2013) argument regarding the difference between the indexed prices and fundamental prices in housing is relevant for the study, as housing market prices (not fundamental prices) reflected by the changes in housing price indicators do not have an impact on the delinquency rates.

6.2. Research Question 2

Does the change in institutional business models and mortgage lending business affect its distance to default?

In analyzing this question we used the panel bank dataset summarized in the last section. The model assumed was a robust random effects model with clustering in order to control for heteroskedasticity and autocorrelation. The equation used is as follows:

$$
DTD_{it} = \beta_0 + \beta_1*\text{HPIChng}_{it} + \beta_2*\text{Mort2TA}_{it} + \beta_3*\text{RWA}_{it} + \beta_4*\text{INTTA}_{it} + \beta_5*\text{WSFDTL}_{it} + \beta_6*\text{NITA}_{it} + \beta_7*\text{L2D}_{it} + \beta_8*\text{Der}_{it} + \beta_9*\text{MortG}_{it} + \beta_{10}\text{Del}_{it} + \beta_{11}\text{RevTA}_{it} + V_{it}
$$

In order to establish the strength of the model we can observe the various tests presented in the last chapter and the r squared value of 0.4409. We can also observe the summary of the alphas or non-model related variation as follows:

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>Min</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>alphafihat</td>
<td>130</td>
<td>1.769888</td>
<td>0.233857</td>
<td>1.34933</td>
<td>2.373445</td>
</tr>
</tbody>
</table>

This tells us how much variance is explained by variation not explained by the model and as we can observe the predicted values are higher than the original values.

We will now analyze the individual hypotheses before presenting our answer to the question.

6.2.1 Interpretations of individual hypotheses

H1 & H2: House prices change and mortgages share of total assets

These two hypotheses had a positive relation with the distance to default as witnessed in the researches by Igan & Pinhero (2009) and Andersson (2008). Our research shows a similar situation as mortgages as a share of total assets is statistically significant and implies that the mortgage as a share of total assets is positively related to the distance to default thereby an increase in mortgages increases the distance to default. This might result from the fact that loans are characterized as assets in a bank’s balance sheet increasing which results in an increase in the bank’s assets on book therefore resulting in an increase in distance to default. However housing prices do not have a significant relation with the distance to default within our research which could be a confirmation
of Sorenson’s (2013) research that fundamental housing prices derived from the user cost model of housing (explained in chapter 3) rather than market house prices affect economy and institutions.

H3: RWA
The model displays that the risk weighted assets have a statistically significant (p value 0.0020) and positive average relation across identity and time with distance to default. This is an important finding which contradicts the research of Wignall & Roulet (2013) who using a time fixed model depicted that risk weighted assets have no significant relation with the distance to default and conclude that the Basel regulation have not led to a risk mitigation in bank portfolios. Our result however confirms the research by Van der Ploeg (2010) and Anderssen (2009) who confirmed that the regulation mechanism developed under the Basel regulatory framework is working in mitigating the risk within the portfolios of financial institutions. This is reflected by our test where in the rise in risk weighted assets by one unit increases the average book distance to default by 1.385 units thereby having a considerable effect on the safety of the banks. However, we should recognize the fact that we have used a different model and proxy for distance to default and the results could reflect a possible distinction between book and market oriented measures.

H4 & H5: Interbank trading assets and whole–sale funding
As elaborated by Wignall and Roulet (2013) the relation the relation between interbank trading assets and whole-sale funding towards distance to default is negative. This is confirmed by our findings however we find that this result is statistically insignificant when considering the book distance to default for Scandinavia conflicting with Wignall and Roulet (2013). This might be a reflection of the dataset constraints or the predictive value by the distance to default is measured.

H6 & H7: Net income to trading assets and loan to deposit ratios
These two predictors do not give a statistically significant relationship towards the distance to default and hence show no relation with the changes over time and over different banks. Igan & Pinhero (2009) saw a similar result within their research as both these measures failed to give a statistically meaningful impact on distance to default measures adopted therein. However, Martin (1977), Avery & Hanweck (1984) and Barth et al. (1985) all discovered that both of these measures to had significant relationships thereby underscoring that a difference might exist because of the bank distance to default measure used based on book values and based on the market values. Furthermore, all three of the studies used a logit model rather than a panel random effects model, which could explain the possible divergence.

H8 & H9: Derivatives and growth of mortgage portfolios
As observable from Wignall and Roulet (2013), Igan & Pinhero (2009) and Hays et al (2009) both these factors are negatively related to the distance to default. We observed s similar relation as the rise in derivatives as a share of assets and growth of mortgage portfolios are increasingly characterized by increasing the riskiness of a financial institution. However within our tests we found that the relation was statistically insignificant, which can be a reflection of the limitations imposed by our dataset constraints.

H10 & H11: Delinquencies and mortgage revenue
Delinquencies within our test had a rather surprising result indicating a positive relation. However since this effect is statistically insignificant we can associate it with variations not related to this predictor but from statistical noise. Mortgage revenue however has a statistically significant relationship with the distance to default this is due to the low p value 0.001 and the high coefficient of 0.79 which indicates that a 1 unit increase in mortgage revenue increases the average within entity and between entity effects by 0.79 units thereby being a fairly significant predictor of distance to default. This confirms our earlier intuition and empirical research that mortgage revenue makes a significant portion of the bank business models in Scandinavia. However, it also explains the presence of large stand alone mortgage institutions and mortgage companies in the region.

6.2.2 Conclusion on Sub Question 2

Does the change in institutional business models and mortgage lending business affect its distance to default?

As witnessed by our test results the change in banks business models and mortgage businesses have had an effect on the distance to default. The distance to default has been determined by the risk weighted assets, the mortgage revenue and the mortgage to total assets while other ratios could not predict a fairly significant relation. Hence the changing business model and mortgage lending business has had an effect on the distance to default for the institutions by making mortgage related segments more important in its determination and capital adequacy closely linked with security.

6.3. Conclusions on the main Research Question

How are mortgage lending institutions affected by the risk emanating from residential real estate market in Scandinavia during the period 2000-2013?
In answering this question, we have tried to establish a two tiered approach. One of which addresses the borrower side and the other the lender side of the real estate market in Scandinavia. Since most of the institutions used in the study are either major mortgage companies or banks controlling the major share of real estate and mortgage lending businesses, we could gather the key insights into answering this question by our two sub questions. The delinquency rate analysis provided us with major determinants of delinquency as prescribed by theory and therefore an insight into the borrower side of the mortgage market. This analysis answers the question by providing us with the key determinants of delinquency, as prescribed by theory, which were interest rates, unemployment rates, mortgage growth and outstanding mortgages as well as an almost significant impact from the debt to income ratios. Hence, within the studied time period delinquency rates on mortgages have been affected by the changing macro and micro conditions elucidating the effect from the borrower side on the institutions, due to changing market conditions. This is seen from the increase in mortgage lending affecting delinquency, an increased risk from macro shocks such as unemployment and interest rate hikes, and a spike in indebtedness among individuals witnessed by the large debt to income ratios.

The second aspect of the question concerns whether factors affecting institutional distress are affected by the residential real estate market conditions. In answering this question we used our sub-question two with the analysis on the determinants of distance to default among banks and lending institutions in Scandinavia. The analysis displays the importance of mortgage share of total assets, revenue from mortgages and core tier one ratio as the most significant determinants of distance to default during this period in Scandinavia. Additionally, summary statistics also show increasing loan to deposit ratios, a larger share of derivative assets and a growth in mortgage portfolios characterizing the latter part of the time series. This essentially depicts a changing nature of the businesses. However, over the course of our time series, institutions have also witnessed a significant impact from changing real estate market conditions as their mortgage portfolios have increasingly expanded and acquired importance in determining their risk of distress. Furthermore, the very nature of mortgage lending institutions has changed over the course of this tumultuous period reflecting a rising share in new risky instruments and increasing reliance on mortgage lending.

Hence, we can safely conclude that mortgage lending institutions have been affected by the residential real estate markets between 2000 and 2013. This is due to the changing characterization of the risks facing their customers, which are transferred onto them via delinquency and through the changing nature of their businesses. However what remains to be seen is whether this effect creates opportunities and spurs growth or whether it manifests troubles and creates major problems.
CHAPTER 7: CONCLUSION

The chapter concludes our research by presenting a discussion on the quality of the research followed by concluding arguments, contributions and recommendations, and suggestions for further research.

7.1 The credibility of research findings

The quality of a research relies on the following three criterions – reliability, validity and generalizability (Bryman & Bell, 2012, p. 157-166).

7.1.1 Reliability

This criterion concerns the issue of consistency of the measures. The criterion delves upon questions such as whether data collection and data analysis are reliable, whether the measures yield the same results as those by other researchers and whether the data was transparent and made sense (Bryman & Bell, 2012, p. 157; Saunders et al, 2011, p. 156). The data used in our study comes from internationally reliable databases, which include the EMF, Eurostat, Thomson Reuters DataStream, OECD databases and published annual reports of the institutions concerned. The credibility of these sources is not questionable since they are abundantly used, cited and scrutinized since they are used for research, policy making and analysis globally. Moreover we have stated clearly the indicators used in the study and elaborated upon the methods used in computing them associating them with the corresponding theories. We have also explained the procedure for the data analysis and compared these to prior research. For these reasons, we can safely conclude that it does not matter who collects the data since following the same framework under same time frame, the data should remain the same. Due to this transparency in data collection and analysis, we can say that our research is replicable by other researchers since we have clearly outlined the step by step procedure we followed and highlighted all the tests and estimators employed within the research in our practical method and empirical research sections. Furthermore, we employed Stata (stata.com) as a statistical tool to detect the relationships between the variables. The software is constructed with standard setups of data input as well as output, therefore we have to strictly adapt to the system and the same for other researchers, and hence the outcome of the test should be consistent for all researchers. In particular, our research would not have problem with ‘subject and participant bias’, which asserted by Saunders et al. (2012, p157) as the inconsistency in the responses of participants. Our quantitative study relies purely on public statistics, which eliminate the possibility of subjectivity and participant bias.

7.1.2 Validity

Validity refers to the issue of a concept actually measuring that concept (Bryman & Bell, 2012. p. 159). This criterion questions the causal effect between a dependent variable and independent variables, and whether this relation is credible rather than being a response to other factors (2012, 42). In response to the question we based our findings on facts and theories extracted from peered reviewed articles to state the causal effect. We interpreted the effect in the light of computational statistical tests with robust regression to control for any estimation errors causing bias. The causal effect in the first model between delinquencies and the macro and micro factors stem from the nature of the countries’ economies, their real estate market conditions and the creditworthiness of
the households. The causal effect for the second model is between bank distress and other accounting factors as prescribed by previous research, outlined in the theoretical framework. Within the given theoretical framework, accessible data and consequent analysis was conducted by comparing the results with those of other studies. Hence, our research can be seen valid within the domains of this criterion.

7.1.3 Generalizability
Generalizability is considered as the external validity of a research. External validity deals with the question that whether the result of the research can be generalised beyond the specific research concept (2012, p. 43). As a response to this question we can state that our sample data, regarding the institutional factors, is representative for banks and mortgage lending institutions in each of the countries studied as prescribed by prior studies. These studies are highlighted within the practical methodology. One could question the number of observation within each of the models, 42 observations for the first model and 130 for the second, as being fewer than necessary to achieve generalizability. We would, however, retort by reasoning that the mortgage lending institutions in the study capture most of the residential real estate market in each of the respective countries mentioned in the study. Therefore the study is generalizable to countries with similar macroeconomic conditions within the given time period. Hence, we can conclude that the results of the research can be generalized to other similar economies within the given time frame.

7.2 Conclusion
The last 13 years have remained as some of the most tumultuous in the recent financial history of the world. In a time period little more than a decade we have witnessed two financial crises, a large external shock due to a terrorist event, two wars and extremely volatile markets across the globe. However within this decade we have also witnessed a massive change in banking regimes and the conversion of everyday commercial lenders and investment houses into large scale financial behemoths, completely changing the nature of credit markets.

Hence, as part of the OECD, Scandinavia has seen a massive change in its real estate and credit markets. The real estate market itself has deviated from fundamentals by dangerous proportions and banks have evolved from commercial lending to large scale investment and holding companies. Furthermore, household and mortgage debts remain at their highest peak for individuals, where as loan to deposit ratios and size of mortgage assets are extremely high within credit institutions’ balance sheets.

Thus such a situation and the lack of a presence of a theoretical framework for assessing Scandinavian mortgage markets, led us to construct this study in pursuit of a simple question: How are mortgage lending institutions affected by the risk emanating from residential real estate market in Scandinavia during the period 2000-2013?

In answering this question we looked at two themes one related to delinquency rates, which addressed the presence of an effect and the extent of it from individuals and the buyer/borrower side of the mortgage markets upon institutions. Within this theme we discovered that delinquency was determined by mortgage growth, outstanding mortgages, unemployment and the risk free interest rate. The second theme was related to the effect of the change in an institutions’ business model and mortgage lending business upon its distance to default. This theme answered the question regarding the
presence and the extent of an impact from mortgage markets and changing business
models upon institutions. Within this theme, we identified risk weighted assets, revenue
from mortgages and mortgages share in total assets as having an effect on the distance
to default. However, in line with the answers presented within the two themes and with
regards to the theoretical framework we presented, we can conclude that there is
certainly an effect upon the large mortgage lending institutions in Scandinavia
emanating from the real estate markets between 2000 and 2013. However, we believe
that it is extremely difficult for us to predict with certainty whether the effect will be
prosperous or disastrous for the economies in Scandinavia. Hence, instead of predicting
an impending scenario we would now present a discussion on our contribution and give
recommendations for the intended audience in line with our research findings.

**Practical contribution and Recommendations:**
In developing this study we specified that the purpose of our alarmist approach was to
address concerns about the Scandinavia real estate markets by investors, shareholders,
analysts, policy makers and academic researchers alike. Furthermore, the purpose of
this study also was to shine a light on large mortgage lending institutions in Scandinavia
and the risk they faced from real estate markets.

Hence via conducting this study, we were able to develop a contribution in line with our
intended purpose. This is as the study into the primary question attempts to fill the gap
between popular concern and academic research by giving a key academic insight into
the Scandinavian residential real estate markets. Meanwhile the individual level of
analysis serves as a guide for the intended audience and develops an understanding of
the structure of the market and the institutions. The first level of analysis discovers the
influence of selected predictors of delinquency, thereby offering a key insight into the
mortgage markets addressing the needs of policy makers and serving as a stepping-
stone for further research for researchers. Meanwhile, the second level addresses the
changing nature of Scandinavian mortgage institutions and the influences into their
distress, which could serve as an insight for investors, financial analysts and firm
managers alike.

However, we would like to further our contribution via this research by suggesting
recommendations for the intended audience. For investors we would recommend
following the price changes and developing the necessary hedges against a real estate
portfolio rather than treating it as a hedging asset itself. Our recommendation is in line
with the present academic research on the volatility in housing prices and rapid
downturns causing problems for investors. For policy makers, analysts and researchers,
we would present this research as a reference point for a more in-depth inquiry into the
mortgage lending institutions and their risk profile. This recommendation is in line with
our belief that the study covers the seller and buyer sides of the Scandinavian market by
delving deep into the specific factors and influences within them. Thus it is a complete
stepping stone for either side of the analysis.

Hence, having fulfilled our intended purpose and having highlighted the contribution of
this study, we conclude this research by presenting suggestions for further research.
7.3 Further Research

In this study we could detect four factors that determined the delinquency rate of mortgagors, and three factors that had significant impact on banks’ distress. However, there are several procedures, which could have improved the study but could not be conducted although due to the time and data constraint we faced. For this reason, we would like to review these by offering suggestions for further research in improving and understanding of mortgage markets.

One such suggestion would be to obtain more specific databases reflecting the features of the residential real estate market or commercial real estate market separately. The use of such a database can allow researchers to demonstrate a complete picture of the real estate market wherein impact of residential and commercial real estate markets could be judged. Also, a further bifurcation would be interesting if the residential real estate market can be broken into specified categories such as flats or small houses and across different regions. Thus studying these separately would allow for a more comprehensive understanding of the house price development.

Furthermore, there are a number of indicators that we think can be improved in further research. Firstly, an inclusion of the user cost, which we discussed in mortgage markets section within chapter 3 could serve for a more elaborate and appropriate understanding of real estate prices. The user cost is a good proxy for house prices because the elements included in this cost, such as interest rate, tax rate of ownership of the house, amortisation cost, earning and capital lost on housing reflect a more true value of the house than simply house price indicator. Secondly, the loan to value ratio which measures the difference in the value of the loan and the house is a good indicator for the risk taking behaviour of banks and mortgagors especially when facing high loan to value ratios. In Scandinavia, this ratio is strikingly higher than elsewhere due to special loan conditions such as infinite terms for loans and low down payments.

Another important improvement, which we could not include in our study because of time constraints, could be the addition of appropriate stress tests and scenario analysis. These tests could detect countries or banks, which were most vulnerable during the volatile real estate market conditions. Hence a suggestion for further research would be to conduct these tests. Throughout the research our focus has been on volatile real estate markets, therefore we suggest constructing scenarios in stress situations by varying the interest rates and/or housing prices to observe how these changes affect the bank distress.

Another suggestion would be to use other methods for measuring bank distress than book distance to default. An interesting case could be where one could obtain a measure for bank distress, which linked both the market factors and the bank book factors. This could create a more dynamic indicator for bank distress. Within this regard, one could possibly use a combination of CAMEL with credit ratings similar to the methods employed by rating agencies. Since credit ratings on their own are rather subjective to rating agencies’ standard criteria and CAMEL is considerably difficult to approximate. What one can do, however, is to compute ratios that match each aspect within CAMEL and then list out the risk profile of the agency. This could be done by employing an ordinal probit model (Greene, 2003, p.710-719) where a CAMEL rating can be matched with a certain risk profile differentiated from high to low. For instance, a risk profile of A- could match a CAMEL rating of 1 indicating that there is no risk of default or
distress and a risk profile of C- will match the rating of 5 indicating high risk of default and so on.

Finally, we would also suggest studying this topic by employing the use of probit and logit models. Since these models employ binary outcomes, which take two possible values, and can therefore incorporate probability of default as an indicator of bank distress (as a dependent variable in the regression). This method has been very popular and has been used by many researchers. For more insights review the works of Campbell and Diertrich (1983), Diaz-Serrano (2005), Koetter and Poghosyan (2008), Hays, Lurgio and Gilbert (2009), Bottazzi, Secchi and Tamagni (2011) and Blundell-Wignall and Roulet (2012).

In line with these suggestions and other such profound methods, we believe further research can improve upon our study by overcoming the limitations of this research and can lead to an even better understanding of the residential real estate market and mortgage lending institutions in Scandinavia.
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