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Enterprise Risk Management Implementation and Default Risk

Evidence of Bank Industry in China and Nordic Countries

by

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Abstract

With the development of the global economy in the 21st century, enterprise risk management (ERM) has been more impactfully implemented by firms. Academics have studied the relationship between ERM and firms' performance, yet few studies have covered the relationship between ERM and default risk, let alone the comparison study between banks in China and banks in Nordic countries, the two important markets in Asia and Europe. This study aims to investigate the relationship between Enterprise Risk Management implementation (ERM) and default risk under the bank industry in both China and Nordic Countries. The study will also compare the results and dig out the reasons behind the different outcomes across the countries.

Our results indicate the same trend as expected that ERM has a significant impact on a bank's default risk no matter CDS or credit ratings as an indicator of default risk. Geographically, this impact is more substantial for Chinese banks rather than in Nordic countries ones due to the performance pressure and investment in internal control systems. However, the influence of ERM on default risk cannot be explained much in the variation of dependent variables when using credit ratings as an indicator of default risk.

Keywords: Enterprise Risk Management, chief risk officer, bank performance, text-based method, LASSO

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1 Introduction

Enterprise Risk Management (ERM) is a framework that focuses on a holistic and integrated level for managing the three types of risks that an enterprise confronts with during daily operation, credit risk, market risk, operational risk, reflecting the default, uncontrollable marketing uncertainty, and internal operating systems, respectively. On top of this ERM, credit risk is the kind of uncertainty that investors concern the most, and ERM can contribute to controlling in the banking industry. ERM is also a framework for managing two related financial conditions, economic capital, and risk transferring, indicating the provision that a company needs to survive under the worst scenarios and the insurance to transfer out the risk, respectively. The aim of the ERM is to maximize a company's value rather than adding up the paperwork and administrative work for the staff.

ERM implementation has so far played an essential role in a company's internal control and risk management part, and an increasing number of companies begin to value the importance of ERM implementation, particularly banks[1]. Since ERM can contribute to improving the management of a company to avoid severe fraud or risky events happening, will ERM directly help a company to decrease the default risk to improve its credit ratings and making lower CDS spread? What is the impact of ERM on the banking industry in China and Nordic Countries, the important financial markets in Asia and Europe? Does applying ERM help banks in these two specific areas benefit from getting a better corporate performance. What is the impact of ERM on the credit ratings of the Chinese and Nordic markets? What are the similarities in the level of impact on the credit ratings by applying ERM in these two markets? This thesis aims to study the relationship between ERM application and default risk in these two markets. It will also use two approaches to analyzes the reason behind the different impacts of ERM implementation in these two markets.

[1] Hu, J.W. and Wang, L.S, 2009

1.1 Background

According to The Committee of Sponsoring Organizations of the Treadway Commission (COSO), ERM aggregates the processes and methods by which companies trying to control the results that all sorts of uncertain factors within the expected acceptable range in the process of achieving future strategic goals. These ensure the realization and promotion of the overall interest of the organization. ERM requires company's board of directors, management, and other employees to participate in the company's strategy formulation, which is used to identify matters that may have a potential impact on the company and management risks within its risk appetite, providing for the realization of corporate goals, reasonably guaranteed process. The primary triggers of publishing the ERM system are the default of two substantial companies in the US: one is the most influential energy American company, Enron Corporation, in 2001; another is one of the biggest American telecom companies, WorldCom, in 2002. Another trigger is the publication of the Sarbanes-Oxley Act in 2002.

COSO has published several versions of instructive documents regarding the enterprise risk management and corporate internal control system, making the Enterprise Risk Management Framework: “The bible of risk management and internal control.” (Zhou, 2019, p.107-108). In 2017, after collecting the ideas and analyzing the new challenges firms are facing, COSO published phase II new ERM framework, emphasizing aligning risk with strategy and performance during companies’ daily operation.

Default risk is the probability that an individual or a firm will fail to pay its debt obligation from a forward-looking perspective by analyzing the current financial status (Kagan, 2019). Lundqvist and Vilhelmsson (2016) highlighted that credit ratings and CDS spread are generally being applied as a standard tool to gauge the default risk. Credit ratings provided by third party agencies such as Standard & Poor's (S&P), Moody's, and Fitch Ratings, are playing a crucial role in the international debt market for more than 150 years, at Ocran’s (2015) viewpoint. For this, the rating scales the credit ratings agencies use a trustworthy assessment that can provide information on the probabilities of an individual, or an entity can pay back the borrowing and not default.

According to Yoshino, N. and Taghizadeh-Hesay F. (2016), there are 3 types of companies that tend to contain high default risks: unwell-managed startup companies, hastily growing and expanding companies - which grow by pursuing extremely aggressive ambition companies and too big to adjust their strategies to catch up the new trend companies. Within these company types which have a high risk of default potential. The potential reason that the three types of companies containing high default risk are mostly due to non-sufficient risk management.

When putting ERM into effect, is there a significant relationship between default risk and the level of ERM implementation in the banking industry in two of the important banking markets, China and the Nordic countries. This paper will estimate the relationship and compare the results to probe the reason behind the differences and similarities. Why these two countries? China takes up 18 places among the top 100 largest banks by total assets in the world in 2019 (S&P Global Market Intelligence, 2019), while the 5 Nordic countries have the biggest and

most comprehensive banking industry in the European market. Due to regulations and political reasons such as government intervention, there must be some differences between banks in these 2 markets, which will include implication reference that both sides can use for strengthening the governance and stock price value-adding.

1.2 Aim and Objectives

The main aim of this thesis is to probe whether the degree of ERM implementation significantly affects the default risk for Chinese and Nordic banks. What are the similarities and differences in the level of impact on the default risk by applying ERM in these two markets? In addition, since China and the Nordic countries are among the most representative growing markets, the investigation of ERM implementation and its effects on default risk might open new venues in pushing research deeper to dive into a niche and new risk management field. That will allow us to picture the geographical influences of ERM implementation.

Since several text-based approaches have already been used to estimate the degree of implementing the ERM, for instance, the keywords combination search on the annual report and the total words counts in annual reports, but these measurements of testing the degree of the ERM implementation still not entirely satisfying. In this article, a new machine learning-based method called least absolute shrinkage and selection operator (LASSO) regression will be employed to test an improved text-based method to determine the dimensions that the closest related to the degree of implementation of ERM, so that one can have a more precise method to estimate ERM implementation.

1.3 Outline of the Thesis

There are five sections in this article. Here we elucidate the concepts of ERM and default risk, their relationship, their implementation and effects within the banking industry in China and Nordic Countries, the motivation of choosing this topic, and the aim of the study. Subsequently, details about the methodology that we use to study the relationship between ERM application and default risk by utilizing both ERM word-based proxy and LASSO regression on determining the dimensions of measuring ERM on two default risk related dependent variables, CDS spread and credit ratings will be presented. On top of this, we provide information on data collection in Bloomberg, Thomson Reuters Eikon, and Datastream. The obstacles we encountered when data collection and the description of the control variables are also presented for future researchers reference. Next, the empirical study will apply by putting the ERM word-based proxy and LASSO regression to determine the dimensions of ERM into practice, difference-in-difference econometric study results will be presented, and the economic interpretation behind the results will be probed and explored.

2 Literature/Theoretical Review

COSO published the first version of the ERM framework in 2004, after which, relevant studies revolving on the importance of ERM, the relationship between the ERM and internal control. Based on the ERM framework, even though many scholars have probed the measurement of default risk or the theoretical influence of ERM on default risk, the study on the relationship between ERM implementation and default risk is seldom seen. In recent years, Lundqvist and Vilhelmsson (2016) started to study the relationship between ERM implementation and default risk by utilizing 78 banks globally, filling in the gap of this area.

2.1 Enterprise Risk Management

In recent years, academic research on the internal elements of risk management generally included two aspects: implementation of motivation and constituent parts. Liebenberg (2010) et al. states that whether or not companies implement risk management measures depends on business conditions and prospects in addition to the reasons for enhancing corporate value. Factors such as market competition and corporate risk appetite, while the company's organizational structure does not adapt to the requirements of corporate risk management and the inertia of the company's unwillingness to change, are the main factors hindering corporate risk management (Kleffner, 2011) on the composition of corporate risk management. These elements are the most classic among the eight proposed by COSO, such as the internal environment, goal setting, event identification, risk assessment, risk response, control activities, information and communication, and monitoring. In addition, some scholars have demonstrated through empirical analysis that corporate governance and organizational culture also play an active role in enterprise risk management (John, 2010).

Enterprise risk management has attracted much attention within the financial world, including financial institutions, consulting firms, and some academic institutions of higher education. Hoyt and Liebenberg (2011) argue that enterprise risk management can manage the risk in an integrated way compared with old-fashioned risk management. On top of this, the ERM can be considered to be useful for making operational and strategic decision-making since the risk awareness of the whole organization has been promoted by this risk management method.

Despite the fact that several studies and institutions showed investigated ERM applications, few studies have illustrated the relationship between ERM and corporate value. Hence, Hoyt and Liebenberg conducted a study on some particular insurance companies that had already implemented ERM programs in order to analyze their impact on corporate value.

The results of this study ultimately showed the positive and significant relationship between the corporate value and ERM, and it could be quantified as a company valued approximately 20% higher than other companies by conducting ERM. Therefore, the result suggests that ERM can be used to increase the value of specific companies. The result of the valuation premium was significant, both economically and statistically, for companies adopting ERM.

In order to have a better understanding of enterprise risk management and ERM implementation, several studies further assessed the determinants and the elements that would have some influence on the ERM and its implementation.

Lundqvist (2015) argues that it is necessary to separate ERM into multiple parts and analyze the determinants of each part to get a better understanding of ERM. On top of this, the researcher believed that the ERM is still traditional risk management but with new risk governance, where the risk governance can be noted as the control and direction of the risk management system. In general, Lundqvist (2015) thinks that overall the ERM was an integrated approach to achieve risk management effectively by combining traditional risk management with risk governance.

In order to know why companies decided to conduct ERM implementation instead of traditional risk management, the researcher designed a survey to collect information on the implementation of risk management among 145 Nordic companies. A variety of questions were listed in the survey of 59 dimensions, and all the responses from companies were analyzed through an exploratory factor analysis, which aimed to find out the component structure of ERM. These dimensions are investigated with exploratory factor analysis turned to a breakdown of ERM into two components, which are traditional risk management and risk governance, respectively. The results of this study showed that these two components do have their determinants. For example, the size of firm and leverage and dividend payments are both highly related to the risk governance. Besides, the level of control the chief executive officers have on the governance decisions also acts as a vital role in risk governance implementation. The researcher believed that this study provided evidence that companies are adopting the ERM implementation in order to emphasize governance needs in the risk management system.

Apart from the determinants that are mentioned previously for ERM, some other studies also illustrate that there are more factors that might highly be correlated with the extent of implementation.

Beasley, Clune, and Hermanson (2005) point out that the stakeholder value would be risky if there are no effective corporate governance mechanisms to manage the portfolio of risks when facing the enterprise. As a result of this, enterprise risk management was employed for board members and management team to supervise the risk when dealing with the enterprise. In their study, Beasley, Clune, and Hermanson (2005) attempt to dig some empirical evidence on the organizational characteristics that are correlated with the extent of ERM implementation, given the fact that ERM implementation is in different stages among organizations. They came up with some assumptive organizational characteristics that they thought might be associated with the implementation of ERM. For instance, the presence of a Chief Risk Officer (CRO), independence of the board of directors and organization size.

Researchers collected the survey and sent it out to all the targeted organizations in order to collect data related to ERM implementation. Overall, the results showed that the board and the management leadership are essential to ERM implementation. For example, the existence of a CRO is positively associated with the extent of ERM implementation. Meanwhile, some other organizational characteristics (e.g., the size of the enterprises) may also have some connection with the extent of ERM implementation.

According to a study from Beasley, Clune, and Hermanson (2005), CROs play an essential role in enterprise risk management. This motivates further research to concentrate on the CRO and its related topics to root out their relationship behind enterprise risk management.

Sabato (2010) believes that CRO could be treated as an important element when analyzing the enterprise risk management since when more specific measures involve either the appearance of a risk committee or designating a CRO will administrate the relevant risks within the institution.

Aebi, Sabato, and Schmid (2011) investigated whether some risk management related to corporate governance mechanisms are correlated with the performance during the financial crisis in 2008. The researchers contribute to some existing studies by focusing on the bank-specific corporate governance that may highly be associated with bank performance. Aebi, Sabato, and Schmid (2011) have collected the first group of five corporate governance variables for the 372 available banks, which are CRO in the executive board, risk committee, the board size, board independence, and the percentage of directors with finance background respectively. Another five groups of corporate governance variables provided more detailed information on the risk committee and the line of reporting of the CRO for the 86 targeted banks. Subsequently, a time-series regression is conducted to measure the performance of banks, while some other financial control variables are included.

Overall, the test results from this research indicated that the CRO reports to the board of directors perform significantly better than the CRO reports to the CEO under the sample during the analyzed financial crisis period. Besides, the results also illustrate that there exists no correlated relationship between a bank's performance and the selected corporate governance variables such as CEO ownership and board independence, etc. Therefore, the research shows that standard governance measures used in the extensive literature on corporate governance and its impact on the valuation of non-financial companies may not be sufficient to describe the relevant governance structure of banks, especially to its crisis performance. Besides, the researchers also proved that in order to get well prepared for any future financial crisis, banks should not only improve the quality and the profile of their risk management function, but some appropriate risk management mechanisms should also be employed to keep the CEO and the CRO at the same level.

Our objective is first to measure the degree of ERM implementation and then find out the relationship between ERM implementation and default risk. It is crucial to understand and generalize some related past studies to assist us in developing further research and also provide some inspirations both in methods and the general idea.

Since it has given us some inspiration about the measurement of the degree of ERM, in a landmark study, Lundqvist and Vilhelmsson (2016) use a new text-based approach to analyze ERM implementation by constructing a proxy with counting the words of the annual report and scoring a firm on ERM related keywords searching. Firstly, they constructed a "difference-in-difference" study by taking the total word number in the annual report before minus the total word number after a bank using a specific phrase "chief risk officer" in its annual report to check the validity of the degree of ERM implementation. They used "chief risk officer" as a treatment effect. For the new proxy scoring a company's ERM implementation according to related keywords, they created a comprehensive list of keywords that are reflecting COSO's eight components of ERM implementation. Then they searched these eighty-three keywords from a company's annual report; whenever there is a keyword found in the annual report, it would give a code to the company as a score — the more keywords found in the annual report. The range of the total credit is from zero to eighty-three, and they found the average of the score for a bank is 47.5 over the whole period.

Another contribution from Lundqvist and Vilhelmsson (2016) related to the relationship between ERM implementation and default risk by two methods: estimating the relationship between ERM implementation and the year-end CDS, and estimating the relationship between ERM implementation and the year-end credit ratings.

They find that whenever the degree of ERM implementation increases one unit, the CDS spread of a bank will drop around 2 base points. However, the relationship between ERM implementation and credit ratings was not significant when controlling the governance characteristics of a bank by applying eight control variables: total assets, return on assets, tier-1-capital ratio, non-performing loans over total assets, provision for loan losses over total assets, corporate governance score, audit committee independence score, and the single most prominent owner. The reason they provided was that rating agencies treated ERM implementation more like a signal for corporate governance rather than an estimate for default risk, and the rating agencies don't have an aligned process for incorporating ERM implementation.

2.2 Default Risk and ERM

In the background of the sovereign debt crisis, many researchers are becoming more and more interested in the stability of the bank system, especially for European banks. Ristolainen (2015) illustrates that apart from the commonly used credit default swap (CDS) spread, there are still some other methods that can be employed as the warning indicators to complete the credit risk assessment. The reason for Ristolainen choosing to study on distance-to-default as the benchmark for comparison with the market-based measure was because of the popularity of the enterprise's default prediction. Also, distance-to-default was usually used the data from the company's balance sheet instead of the market data, which makes it become an attraction to CDS spread in analyzing credit risk.

After analyzing 37 large European banks between 2008 and 2013, the research found out that the sharp rise and change in credit risk implied by the CDS spread during the crisis time. As for some banks that are small and the banks that are in "problem" countries (e.g., Portugal, Italy, Greece, and Spain), the distance-to-default should be conducted in assessing the credit risk in banks. Moreover, the distance-to-default can be seen as a useful warning indicator of bank credit reputation changes, especially when these conditions are met.

On the basis of Ristolainen's (2015) study using distance-to-default as the benchmark method and market-based method to gauge risk management, Matthies (2013) extended his study areas to the relationship and how the capital market, credit ratings and default risk affect each other.

Matthies (2013) focuses on the current state and some previous findings of empirical research on corporate credit ratings and their relationship with other entity ratings. Specifically, the study considered the results from three aspects: the relationship between credit ratings and corporate defaults, the impact of ratings on the capital market, and the determinants of credit ratings and rating changes. The study also introduced how these three lines of research interacted with each other and showed the importance of each line in other fields.

The final results showed that the rating scale had been highlighted when analyzing the credit ratings and their relationship to corporate default in the first line of study. Also, the difference in rating classes did not correspond to the equivalent difference in default probability, which can be noted as a piece of essential information for the remaining two lines of research. Moreover, the relevance of changes in credit ratings to the capital markets could only be measured when they are conditional on a corresponding change in default probability. Besides, the market response around rating changes is asymmetric. The asymmetry is caused by a through-the-cycle method since a rating agency tries to estimate the long-term credit level independently of the impact of short-term business cycles. However, the ratings are indeed related to the business cycle.

Hence, some macroeconomic variables, financial ratios, and corporate governance characteristics can all be seen as the determinants of credit ratings.

Finally, the research emphasized the relationship between financial statements and credit ratings. Financial statements are a vital element in determining credit ratings. Also, it can reduce the main agent problem between management and stakeholders and realize the possible corporate governance mechanism of wealth redistribution from bondholders to shareholders, which is very important to determine the credibility of the enterprise.

Fraser and Simkins' (2007) research shows the same result as Matthies' (2013) on the aspects of the "through-the-cycle method may cause the credit ratings to be asymmetric" problem.

Fraser and Simkins (2007) discuss that the effect of ERM implementation is not instantaneous and not discernible by the financial market. They argued that credit rating agencies such as Moody's and Standard & Poor's do take accounts for ERM implementation as the credit rating agencies recognize the significant effect of ERM implementation on decreasing the cost of debt, reducing the overall cost of equity and increasing the company's value. For this consideration,

firms applying ERM would be given a higher credit rating. They also revealed that ERM could be quantified and measured; for example, S&P assess ERM from five aspects[2].

Carol's study on the relationship between ERM and credit rating (2017) shows the same opinion[3] as to the opinion of Fraser and Simkins (2017). She mentions that ERM is an essential measure that estimates a company's susceptibility and sensitivity to test and evaluate the default risk, and the capability of a company to absorb a loss. At credit rating agency sides, the reason that they include ERM as an indispensable adding is that "corporate enterprises with a deliberate, consistent, articulated, resourced, and integrated approach that effectively identifies, selects and prudently mitigates risks are more likely to build long-term credit strength as compared to enterprises with a casual, opportunistic, or reactive approach" (S&P, 2013).

The nature of the capital market pushes companies to adopt ERM so to decrease transaction, which in turn increases the value of an entity and lowers the default risk (Smith and Stulz, 1985). On top of this, implementing ERM has the ability to cut back on the volatility of cash flows so that the probability of financial distress drops, and the default risk declines as well (Bartram, 2000). Several studies have used various methods of financial instruments to reveal the benefits of taking ERM and relevant governance actions on declining the default risk of a bank, such as Brunzell, Hansson, and Liljeblom's (2011) study uses hedging related derivatives showing that taking ERM is a value-increasing effect for companies.

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[2] The five aspects S&P assess a financial institution are: business risk, risk management, risk governance, operational risk, credit risk, reputational risk, and the quality of management. (S&P 2006)

[3] Carol, L., 2017

3 Methodology

Many approaches have been invented to measuring the effect of ERM on credit ratings, company value, and so on, and most of them are number based. In 2016, Lundqvist and Vilhelmsson created a new text-based method for measuring ERM implementation on US banks. This study applies the same method as Lundqvist and Vilhelmsson's as well as another new survey and texted-based approach inspired by Lundqvist and Vilhemsson to study the effect of ERM implementation on Chinese banks and Nordics banks. Three authorized terminals are used to extract data. Data related descriptions and the obstacles when assessing data are presented for further researches.

3.1 Research Approach

There are few methods to measure the ERM implementation according to some previous researches. First of all, Hoyt and Liebenberg (2011), and Beasley et al. (2008) conducted an approach to use the chief risk officer as an indicator for the implementations of ERM. However, due to the fact that CRO only reflects the governance pillar out of the three ERM pillars so that this method might have some limitations for ERM implementation. Secondly, Gordon et al. (2009) tried to capture the four ERM objectives that are stated in COSO (2004) by developing an ERM index to measure the ERM implementation. This method focuses on the effectiveness of ERM instead of the degree of ERM implementation. Thus, this method isn't employed in this study. In addition, another commonly used survey-based method was developed by Lundqvist (2014) to find out the companies' willingness and decision to adopt the ERM implementation by receiving first-hand data from the survey. To fulfill our objective of this study, we consider using an integrated approach to measure ERM implementation, which contains both the text-based searches of the annual report and a survey-based method.

For the text-based searches method, 83 dimensions are included to provide a comprehensive picture of the implementation of ERM. We try searching different word combinations within the dimensions to find the hits in our samples. The survey-based method requires the response from our target banks regarding their level of ERM implementation. We send out the questionnaire to all the banks in our sample, which contains a firm's level of implementation of various perspectives of the risk management process and the degree of ERM they had already implemented. Given the COSO definition, the degree of ERM implementation usually on a scale from 0 ("not at all") to 3 ("robustly implemented"). Then, we still use the text-based searches in large dimensions to find out the keywords that are significantly correlated to the degree of ERM implementation. Because the weights assigned in each keyword is essential, Lasso regression will be employed to estimate the relative weights of the word combination

from the training sample, which refers to ERM implementation from the responses of the survey.

In statistics and machine learning, Lasso is a method that aims to reduce a large number of predictor variables to improve the model's predictive accuracy. Lasso was first introduced in 1986 and then got rediscovered and popularized in front of the crowds in 1996 by Tibshirani.

As for the default risk, we use credit ratings and CDS Spread as the proxy for the banks' default risk. The CDS Spread is the amount paid for insurance against default and is a direct market-based measure of the firm's default risk, and credit ratings are opinions of the credit rating agency regarding a corporation's relative default risk (S&P, 2011). CDS spread commonly used as warning indicators to complete the credit risk assessment (Ristolainen, 2015). The reason to choose a two-measure method is that Lundqvist and Vilhelmsson (2016) believe that credit ratings are relatively stable so that it might be less flexible to observe the changes in default of risk over time. However, CDS Spread can capture the time-varying changes more efficiently. Additionally, Hilscher and Wilson (2013) point out that CDS Spread highly related to both default probability and systematic default risk, while credit ratings can only indicate the changes in systematic risk. Hence, it is proper to select both of these two measures since they can better present the default risk in many aspects, and it can provide a more accurate result when considering the ERM's effect on default risk.

3.2 Research Design

3.2.1 ERM Implementation Measurement

Due to some existing studies from Desender (2011) and Lundqvist (2014), we intend to create a list that filled with a variety of dimensions of ERM implementation. Based on the 83 dimensions of ERM that Lundqvist and Vilhelmsson (2016) have conducted, this article continues to include these dimensions since they will present the specific eight components of ERM implementation from COSO.

The text-based searches of the annual report are chosen to measure the ERM implementation. Firstly, we intend to search the annual reports in determining dimensions by using a single word or word combinations. For explaining the approach, taking the keyword "financial risk" as an example, firstly, financial risk can be seen as one of the dimensions of ERM implementation. Secondly, we search "financial + risk" in annual reports and if there are ± 200 characters apart from the word "risk" to the first word "financial", a hit will be recorded if this situation happens; therefore, there can be many hits for one-word combination. Besides, this approach should work the same for a three-word combination. For instance, when we search the combination of the words "chief risk officer", a hit will be noted if there are ± 200 characters between the word "officer" and the first word "chief".

After searching all the word combinations, we mark the combinations that have at least one hit with an index one and others without any hit an index zero by using some coding. Nevertheless,

for several dimensions that have a few sets of combinations, we would like to sum the number of hits of each combo and put more weight on the word combinations. Additionally, a one for that dimension is an "or" function of the individual search combinations, and then the degree of ERM implementation can be the result of the sum of the coded variables. Therefore, the degree of ERM implementation should stay in the interval between 0 and 83 since the binomial coding provides equal weight to the search word combinations. The search combinations in different dimensions with a hit will be put into the CDS and credit rating sample to find out the corresponding relationship separately.

Another survey-based approach can also measure the ERM implementation. We sent out questionnaires to all the banks in sample. The survey consists of many perspectives of the companies' risk management process and the degree of ERM implementation that they had already conducted from a scale from 0 ("not at all") to 3 ("robustly implemented"). Then, we still use the text-based searches in large dimensions to find out the keywords that are correlated to the ERM implementation significantly from the banks' responses. Unlike the previous ordinary text-based method, this time, we employ Lasso to estimate the weights of word combinations and instead of giving them equal weights. After running the regression, Lasso picks the most significant variables or dimensions that can reflect the ERM implementation with effectiveness.

3.2.2 Default Risk Measurement

We break the default risk into two segments: CDS Spread and credit ratings. Since both, the CDS Spread, and credit ratings are driven by a bank's credit quality and level of default risk that is otherwise unobservable (Lundqvist and Vilhelmsson 2016).

3.2.3 Credit Default Swaps

Giglio (2016) claims that the credit default swap (CDS) market is a contract that provides insurance against default events and is also a market that is controlled by some financial agencies. It is known that most of the banks have CDS contracts that are different in maturity. In this study, we select the most widely picked contracts with the maturity to five years, since the most common specifications may reduce the variability between the 102 sample banks.

3.2.4 Credit Ratings

Standard & Poor's (S&P), Moody's, and Fitch Group are known as the biggest three credit rating agencies, and they almost control approximately 95% of the credit rating business. We choose the S&P to obtain the required credit ratings since S&P is the first rating agency to enterprise risk management into their credit rating system.

3.2.5 Control Variables

A different variety of control variables are included for the targeted banks based on several bank related and corporate governance related aspects. These control variables stem from previous studies. Curry et al. (2008) found that the credit ratings present some inter-temporal

characteristics when taking some bank characteristics, financial market conditions, past supervisory information, and aggregate macro-economic factors into account. Researchers Bissoondoyal-Bheenick and Treepongkaruna (2011) pointed out that ownership structure, strategic management, and regulations should be applied by agencies in their assessment when giving credit ratings. Since we use CDS Spread and credit ratings as the proxy for default risk, we will conduct the same control variables for both CDS Spread and credit ratings and construct the panel regression separately. The control variables chosen are showing the following: number of words, total assets (TA) (measured in trillions), ROA, Tier 1 capital ratio, nonperforming loans over total assets, provision for loan losses over total assets, and percentage of institutional ownership of the outstanding share.

Lundqvist and Vilhelmsson (2016) choose 9 control variables in their study, including 3 corporate governance control variables. In this article, the single biggest owner variable in their study is switched to institutional ownership of the outstanding share, since these two variables have the similar implications, and can both measure the ownership stake in a company that is held by large financial institutions. Due to a large amount of missing data, another two corporate governance control variables are excluded, for instance, corporate governance score and audit committee independence. Because if we insist on using these two variables, it will eventually result in insignificance in the panel regression. Moreover, institutional ownership of the outstanding share can still represent the corporate governance variable. Therefore, it would not have a big impact on the research result.

3.2.6 Validity of Measure

A difference-in-difference study is applied in order to make sure of the validity of the measure of ERM implementation. According to Lundqvist and Vilhelmsson (2016), the hiring of a Chief Risk Officer will be the treatment effect. The proxy for this study is to calculate the first occurrence of the keyword “chief risk officer” in the sample banks’ annual report. Then, the difference between the degree of ERM implementation can be counted as:

$$(°\mathrm{ERM}_t - °\mathrm{ERM}_{t-1}) - 1$$

Where the t refers to the year that banks include “chief risk officer” in their annual reports, the treatment effect will be achieved by subtracting 1, which means that when the keyword “chief risk officer" appears, the degree of ERM implementation will have an increase by 1.

For the CDS Spread samples in Chinese banks, there are 17 bank-years for the treatment sample and 176 bank-years for the control sample. Moreover, the difference has an average increase of 6.36 in the treatment sample of ERM implementation. Regarding the control sample, the difference possesses an average increase of 0.38 of the degree of ERM implementation in the control sample. As for the credit rating sample in Chinese banks, there exists 19 bank-years for the treatment sample and 154 bank-years for the control sample. In this case, the difference has an average increase of 8.88 in the treatment sample of ERM implementation, while in the control sample, the number is 0.17. The p-values for the difference of means are 0.000218 and 0.00000417, respectively, for CDS Spread and credit ratings in Chinese banks. The result

illustrates that using Chief Risk Officer as the treatment effect does have a significant influence on the measure of ERM implementation in Chinese banks.

On the other hand, for the CDS Spread sample in Nordic banks, there are 14 bank-years for the treatment sample and 187 bank-years for the control sample. In the treatment sample, the difference has an average increase of 9.74 of ERM implementation, and the number is 3.33 for the control sample. With regards to the credit ratings for Nordic banks, there exists 13 bank-years for treatment sample, while 198 bank-years for the control sample. This time the difference possesses an average increase of 10.45 in the treatment sample for the degree of ERM implementation, and the number is 2.70 for the control sample. The p-values are 0.00000661 and 0.00000411 for CDS Spread and credit rating samples accordingly. The numbers significantly show that this treatment is also highly relevant to the measure of ERM implementation for Nordic banks.

3.2.7 Lasso (Least Absolute Shrinkage and Selection Operator) Regression

Lasso regression is a method in machine learning and statistics for reducing a large number of potential predictors to improve the model's predictive accuracy. This method is a compressed estimate; it constructs a penalty function to obtain a more refined model, making it compress some coefficients. At the same time, Lasso will set some coefficients to zero. Therefore, it retains the advantage of subset shrinkage and is a method of processing biased estimates with complex collinear data.

The basic concept of Lasso is to minimize the sum of squared residuals under the constraint that the sum of the absolute values of the regression coefficients is less than a constant so that some regression coefficients that are strictly equal to 0 can be generated to obtain an interpretable model, which would help reduce the dimensions.

A lasso regression finds the parameter vector β, β_0 that minimizes the expression:

$$\min_{\beta,\beta_0}\left(\frac{1}{2N}\sum_{i=1}^{N}\left(y_i-\beta_0-x_i^T\beta\right)^2+\lambda\sum_{j=1}^{p}|\beta_j|\right)$$

The first equation $\sum_{i=1}^{N}(y_i-\beta_0-x_i^T\beta)^2$ is the linear regression part, which represents the deviation between the estimated equation and the measured value. The second equation $\lambda\sum_{j=1}^{p}|\beta_j|$ is a penalty function that aims to achieve the purpose of shrinkage. When λ becomes larger and larger, the estimated equation parameters will be closer to 0. Thus, the complexity of Lasso is controlled by λ; the larger the λ, the greater the penalty for the linear model with many variables. Ultimately, a model with fewer variables will be obtained.

K-fold cross validation will be conducted to pick up the λ. The general idea of cross validation is to divide the original sample into a training sample and an evaluation sample. The model is fitted to the training sample for many different values of λ and for each λ the "forecast" error is computed for the evaluation sample, the value of λ that minimizes the forecast error is then used in the final step of the estimation which is conducted on the entire sample. K-fold cross validation splits the sample randomly into K different subsets, taking one of the subsets as the

validation set, the model is estimated over the remaining K-1 sets for a range of values of the parameter λ. This whole procedure is then repeated K times so that each partition is used exactly once for evaluation, and then the average λ is picked from the K λ's that minimized the forecast error.

Jorge and Chan (2017) claim that Lasso regression seems quite useful for creating sparse models in high multidimensional data environments. As a result, the increased use of Lasso gains popularity in forecasting the models both in economic and financial fields.

By using the Lasso regression, we aim to find out the keywords that are most related to ERM implementation and cancel out some irrelevant word combinations, since Lasso can handle the high dimensional problem. In our case, in order to get a better understanding of the importance of word combinations we have chosen, Lasso will help pick up the most significant keywords that are highly related to ERM implementation out of the 83 dimensions. In the Lasso regression, the dependent variable will be ERM implementation (0-3) from the survey responses. Meanwhile, the explanatory variables will be the 83 keyword combinations from the banks' annual reports. As mentioned before, the K-fold cross-validation method is employed to pick up the λ (K=10). We will repeat this process 10 times to obtain the dimensions that are significantly correlated to the ERM implementation.

3.3 Data Collection Method

For the data collection part, Bloomberg, Datastream, and Thomas Reuters Eikon are employed to extract all data needed to run the regression. Besides, all the annual reports were downloaded from each bank's official website. Data for LASSO regression are from the survey sent out people holding CFO, CRO, or at least risk manager level of the banks as well as from the 83 ERM dimension keywords search.

Inspired by Lundqvist and Vilhelmsson (2016) and Liebenberg and Hoyt (2003), a list consisting of Chinese banks and Nordics banks is being created as a sample for banks with total assets over 1 billion US dollars. This bar is set because for among all listed banks in China market, banks with total assets over one billion accounts for 93% of the population; while for banks in the Nordic market, banks with total assets over one billion accounts for 84% of the population. Hence, this sample can explain well the general status of the population and can do fit us on the time horizon. The final sample consists of 48 Chinese banks, 18 Danish banks, 10 Swedish banks, 21 Norwegian banks, 3 Finnish banks, and 2 Icelandic banks.

As for dependent variables that represent default risk, CDS and credit ratings are kept, for they have been commonly used as indicators of default risk. CDS spread are extracted from the Bloomberg terminal. Some scholars choose to get CDS data from DataStream since the database begins to provide CDS data from 2007, yet Bloomberg has way long history of providing CDS data back to the late 1990s, so that's why we choose this resource. In addition, there are 50-70 different kinds of CDS contracts being used by banks (Lundqvist et al., 2016), and CDS with 5-year maturity is the most commonly used one among banks. The most accurate

data supplied by Bloomberg is the 5-year Bloomberg Issuer Default Risk Implied CDS Spread, so that is the CDS used in this paper.

For credit ratings, which is the scoring that more and more banks cared about after the subprime debacle in the US in 2008, there are three credit rating agencies provides the most high-quality market intelligence data. Among all the three companies, S&P is the first one put ESG into their dimension for credit ratings. After DataStream upgraded its database in 2016, historical credit ratings for banks can be no longer available in this database, and Bloomberg only has the spot credit ratings which is S&P LT Local Currency Issuer Credit Ratings for all companies, that is why Thomson Reuter Eikon is used to get the historical credit ratings one bank by bank.

Control variables are applied to test the relationship between ERM implementation and default risk. As mentioned in the previous section, 7 control variables are chosen as explanatory variables based on whether they can reflect the 8 ESM components listed by COSO (2014) by inspiration of Lundqvist and Vilhelsson (2016), Hoyt and Liebenberg (2011), Curry et al. (2008) and Bissoondoyal-Bheenick and Treepongkaruna (2011). Most of the seven control variables are available from Bloomberg terminal: total assets, ROA, Tier 1 capital ratio, Non-performing loans/ TA, Provision for loan losses/ TA, Instit Owner % Shares Out. ESG disclosure score database was upgraded in DataStream in 2015. Its definition in the DataStream system is "an overall company scored based on the self-reported information in the environment, social and corporate governance pillars (DataStream, 2016)", while in Bloomberg, all three pillars, that is the environment, social, and governance can be extracted individually apart from an overall ESG score. And when comparing the data from DataStream and Bloomberg, more than 80% of data are missing in 2016 for all banks, while only 60% of the data are missing in 2016. The same situation happens in Bloomberg as well. Therefore, this planned-to-use control variable is not included in this article. As for another control variable, words in thousands of each bank's annual reports every year are calculated by Python.

Among all three corporate governance-related variables (audit committee independence, ESG score, and single biggest owner) that have been used by Lundqvist et al. (2016) for estimating ERM, single biggest owner, which means percentage ownership of the single biggest owner by voting power, it can no longer be found either in DataStream, Bloomberg or Thomson Reuter Eikon. Notwithstanding, there is another indicator that can reflect the corporate governance-related voting power, Institutional Ownership of Outstanding Share, which demonstrates the percentage of share outstanding held by institutions. Institutions include 13Fs, the US, and international mutual funds, schedule Ds (US Insurance Companies), and Institutional stake holdings that appear on the aggregate level (Bloomberg, 2010). And this concept aligns with the fundamental idea of the single biggest owner, so we choose to use Institutional Ownership of Outstanding Share as our last control variable.

For the ERM implementation estimator, there are two methods selected for it. The first one is to use a word-based design to target the ERM related keywords. Liebenberg and Hoyt (2003) write in *the Risk Management and Insurance Review*, in most cases, banks are more commonly disclose their risk management on specific risks rather than the integrated risk management, which makes it difficult to know whether the banks have ERM implemented or not. On the contrast, Kirpatrick (2009) writes in *OECD Journal: Financial Market Trends*, that "disclosure

about the system for monitoring and managing risk is increasingly regarded as good practice," which displays that firms may display the ERM dimension rather than the integrated ERM implementation directly. Hence, as mentioned in the above section, the combination of the keywords will be used to search ERM dimensions so as to find the ERM implementation. All 83 keywords combination is inspired by Desender (2011), COSO ERM Framework (2014), and Lundqvist (2014). Python is the tool to go through all the annual reports and check if there is any of the 83 keywords combination appearing in the annual report from 2006 to 2016; if there is a combination detected, it will be noted down as a character hit and recorded as 1, otherwise will be recorded as 0. Of note, for each keyword combination, the distance between each keyword must be within 200 characters distance from the first word to make a valid combination.

For the second approach, we target which ERM dimension is the most relevant to the ERM implementation. And the ERM implementation is measured by the survey to management level with the title of CFO, CRO, or at least risk manager of the target banks. All the information is searched from banks' official websites. This survey can provide a straightforward view of ERM implementation straight from the target banks. For each question, it is marked from 0 to 3 for the ERM implementation keywords combination according to the answer "not at all," "somehow implemented," "implemented but improvement needed," "robustly implemented"; for questions with answer "don't know/ not sure," it will be marked "N/A". Therefore, the range of total score for the ERM implementation is from 0 to 240. Afterward, taking the score of the ERM implementation as dependent variables and applying the ERM dimension for each bank of all years for all 83 dimensions as independent variables, all the ingredients are put into LASSO regression to test which ERM dimensions have the closest impact on the ERM implementation. Subsequently, employing the valid ERM dimensions data together with control variables to run OLS panel regression on both CDS and credit ratings to probe the relationship between ERM and default risk.

Of note, that for confirming the efficiency of the first methods on measuring ERM implementation consideration, the variables are put into regression step by step when running the OLS panel data regression: firstly, selected ERM dimensions are put as independent variables to run a regression with default risk indicators, which noted as speculation I; secondly, selected ERM dimension together with total words in thousand in the annual report are put into regression to estimate the relationship between ERM and default risk, which noted as speculation II; thirdly, selected ERM dimensions and bank characteristic related control variables are put into regression as independent variables, noted as speculation III; fourthly, selected ERM together with the corporate governance-related control variables are put into regression as speculation IV; at last, for speculation V, all the ERM dimensions and control variables are put into regression. After further comparison, the effect of each independent variable on the default risk can be found clearly.

In this study, due to time limitation, only the banks with total assets over 1 billion US dollars will be included, due to the fact that these banks make up more than 80% of the banking sector in both selected markets. In addition to this, banks with total assets over 1 billion in these two markets are listed and have shown adequate disclosed information.

Furthermore, only 7 control variables (word count, total assets, ROA, tier 1 capital ratio, non-performing loans/ total assets, provision for loan loss/ total assets, percentage of institutional ownership over the total outstanding shares) are used to estimate the relationship between ERM and default risk as Curvy (2008), Bissoondoyal-Bheenick, and Treepongkaruna (2011) suggest these 7 control variables can reflect the eight elements of ERM (COSO, 2004).

3.4 Data Description

The data for all control variables and CDS spread has been downloaded from the Bloomberg terminal, and all annual reports from 102 banks have been downloaded from banks' official websites. In addition, the credit rating related data are extracted from the Thomson Reuters Eikon database. After organizing and doing analysis, some basic characters of data have been shown in the tables below.

3.4.1 Degree of ERM Implementation (°ERM)

Figure 3.1 shows the 11-year dimension changes in the average number of the ERM keywords "hits" from an annual report for each market from 2006 to 2016. The full score of the degree of ERM implementation for a company at one year can get is 83 because of the 83-dimension measurement mentioned in the previous section, while the bottom line of the score is 0. What stands out in this figure is that there has been a smooth rise for the degree of ERM implementation both for the banks in China market and the Nordic Country market: In 2006, the average score of the degree of ERM for the Chinese banks is 41.54 while this score has increased to 58.00 by the end of the year 2016; In 2006, the average score of the degree of EMR for the Nordic banks is 44.25 while this score increased to 47.00 in 2016. This continual incline trend is corresponding to the expectation that the level of bank disclosure is rising per investor's demand and monitoring requirement (Zimmerman and Sowerbutts, 2013).

In general, the average score of the degree of ERM for Chinese banks is higher than the banks in the Nordic Countries. One of the reasons is that from the total asset (TA) level, the average size of Chinese banks is larger than the Nordic banks. Therefore, the banking regulatory commission requires the Chinese banks to disclose more information both in their Chinese version of the annual report but the English version of the annual report as well. Another plausible explanation is the Chinese banks have expanded their business to more oversea markets, absorbed more foreign capitals (for instance, from the sample, 68.75% of the Chinese banks choose to publish annual reports in both English, and local language whilst 57.41% of the Nordic banks do so) and is supervised by more financial institutions.

Despite the general remarkable time-dimension increase in the degree of ERM implementation for both markets, there is significant cross-sectional variation. For banks in China, the 1st quartile is 37.00, and the 3rd quartile is 46.50 in 2006; after 11 years, the 1st quartile is 50.00, and the 3rd quartile is 58.00 in 2016. For banks in the Nordic countries, the 1st quartile is 25.50, and the 3rd quartile is 44.25 in 2006 while in 2016, the 1st quartile is 36.50 and the 3rd quartile is 47.00. The variation is getting smaller for both markets but still exists.

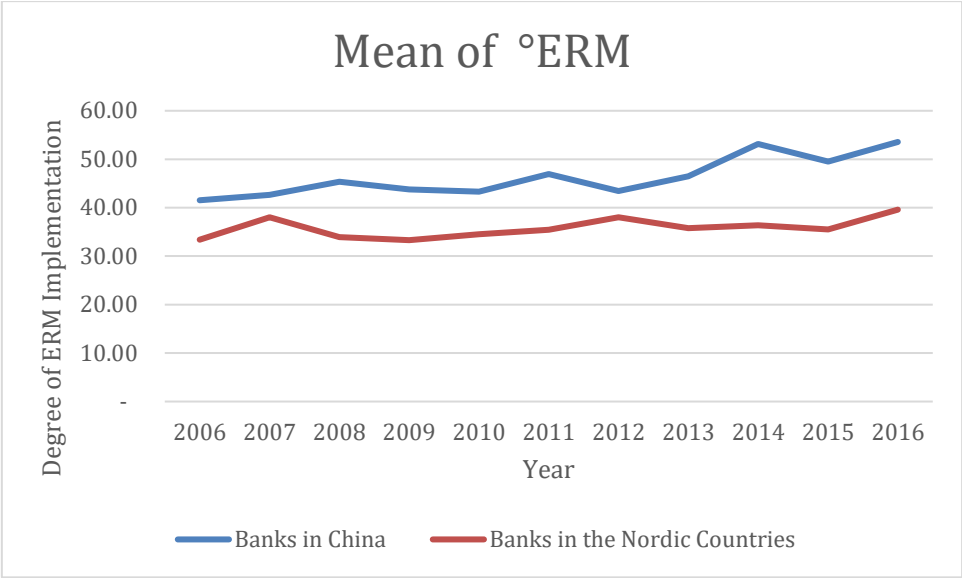

Figure 3.1 Degree of ERM Implementation in China and Nordic Countries

Regarding the keyword hits of the degree of ERM implementation, there is dimension unevenness among all the dimensions. 32 out of 83 dimensions have over 65% of the hits through all 462 bank-year samples. There are 8 dimensions at the highest percentile dimensions (90%) taking up 27.81% of the total hits, comparing to there are 8 dimensions at the lowest percentile (10%). The 12 dimensions with the highest percentile hits are: litigation, strategy/ strategies, liquidity, financial + risk, interest + rate, internal + audit, environment, board + responsibility, and train/ educate/ coach. These eight characters are showing clearly the corporate governance-related factors and tell the difference between high risk managing capability banks and low risk managing capability banks.

3.4.2 CDS and Credit Ratings

Next, more detailed descriptive statistics for the CDS and credit ratings as default risk estimators, together with the degree of ERM implementation score is displayed in Table 3.1, Table 3.2, and Table 3.3. Table 3.1 shows a more general trend for the descriptive statistics for banks in both markets. Subsequently, a more detailed market-wise statistical data description is presented in Table 3.2 and Table 3.3.

In Table 3.1, the average of CDS spread raises from 10.98 base points to 153.87 base points, which is around 15 times higher. CDS spread is a signal for systematic risk, and the CDS spread was escalated sharply high for the systematic risk increased remarkably in 2008. Afterward, the CDS spread began to climb gradually year by year because regulators had more sensitivity and concern on credit events(Giglio, 2016). Therefore, the trend reflects the reality and our intuition.

S&P credit rating system Long-term Issuer Credit Ratings assigned on globally recognized 'AAA' through 'D' - rating scale. In this rating system, ‘AAA’ denotes the highest credit rating meaning “an obligor has extremely strong capacity to meet its financial commitments” (S&P Global Rating official website), and ‘C’ and ‘D’ denote the lowest credit rating meaning "an

obligor “highly vulnerable, perhaps in bankruptcy or in arrears but still continuing to pay out on obligations” and “there to be a default”, respectively. For an entity with credit rating AAA to BBB, an entity is considered “investment grade”; from “BB” to “D”, S&P put them into “non-investment grade” or “speculative grade”.

For research consideration and enlightened by Lundqvist and Vilhelmsson (2016), the credit ratings are re-grouped to 4 category: banks with rating AAA or AA belong to the first category, banks with rating A belong the second category, banks with rating BBB belong to the third category and banks with the other speculative ratings belongs to the fourth category. Besides, all plus and minus ratings are summarized to the same category.

Statistically, credit rating sample is not big before 2008 owing to most of the banks have not yet been included in the S&P issuer credit rating system even though their total assets have excessed 1 million US dollars and reached an adequately high level compared to the other peer banks worldwide. Before 2010, nearly half of the banks are in the AAA or AA category, but there are also close to one-third of the banks fall into the non-investment grade category. This situation has a critical improvement from 2010 to 2016. In 2016, 63.50% of the banks were in the category AAA or AA, and 20% of the banks are in category A. Only 10% of the banks in the dataset fall into the non-investment category.

For the degree of ERM implementation (°ERM) in the CDS sample and credit rating sample, the time-wise ascensional tendency has been analyzed in section 3.4.1, thus no redundant discussion here.

Some special findings occur when collecting data. There are two special types of credit ratings found when extracting data: “NR” , which means not rated in this specific rating system or this year, and “WR”, which means withdrawal rating. Occasionally these two special types of ratings happened in the sample set. Another interesting finding is that S&P believes that rating ‘D’ indicating the entity to be bankrupt. However, in reality, the bank may recover and survive if there is new cashflow invested in. For example, China CITIC Bank has been rated as D from 2006 to 2010. After the government injected a considerable amount of capital, the bank survived and got a BB rating in 2011. Similar government bailout cases happened to Bank of Communication in 2009, Swedbank in 2009, and Spar Nord Bank in 2011.

Table 3.1 Descriptive Statistics for the Credit Default Swap Prices, Credit Ratings, and Degree of Enterprise Risk Management Implementation Scores at Mixed Markets

Mixed Markets	**All Years**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
					Credit Default Swap (CDS) Sample							
# observations:	635	43	50	51	52	55	57	57	60	62	65	83
CDS Spread												
Mean	130.85	10.98	42.38	204.90	104.25	127.36	241.88	170.82	127.37	95.50	119.42	153.87
St.Dev	94.09	7.48	25.44	136.15	50.17	73.85	64.21	68.93	63.88	49.46	73.29	95.46
1st quartile	65.00	7.00	26.00	116.00	69.25	84.00	193.00	119.50	77.25	55.75	61.50	66.00
Median	94.00	8.00	31.00	133.00	85.00	92.00	230.00	137.00	88.50	65.50	74.00	84.00
3rd quartile	198.00	9.00	60.00	333.00	152.00	176.00	280.50	237.50	205.00	154.00	208.00	254.00
Max	511.00	33.00	109.00	475.00	242.00	511.00	430.00	391.00	277.00	191.00	234.00	285.00
Min	5.00	5.00	12.00	53.00	46.00	63.00	85.00	52.00	44.00	34.00	38.00	52.00
Degree of enterprise risk management implementation (°ERM)												
Mean	34.41	23.86	26.58	27.79	26.23	30.45	35.68	36.70	37.51	40.47	41.26	40.85
St.Dev	21.48	21.61	22.76	22.78	21.36	23.50	21.40	20.10	19.37	20.22	17.98	19.55
1st quartile	9.00	0.00	0.00	0.00	0.00	0.00	17.25	31.25	33.00	33.50	35.75	37.00
Median	42.00	29.50	35.00	37.00	33.00	37.00	44.50	42.50	44.00	47.00	48.00	47.00
3rd quartile	52.00	45.50	47.50	49.25	49.00	52.25	53.75	53.50	53.00	54.00	54.00	55.00
Max	86.00	52.00	58.00	55.00	54.00	58.00	61.00	61.00	59.00	86.00	58.00	61.00
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
					Credit Rating Sample							
# observations:	447	5	20	28	36	41	43	50	50	53	58	63
Credit ratings												
# AAA or AA	271	0	9	18	18	20	23	34	36	31	42	40
# A	69	4	5	3	6	7	6	6	3	5	11	13
# BBB	46	0	1	0	0	1	8	7	10	11	4	4
# <BBB	61	1	5	7	12	13	6	3	1	6	1	6
Degree of enterprise risk management implementation (°ERM)												
Mean	25.92	36.80	30.37	31.85	22.88	25.92	31.39	29.75	36.18	36.84	35.62	39.78
St.Dev	24.63	18.46	22.68	22.34	22.27	24.63	23.34	22.64	20.05	22.86	24.90	21.42
1st quartile	0.00	19.00	0.00	0.00	0.00	0.00	0.00	0.00	29.50	15.00	0.00	36.50

Median	31.00	46.00	38.00	41.50	21.00	31.00	39.50	38.00	43.50	46.00	47.00	48.00
3rd quartile	51.75	50.00	51.00	51.00	47.00	51.75	51.25	49.25	51.75	53.00	53.50	55.50
Max	58.00	52.00	58.00	55.00	58.00	58.00	61.00	59.00	59.00	86.00	86.00	61.00
Min	0.00	7.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: Year-end CDS spread is derived from Bloomberg Terminal, and the year-end credit ratings are derived from Thomson Reuter Eikon. Details of 5-year CDS spread selection, and S&P long-term issuer credit rating is disclosed in the main text. All credit ratings have been regrouped to 4 categories. The plus and minus ratings are regarded as the same category as the major ratings. The degree of the ERM implementation is obtained by keyword searching from annual reports for 83 dimensions that represent ERM via python. See more details in the main text.

Table 3.2 and Table 3.3 demonstrates the descriptive statistics for the CDS, credit ratings as the measurement of default risk by two different markets. There are more Nordic banks included in the CDS sample pool than the Chinese banks even though the total number of Chinese banks (48) included sample pool is similar to the total number of the Nordic banks (54). The plausible explanation is the banks in China have a comparably short history and the financial instruments' development is relatively slower (Wu, 2009). For instance, 87.50% of the Chinese banks in the sample pool are established after 1978, the year that China published the Opening and Reform Policy which allows non-stated owned business open and foreign investment to set up in mainland China. Another example is that 75% of the banks are established after 1993, the year that China published financial regulation reform policy to allow commercial bank and non-state-owned financial institutes setup. The Nordic banks have a relatively long history: 38% of the Nordic banks in the sample are established before 1900, 55.56% of the banks in the sample are established before 1973, and only 20.37% of the banks are established after 2000. Another reason is the government intervention, that is, the banking regulatory commission in China uses strict rules to bar out most of the commercial banks to issue financial instruments like CDS to avoid inexperienced Chinese commercial banks being default due to issuing advanced financial instruments. Meanwhile, the Nordic market is relatively open and active and does not have such regulations to hold back Nordic banks to issue advanced financial instruments like CDS.

Through all the period, the CDS spread for the banks in China is more than twice higher than the CDS spread for the banks in the Nordic Countries. The reason behind this phenomenon is that the banks in China are relatively young and the history of handling advanced financial instruments is relatively short, so the investors reckon the systematic risk and default risk for Chinese banks is relatively high, and the capability of hedging risks for Chinese banks is relatively weaker than the long-history experienced Nordic banks in general (Zhou and Liang, 2006).

The CDS of Chinese banks is higher than Nordic countries ones (Figure 3.2) . The peak of the average CDS Spread in China in 2008 is the outcome that the local government decided to cut down the financing of local government borrowers. That decision stirred the worry during 2008 the global financial crisis. The highest point of the average CDS Spread in Nordic banks in 2011 is a consequence of the European Sovereign debt crisis.

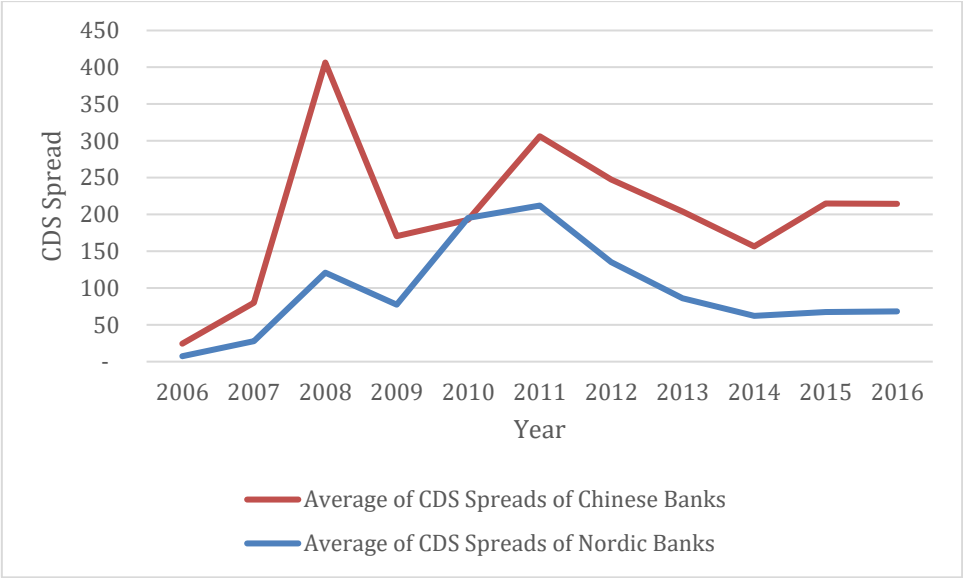

Figure 3.2 Trend of CDS Spread in Two Markets

As for credit ratings, there are fewer Nordic banks included in the S&P Long Term Issuer credit rating system than the Chinese banks from 2009 for a total 447 bank-year sample pool. In 2016, there are 20 Nordic banks involved in the credit rating system, which is half of the number of Chinese banks. Another finding is that all the Nordic banks in the sample were at the A category in 2006 while half of the Chinese banks were in AAA or AA category and the other half are in below BBB category. The situation significantly changed after eleven years, when 84% of Chinese banks were counted as AAA or AA category. Conversely while merely 20% of the Nordic banks are rated to this category. Nevertheless, when taking together AAA or AA category and A category, the banks in two markets basically show the same result in 2016: 84% of the Chinese banks and 85% of the Nordic banks are in this combined category, which means the banks in both countries present strong credit capacity.

At the downside, the Nordic banks are doing a more efficient job on improving the banks from the speculative-grade (below BBB) category than the Chinese banks. At the beginning in 2006, there were 50% of the Chinese banks infiltrated into the non-investment grade while no Nordic banks were so. In 2016, 12% of the Chinese banks are categorized as below BBB level while only 5% of the Nordic banks were in that category. Moreover, there were 3 Chinese banks in our sample have slipped into D or D+ rating for once or more than once, but just 2 Nordic banks have met the same situation. The same reason for all these 5 banks having encountered such extreme position but survived and now have ratings outside non-investment grade is that the state government reached out and bailed them out.

Table 3.2 Descriptive Statistics for the Credit Default Swap Prices, Credit Ratings, and Degree of Enterprise Risk Management Implementation Scores in China

Chinas	**All Years**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
						Credit Default Swap (CDS) Sample						
#observations:	210	9	14	15	15	17	18	18	21	22	23	38
CDS Spread												
Mean	217.16	24.44	80.00	406.47	170.40	192.71	306.39	247.44	204.05	156.41	214.70	255.32
St.Dev	88.03	5.50	16.10	52.94	32.47	27.56	35.25	28.53	20.64	12.77	10.67	24.53
1st quartile	166.75	21.50	68.25	383.00	160.00	172.00	277.00	229.00	191.50	152.00	205.00	246.50
Median	218.00	24.00	76.50	413.00	168.00	193.00	313.50	246.00	209.00	157.50	216.00	258.00
3rd quartile	262.50	28.50	96.00	452.00	191.00	217.50	332.25	274.25	218.50	166.00	223.00	271.25
Max	475.00	33.00	109.00	475.00	242.00	233.00	363.00	290.00	227.00	175.00	234.00	285.00
Min	14.00	14.00	57.00	296.00	112.00	144.00	243.00	191.00	140.00	115.00	190.00	146.00
Degree of enterprise risk management implementation (°ERM)												
Mean	41.39	34.75	32.92	37.92	29.62	42.20	44.13	40.75	42.79	47.00	47.90	42.48
St.Dev	21.75	21.80	24.87	22.09	24.28	22.09	21.37	23.23	20.08	21.79	16.39	22.55
1st quartile	42.00	9.75	0.00	20.00	0.00	43.00	48.00	19.50	46.00	48.00	49.00	43.50
Median	51.00	45.00	43.00	47.00	42.00	52.00	53.50	52.00	50.00	53.50	52.00	52.00
3rd quartile	55.00	49.25	53.00	54.00	50.00	54.00	55.00	56.00	55.00	56.00	56.50	56.50
Max	86.00	52.00	58.00	55.00	52.00	58.00	61.00	61.00	59.00	86.00	58.00	61.00
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
						Credit Rating Sample						
#observations:	285	2	6	14	21	26	29	33	33	37	41	43
Credit ratings												
# AAA or AA	242	0	2	12	18	20	23	32	32	29	38	36
# A	13	1	1	0	2	2	3	1	0	2	1	0
# BBB	9	0	1	0	0	1	2	0	1	1	1	2
# <BBB	21	1	2	2	1	3	1	0	0	5	1	5
Degree of enterprise risk management implementation (°ERM)												
Mean	32.44	49.00	44.83	42.46	21.79	28.59	28.48	24.29	34.64	33.83	37.57	36.29
St.Dev	25.34	4.24	22.12	19.38	24.45	26.86	26.75	26.10	23.44	27.22	23.42	25.83
1st quartile	0.00	N/A	37.50	42.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Median	48.00	49.00	53.00	50.00	2.00	46.50	48.00	5.50	47.50	47.50	49.50	50.00
3rd quartile	54.00	N/A	55.75	54.00	49.00	53.00	54.00	53.00	53.00	55.00	54.50	56.00
Max	86.00	52.00	58.00	55.00	58.00	58.00	61.00	59.00	59.00	86.00	58.00	61.00
Min	0.00	46.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: Year-end CDS spread is derived from Bloomberg Terminal, and the year-end credit ratings are derived from Thomson Reuter Eikon. Details of 5-year CDS spread selection, and S&P long-term issuer credit rating is disclosed in the main text. All credit ratings have been regrouped to 4 categories. The plus and minus ratings are regarded as the same category as the major ratings. The degree of the ERM implementation is obtained by keyword searching from annual reports for 83 dimensions that represent ERM via python. See more details in the main text.

Table 3.3 below displays the CDS, credit ratings, and the degree of the ERM implementation (°ERM) score for banks in the Nordic market.

Table 3.3 Descriptive Statistics for the Credit Default Swap Prices, Credit Ratings, and Degree of Enterprise Risk Management Implementation Scores in Nordic Countries

Nordic Countries	**All Years**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Credit Default Swap (CDS) Sample												
#observations:	425	34	36	36	37	38	39	39	39	40	42	45
CDS Spread												
Mean	88.20	7.41	27.75	120.92	77.43	98.13	212.10	135.46	86.08	62.00	67.24	68.20
St.Dev	62.48	1.18	4.88	26.34	24.37	69.23	51.36	50.74	33.34	22.26	21.02	9.09
1st quartile	56.50	6.75	25.00	109.75	65.50	82.00	188.00	116.00	73.00	53.25	57.00	61.00
Median	75.00	8.00	27.50	124.50	73.00	86.00	214.00	125.00	81.00	60.00	65.00	66.00
3rd quartile	108.50	8.00	32.00	136.00	88.00	92.25	233.00	138.00	88.00	65.00	71.75	74.50
Max	511.00	9.00	35.00	183.00	187.00	511.00	430.00	391.00	277.00	191.00	184.00	91.00
Min	5.00	5.00	12.00	53.00	46.00	63.00	85.00	52.00	44.00	34.00	38.00	52.00
Degree of enterprise risk management implementation (°ERM)												
Mean	29.44	19.50	22.95	21.52	24.23	22.78	30.04	34.00	33.33	35.24	35.68	39.04
St.Dev	19.88	20.45	21.23	21.35	19.76	21.51	19.91	17.71	18.12	17.60	17.64	15.81
1st quartile	2.00	0.00	0.00	0.00	0.00	0.00	5.25	31.25	31.50	30.50	29.00	35.00
Median	36.00	15.50	34.00	24.00	28.50	29.00	34.50	38.00	38.00	41.00	41.00	42.50
3rd quartile	45.00	39.25	40.00	41.00	39.00	41.00	46.75	46.50	44.75	47.00	46.50	47.25
Max	61.00	51.00	51.00	54.00	54.00	55.00	58.00	56.00	55.00	58.00	58.00	61.00
Min	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Credit Rating Sample												

#observations:	162	3	14	14	15	15	14	17	17	16	17	20
Credit ratings												
# AAA or AA	29	0	7	6	0	0	0	2	4	2	4	4
# A	56	3	4	3	4	5	3	5	3	3	10	13
# BBB	37	0	0	0	0	0	6	7	9	10	3	2
# <BBB	40	0	3	5	11	10	5	3	1	1	0	1
Degree of enterprise risk management implementation (°ERM)												
Mean	34.46	28.67	23.69	21.23	24.36	21.71	37.00	39.31	38.88	42.87	43.67	45.78
St.Dev	17.01	20.60	20.37	20.49	19.72	20.91	14.01	9.51	12.32	7.02	7.69	7.62
1st quartile	30.00	7.00	0.00	0.00	0.00	0.00	32.00	34.25	33.00	38.00	37.00	41.50
Median	38.50	31.00	34.00	24.00	27.00	27.50	36.00	39.50	40.00	44.00	44.00	44.50
3rd quartile	46.00	48.00	40.00	41.00	40.50	36.25	48.50	46.50	45.00	47.00	52.00	50.00
Max	61.00	48.00	51.00	54.00	54.00	54.00	51.00	52.00	55.00	54.00	56.00	61.00
Min	0.00	7.00	0.00	0.00	0.00	0.00	0.00	14.00	3.00	30.00	30.00	32.00

Note: Year-end CDS spread is derived from Bloomberg Terminal, and the year-end credit ratings are derived from Thomson Reuter Eikon. Details of 5-year CDS spread selection, and S&P long-term issuer credit rating is disclosed in the main text. All credit ratings have been regrouped to 4 categories. The plus and minus ratings are regarded as the same category as the major ratings. The degree of the ERM implementation is obtained by keyword searching from annual reports for 83 dimensions that represent ERM via python. See more details in the main text.

3.4.3 Control Variables

As mentioned in the previous section, there are 7 bank- and corporate governance-wise risk managing related control variables analyzed here, and all of them obtained from Bloomberg (except from "total word count"). The first 6 control variables represent the capability of risk management, and the last control variable represents the ability of a bank's corporate governance. All bank cross-sectional-wise control variables can reflect one or more out of the eight ERM model components. More details are as tables below.

Table 3.4 Descriptive Statistics of the Control Variables

Variables	Mean	Std.	1st quartile	Median	3rd quartile	Max	Min
# words (in thoudsands)	70.966	30.367	38.967	69.022	80.150	167.026	4.854
Total assets (TA) (in billion)	242.556	539.601	2.517	19.424	250.781	3478.100	0.145
Return on assets (ROA) (%)	0.825	0.681	0.523	0.889	1.154	4.004	-4.665
Tier 1 ratio (%)	13.108	7.185	9.448	11.950	15.648	151.000	3.680

Nonperforming loans/TA (%)	0.007	0.009	0.003	0.005	0.008	0.085	0.000
Provision for loan losses/TA (%)	0.002	0.003	0.000	0.001	0.002	0.026	-0.019
Instit Owner % Shares Out	36.784	28.035	11.231	33.716	57.343	97.804	0.000

Note: Total word count is obtained from the annual report on the banks' official website. All the other bank-wise cross-sectional control variables are obtained from Bloomberg Terminal. The year range is from 2006 to 2016. Definitions of the control variables are enclosed as Appendix A.

Now, let's see what is the trend by countries.

Table 3.5 Descriptive Statistics of the Control Variables in China

Variables	**Mean**	**Std.**	**1st quartile**	**Median**	**3rd quartile**	**Max**	**Min**
# words (in thoudsands)	85.116	28.703	68.833	84.618	109.256	135.280	6.930
Total assets (TA) (in billion)	534.841	776.671	59.513	189.598	669.055	3478.100	4.691
Return on assets (ROA) (%)	1.058	69.240	0.936	1.085	1.199	2.404	-0.174
Tier 1 ratio (%)	9.969	2.584	8.665	9.585	10.968	27.380	3.680
Nonperforming loans/TA (%)	0.006	0.005	0.003	0.005	0.007	0.056	0.000
Provision for loan losses/TA (%)	0.002	0.002	0.001	0.001	0.002	0.012	-0.002
Instit Owner % Shares Out	54.358	25.552	38.592	51.867	67.602	97.804	0.000

Note: Total word count is obtained from the annual report on the banks' official website. All the other bank-wise cross-sectional control variables are obtained from Bloomberg Terminal. The year range is from 2006 to 2016. Definitions of the control variables are enclosed as Appendix A.

Table 3.6 Descriptive Statistics of the Control Variables in Nordic Countries

Variables	**Mean**	**Std.**	**1st quartile**	**Median**	**3rd quartile**	**Max**	**Min**
# words (in thoudsands)	59.465	31.290	38.121	52.453	78.498	167.026	4.854
Total assets (TA) (in billion)	70.061	169.721	0.867	3.865	18.991	928.200	0.145
Return on assets (ROA) (%)	0.698	0.794	0.383	0.640	0.961	4.004	-4.665

Tier 1 ratio (%)	15.029	8.335	12.100	14.425	17.500	151.000	6.420
Nonperforming loans/TA (%)	0.010	0.013	0.003	0.006	0.010	0.085	0.000
Provision for loan losses/TA (%)	0.002	0.004	0.000	0.001	0.002	0.026	-0.019
Instit Owner % Shares Out	26.983	24.365	4.739	22.667	40.978	87.768	0.000

Note: Total word count is obtained from the annual report on the banks' official website. All the other bank-wise cross-sectional control variables are obtained from Bloomberg Terminal. The year range is from 2006 to 2016. Definitions of the control variables are enclosed as Appendix A.

The analyzed/collected data displayed different geographical features between Chinese and Nordic countries banking systems (Table 3.5-3.6). Chinese banks have more total assets than Nordic banks, and averagely, the total assets of banks in China are 7.5 times more than the total assets in Nordic banks. For example, the total assets of the biggest bank in China (Industrial and Commercial Bank of China, 2016) is 3.75 times more than the biggest bank in Nordic countries (Nordea Bank, 2011). Another example is that the total assets of the smallest bank in China (Zheshang Bank, 2006) are 32.37 times more than the largest bank in Nordic countries (BRAbank, 2006), which reveals that banks in China are generally larger than the ones in Nordic countries. Regarding ROA, the banks in China also reveal the same trend as total assets: the ROA in Chinese banks is higher than the ROA in Nordic banks on average.

As for tier 1 capital ratio, the measurement of the core measure of a bank's financial strength from a regulator's point of view, Nordic banks show a better performance than Chinese banks. Nevertheless, banks in China outperform banks in Nordic countries when it comes to another corporate governance variable: the percentage of institutional ownership over total outstanding shares. Afterward, the correlation between the dependent variable, CDS spread, and 8 independent variables are displayed in the correlation matrix below.

Table 3.7 Correlation Matrix Between Variables

Variables	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. Log CDS price	1.00	-0.53	-0.33	-0.26	-0.09	-0.11	0.08	0.15	0.26
2. °ERM		1.00	0.28	0.37	0.11	0.00	-0.11	-0.00	0.49
3. #wordcount			1.00	0.60	-0.02	-0.15	0.07	-0.16	0.27
4. Total assets (TA)				1.00	-0.14	0.13	-0.01	-0.09	0.24
5. Return on assets (ROA)					1.00	-0.04	-0.47	-0.44	0.28
6. Tier 1 ratio						1.00	0.07	0.01	0.26
7. Nonperforming loans/TA							1.00	0.42	0.17

8. Provision for loan losses/ TA	1.00	0.27
9. Instit Owner % Shares Out		1.00

The negative correlation between the degree of ERM implementation and the log of CDS spread (Table 3.7) corresponds to our intuition that if a bank employs a high level of ERM, it will have a lower default risk. The same negative correlation applies to the total word count of financial annual report, indicating the more information a bank discloses, the lower the default risk the investors believe it contains. Table 3.7 also shows that ERM has a significant positive correlation with the total words count, which demonstrates the total words count in an annual report can somehow be a signal for a high degree of the ERM implementation. The relationship between two bad loan measures with CDS spread is in line with the reality as well; that is if a bank accrues more provisions for loan losses or has more non-performing loans, the less financial health the bank is so, the higher CDS spread the bank carries. The correlation matrix captures the positive relationship between the ROA and Institute Owner % Shares Out as well, illustrating potentially if a bank has more institutional owners, the more likely it has a relatively stable financial situation yielding more return on assets for equity holders.

Before proceeding to the regression, it is important to point out that among three variables that have a relatively larger correlation level with the log CDS, °ERM has a more significant impact on the default risks. This will be discussed in the next chapter. And the two highest correlation score is between the °ERM and logCDS and between the total assets and the total word count, which also hints two possible trends, that is, the higher the degree of ERM implementation is, the lower the CDS; and the larger the bank size is, the more likely its annual report has more words. More details will be disclosed in the next section.

3.4.4 Survey Collection Results

To get first-hand data from the degree of ERM implementation for the banks and provide data for Lasso regression, a survey is designed to get the direct response from CEO, CRO, CFO, or at least risk manager level staff for banks in our sample.

Personal information repository, contact information enclosed in the annual reports, LinkedIn and hotline service mailboxes are the resources we used to reach the locked interview targets. Among all 102 banks, the contact information of 30 Chinese banks and 49 Nordic banks have been gathered. A polite and clear stated email is sent out for at least one contactor of each bank. In the survey, the CEO, CRO, CFO, or risk managers are required to evaluate the ERM implementation status and answer to what degree does the firm implement ERM. Inspired by Lundqvist and Vilhelmsson, the magnitude of the degree of ERM implementation is separated on a scale from 0 (“not at all”) to 3 (“robustly implemented”).

There are 26 surveys collected: 11 are from banks in China and 15 from the banks in the Nordic countries. The survey collect ratio is 32.91%. The CEO from a Norwegian bank, Sbanken, and the CRO from a Danish bank, Jyske Bank, replied to us the most promptly.

Table 3.8 Survey Feedback

Market / Score	Not at all	Ad hoc implementation	Implemented but improvements needed	Robustly implemented	Total
China	0	0	2	9	11
Nordic	0	0	4	11	15
Total	0	0	6	20	26

There are no banks think that they haven't implemented the ERM at all (see Table 3.8) after COSO published the first official version of the enterprise risk management framework in 2004 and the second revised framework in 2017. No banks replied that they have ad hoc implemented the ERM. 8 banks believe that they have implemented the ERM, but at a certain point, improvement is still needed, while 19 banks have strong confidence that they have robustly implemented the ERM. The average score for the ERM implementation for the sample is 2.76.

A possible explanation for these results may be the strict monitoring pressure and bank size. As the total asset 1 billion is the benchmark for selecting banks for this research, the banks for both markets in the sample are comparatively large; therefore, the public and the banking regulatory commission force them to apply ERM for risk control consideration. Another explanation is that it has been around 14 years after the ERM framework being published. Learning from the lessons in the 2008 financial crisis, 2011 European sovereign debt crisis, and 2015 China stock market crash, the banks in China and Nordic Countries have built up the consciousness of enhancing the ERM implementation to slide away from potential default risks.

Having discussed the descriptive statistics of the data collected, more analysis procedures and discussions regarding the regression results will be addressed in the next chapter.

4 Analysis and Discussion

Previous studies based on American banks reveal that there is a significant negative relationship between the degree of ERM implementation and CDS spread, but not clear enough regression results are detected when the credit ratings are taken as dependent variables. In chapter three, a potentially significant negative impact of the degree of ERM on the default risk estimators have been found from the descriptive statistics and the correlation matrix. In this chapter, panel regression, ordered probit model are utilized to find steady shreds of evidence for proving our assumptions about the relationship between the degree of ERM implementation and the default risk. Furthermore, a new machine learning method, Lasso, has been applied to probe which ones among all 83 dimensions have even stronger with default risk estimators.

4.1 OLS – Panel Regression Results

In this section, panel regression with regional fixed effects will be applied to test the relationship between CDS and the degree of ERM implementation and bank-wise control variables.

The basic model for panel data is a two-dimension dataset that we get from both the time dimension and cross-sectional dimension. In this article, the model between CDS and the degree of the ERM implementation is like:

$$CDS_{i,t} = \alpha + \beta x_{i,t} + \varepsilon_{i,t}$$

where i =1,…102, representing the 48 banks from China market and 54 banks from the Nordic market (102 banks in total), and t =1,…11, representing the 11 years time-dimension. In the regression, fixed effect means the dataset is based on a cross-sectional dimension then expand time dimensions.

When credit ratings are treated as dependent variables, ordinal probit modeling is imposed on for regression since the dependent variable, credit ratings, aren't linear. In this section, for coding consideration, the 4 categories of credit ratings are assigned to number 0 to 3, where 3 for AAA or AA category, 2 for A category, 1 for BBB category, and 0 for the last category. From three to zero, the categories have priority; therefore, the ordinal probit model is a choice that suits our cases. Marginal effects will also be calculated for the primary independent variable, the degree of ERM implementation.

Most of the regressions are done in MatLab, but the ordinal probit modeling regression and the calculation of marginal effect are done in Stata as Stata has a built-in command for this purpose, and the command works accurately. The whole regression process is divided into 5

specifications. At specification I, solely the degree of ERM implementation as the independent variable is put into regression to analyze the relationship between the °ERM and the default risk estimator. At specification II, both °ERM and the total word count are treated as the independent variables to put into the regression for testing which one is more significant correlated with the default risk estimator owing to previously it finds that these two variables both have high level negative correlation with the LogCDs. Next, °ERM and all the risk managing related control variables are placed into the regression as specification III to test which variables have significant influence on the default risk estimator and if °ERM can still standing out from all these explanatory variables. For the last step, at specification V, the degree of ERM implementation along with the 7 bank-wise control variables are brought into the regression to testify the assumption if °ERM is prominent to associate a bank to alleviate default risk compared to the other control variables. Market comparison is going to be analyzed and discussed, as well.

4.1.1 CDS spread and the Degree of ERM Implementation

The results obtained from the preliminary analysis of °ERM for banks in the China market and Nordic market are summarized in Table 4.1 and Table 4.2.

In Table 4.1, the degree of ERM implementation is significant at all specifications both for the banks in the China market when CDS is the dependent variable. Even though both the degree of ERM implementation and the total word of an annual report have significant results, the degree of ERM is more significant at a higher level. Additionally, the coefficients of the degree of ERM implementation on the CDS spread have a practical meaning, that is, when there is one unit increase of the ERM implementation, there is 4% decrease of the CDS spread for the Chinese banks at specification I. Considering the average of the CDS spread of all years for all the Chinese banks is 217.16 base point, 4% decrease of CDS spread means 8.69 base point. This reality meaning is in line with our intuition.

In specification III, the degree of ERM implementation and non-performing loan/TA are significant at 1% level, total asset and ROA are significant at 5% level, and Provision for loan losses/ TA is significant at 10% level. The results illustrate when there is one unit increase of the degree of ERM, there will be 3.9% decrease of the CDS spread; when there is one unit increase of the non-performing loan/ TA, there is 0.6% increase of CDS; when there is one unit increase of ROA, there is 17.4% decrease of the CDS spread; when there is one unit increase of Provision for loan losses/ TA, there is 1.1% increase of the CDS spread.

In specification IV, inputting °ERM and the institutional ownership proportion on the total outstanding shares, but variables have significant output in the table. However, the positive coefficient of the Institute Owner % Shares Out is out of the expectation. In specification V, controlling both the bank-wise variables and the corporate governance variables, the variables attached to our primary interest, °ERM holds the significant result in like manner.

Notwithstanding, not over 50% high-level coefficients of the determination show that these results may not explain the fact at a comparatively wide range.

Table 4.1 CDS Sample – OLS Panel Regression Results for banks in China

Explanatory variables	Specification I	Specification II	Specification III	Specification IV	Specification V
°ERM	-0.040 ***	-0.048***	-0.039 ***	-0.035***	-0.029 ***
	(0.804)	(0.828)	(0.778)	(0.796)	(0.796)
#Wordcount (in thousand)		-0.029**			-0.170 **
		(0.648)			(0.759)
Total assets (TA) (in billion)			-0.030 **		-0.020 **
			(0.027)		(0.028)
Return on Asset (ROA)			-0.174**		-0.187**
			(64.140)		(68.669)
Tier 1 Ratio			-0.129		-0.149
			(7.866)		(7.919)
Nonperforming loans/TA			0.006***		0.005***
			(4,852.275)		(4,838.976)
Provision for loan losses/TA			0.011*		0.056*
			(8,563.52)		(9,146.71)
Institut Owner % Shares Out				0.104*	-0.127
				(0.652)	(0.720)
Regional Fixed Effect	Yes	Yes	Yes	Yes	Yes
R^2	18.70%	26.10%	36.81%	18.59%	37.95%
# observations	95	95	95	95	95

*Note: 2006 – 2016 year-end data are derived from Bloomberg Terminal for all the control variables apart from the total word count. Total word count and the degree of ERM implementation are extracted from the annual report by the text-based method. A cross-sectional fixed effect is used for all the specifications. All the standard deviations for the corresponding variables are placed in parenthesis below coefficient. *denotes the significance at the 10% level, **denotes the significance at 5% level, and *** denotes the significance at 1% level. Definitions of the variables are listed in Appendix A. More detailed information can be seen in the main text.*

Table 4.2 CDS Sample – OLS Panel Regression Results for banks in Nordic Countries

Explanatory variables	**Specification I**	**Specification II**	**Specification III**	**Specification IV**	**Specification V**
°ERM	-0.007***	-0.011**	-0.008***	-0.010***	-0.004***
	(0.658)	(0.725)	(0.632)	(0.572)	(0.672)
#Wordcount (in thousand)		-0.001*			-0.001*
		(0.516)			(0.536)
Total assets (TA) (in billion)			-0.042		0.033*
			(0.190)		(0.177)
Return on Asset (ROA)			-0.065***		-0.049**
			(20.860)		(19.648)
Tier 1 Ratio			-0.005**		-0.001
			(1.845)		(1.990)
Nonperforming loans/TA			0.047		0.019
			(1,213.455)		(1,131.976)
Provision for loan losses/TA			0.022*		0.010
			(11,355.826)		(11,170.121)
Institut Owner % Shares Out				0.018***	0.016
				(0.361)	(0.452)
Regional Fixed Effect	Yes	Yes	Yes	Yes	Yes
R^2	20.00%	20.46%	34.75%	31.83%	47.23%
# observations	78	78	78	78	78

*Note: 2006 – 2016 year-end data are derived from Bloomberg Terminal for all the control variables apart from the total word count. Total word count and the degree of ERM implementation are extracted from the annual report by the text-based method. A cross-sectional fixed effect is used for all the specifications. All the standard deviations for the corresponding variables are placed in parenthesis below coefficient. *denotes the significance at the 10% level, **denotes the significance at 5% level, and *** denotes the significance at 1% level. Definitions of the variables are listed in Appendix A. More detailed information can be seen in the main text.*

The results obtained from the preliminary analysis of all variables for the Nordic banks are set out in Table 4.2. the degree of ERM implementation is significant at all specifications both for the banks in the Nordic market, indicating the strong relationship between the ERM implementation and the default risk. Likewise, the degree of ERM implementation and the total word of an annual report has significant results in specification II, but the degree of ERM is more significant at a higher level. What's more, when there is one unit increase of the ERM implementation, there is 0.7% decrease of the CDS spread for the Nordic banks at specification I. Considering the average of the CDS spread of all years for all the Nordic banks is 88.20 base point, 0.7% decrease of CDS spread means 0.62 base point.

In specification III, the degree of ERM implementation and ROA are significant at 1% level, Tier 1 Ratio is significant at 5% level, and Provision for loan losses/TA is significant at 10% level. The results demonstrate that when there is one unit increase of the degree of ERM, there will be 0.8% decrease of the CDS spread; when there is one unit increase of ROA, there is 6.5% decrease of CDS; when there is one unit increase of Tier 1 Ratio, there is 5% decrease of the CDS spread; when there is one unit increase of Provision for loan losses/ TA, there is 2.2% increase of the CDS spread.

In specification IV, both the degree of ERM implementation and the institutional ownership proportion on the total outstanding shares are significant at 1% level. The coefficient of the Institut Owner % Shares Out indicates when there is one unit increase of these variables, there is a 1.8% increase of CDS spread. In specification V, the primary explanatory variables, °ERM, is still significant at 1% level. Meanwhile, the previous significant variable, the institutional ownership proportion on the total outstanding shares, in specification III, is not significant anymore; besides, the positive coefficient still exists.

Comparing the regression results between the Chinese and Nordic markets, the importance of the degree of ERM implementation on the CDS spread has been revealed by the significant outcomes. This negative influence is higher for banks in the China market than the banks in the Nordic market, even though the average of CDS spread of the Chinese banks is more than twice higher than that of the Nordic banks. The total word count shows a significant effect on the CDS spread as well, which implies that investors think highly of the degree of annual report disclosure for both markets, particularly the Chinese market. ROA is significant for banks in China and the Nordic Countries, indicating the investors' concern about the ROA as a critical indicator for CDS spread as well as the degree of ERM implementation. Furthermore, controlling all the bank-wise variables and corporate governance variables, the significance level of ROA is not as critical as the degree of ERM implementation, which implies that the degree of ERM implementation is still the first prior important factor to CDS. The non-performing loan losses/TA is significant for the banks in China market yet relatively less significant in the Nordic market. One reason could be that the banks in the Nordic market are experienced and skills in issuing complex financial instruments to hedge the potential risks in the financial market, hence the investors no longer keep an eye on this specific factor at a comparatively high level.

Similar to the coefficients of the determination of the panel regression results for the banks in China market, some of the coefficients of the determination for the Nordic banks' panel

regression are not very high. Nevertheless, the regression results of specification III and specification IV for Chinese banks and of specification V of the Nordic banks are over the acceptance level and have critical research meaning since the r-squared value is over 35% principle for social science.

Taken together, these results suggest that there is a sound association between the degree of ERM implementation and the CDS spread.

4.1.2 Credit Ratings and the Degree of ERM Implementation

Turning now to the experimental evidence on credit ratings as dependent variables. Credit ratings are discrete and non-linear, and the ratings have ordinal meanings; therefore, as mentioned in the previous section, all the ratings have been regrouped to 4 different categories, AAA or AA, A, BBB, below BBB. For regression consideration, AAA or AA is denoted as 3, A as 2, BBB as 1, and below BBB as 0, then putting them in Stata for ordinal probit modeling regression. The marginal effects for credit ratings equal to 3, 2, 1, 0, are calculated separately on account of the coefficients of the probit regression alone is not able to give enough information for economic interpretation. The marginal effects are listed in order beside each specification in Table 4.3 and Table 4.4. Besides, the p-values are displayed under the corresponding coefficients.

In the first place, the degree of ERM implementation can be seen significantly impact the default risk estimator, credit ratings, for all specifications of banks of the China market apart from specification II, for all specifications of banks of the Nordic market apart from specification II and specification V, illustrating that the variable attached with our prime researching interest still holds the position that has a significant influence on the default risk on both markets, generally. The coefficients of the Chinese banks are higher than the coefficients of Nordic banks, one of the plausible explanation is that the investors and the market tend to believe the Nordic banks in our sample have already had steady performance and earned more trust because they have a relatively long history, are more functioning comprehensive and more capable of issuing financial instruments to hedge risks than the banks in China.

This phenomenon is embedded in the marginal effects as well. For example, in specification I of the ordinal probit regression result of the China market, the marginal effects for °ERM on the credit rating AAA or AA is 8.43%, implying that the degree of ERM implementation increase one unit, the magnitude for banks staying in AAA or AA is 8.42%; the degree of ERM implementation increase one unit, the magnitude for banks staying in credit rating A is -3.82%, credit BBB is -3.25%, credit below BBB is -15.49%, respectively, which means the ERM implementation is an association on credit rating escalation. The marginal effects of the °ERM for Nordic banks confirms that the ERM implementation helps the top rating banks to maintain their credit ratings, and the A and BBB rating banks to leave their current rating and upgrade to the next level. The marginal effects for the below BBB rating banks are unknown for the reason that there is no bank in the Nordic sample that has below BBB ratings. Furthermore, the marginal effects of °ERM on the Nordic banks are smaller than that on the Chinese banks on account of the market has certain tendency showing that even though the proportion of the Chinese banks in AAA or AA and A categories evenly ties with the Nordic banks, there is more

room for the Chinese banks to improve their performance by enforcing to implement ERM at a higher level.

The total word count of annual reports shows relatively significant results as well, and this significance is stronger for the Nordic banks than the Chinese banks. Moving on to the other bank-wise controlling variables and the sole corporate governance control variables, Institute Owner % Shares Out, the outcomes are contrary to that regression results when CDS as dependent variables. The variables do not significantly impact the credit ratings for specifications at both markets, except Nonperforming loans/ TA at specification III of the Nordic banks, and Institute Owner % Shares Out at specification IV of the Nordic banks. Taking into account the *Corporate Ratings Methodology* of the Standard & Poor Ratings Service, the outcome can be partly explained that these control variables may not be critically regarded as evaluating indicators or they are involved in the bucket of the evaluating factors yet so not put the large scale of weights on in either the business profile sector or the financial risk profile sector.

Another finding that may help us understand the result is the coefficients of determinations. These show that the ordinal probit modeling results may not be applicable to explain at high-level percentage since none of the r-squared are above 35% social science regression principal even if the bank-year sample size for both markets are large. Despite that, the trend and the significant impact of the degree of ERM implementation on credit ratings remain strong supporting the contribution of ERM implementation to the default risk for the banks in these two markets.

Table 4.3 Credit Rating Sample – Probit Regression Results for banks in China

Explanatory variables	**Specification I**	**Marginal Effects**	**Specification II**	**Marginal Effects**	**Specification III**	**Marginal Effects**	**Specification IV**	**Marginal Effects**	**Specification V**	**Marginal Effects**
°ERM	0.061	8.426%	0.034	5.229%	0.055	0.747%	0.060	0.822%	0.032	0.416%
	[0.043] **	-3.815%	[0.223]	-2.460%	[0.088] *	-0.360%	[0.043] **	-0.377%	[0.028] *	-0.226%
		-3.253%		-0.216%		-0.305%		-0.324%		-0.194%
		-15.494%		-0.985%		-1.412%		-1.523%		-0.837%
#Wordcount (in thousand)			0.018						0.024	
			[0.052] *						[0.071] *	
Total assets (TA) (in billion)					0.000				0.000	
					[0.905]				[0.417]	
Return on Asset (ROA)					0.088				0.746	
					[0.462]				[0.575]	
Tier 1 Ratio					0.152				0.106	
					[0.325]				[0.526]	
Nonperforming loans/TA					-85.952				-28.345	
					[0.419]				[0.819]	
Provision for loan losses/TA					-52.364				-1.470	
					[0.799]				[0.994]	
Institut Owner % Shares Out							0.006		0.002	
							[0.354]		[0.796]	
R^2	14.93%		15.42%		17.43%		16.18%		20.23%	
# observations	96		96		96		96		96	

*Note: 2006 – 2016 year-end data are obtained from Bloomberg Terminal for all the control variables apart from the total word count. Total word count and the degree of ERM implementation are extracted from the annual report by the text-based method. All p-values for the corresponding variables are placed in square brackets below the coefficient. *stands for the significance at the 10% level, **stands for the significance at 5% level, and *** stands for the significance at 1% level. The percentage of marginal effects are for the category AAA or AA, A, BBB, below BBB from top to bottom, respectively. More detailed information can be seen in the main text.*

Table 4.4 Credit Rating Sample – Probit Regression Results for banks in the Nordic Countries

Explanatory variables	**Specification I**	**Marginal Effects**	**Specification II**	**Marginal Effects**	**Specification III**	**Marginal Effects**	**Specification IV**	**Marginal Effects**	**Specification V**	**Marginal Effects**
°ERM	0.010	0.048%	0.010	0.318%	0.000	0.053%	0.015	0.476%	0.010	0.604%
	[0.098] *	-0.255%	[0.537]	-0.080%	[0.090] *	-0.084%	[0.046] **	-0.117%	[0.790]	-0.274%
		-0.071%		-0.238%		-0.136%		-0.359%		-0.331%
		N/A		N/A		N/A		N/A		N/A
#Wordcount (in thousand)			0.0200						0.010	
			[0.000] ***						[0.550]	
Total assets (TA) (in billion)					-0.000				-0.000	
					[0.250]				[0.789]	
Return on Asset (ROA)					0.347				0.250	
					[0.667]				[0.800]	
Tier 1 Ratio					0.073				0.040	
					[0.153]				[0.512]	
Nonperforming loans/TA					-105.06				-80.051	
					[0.053] *				[0.216]	
Provision for loan losses/TA					-867.500				-1,015.840	
					[0.359]				[0.417]	
Institut Owner % Shares Out							0.028		0.012	
							[0.024] **		[0.513]	
R^2	10.02%		14.37%		21.24%		15.18%		28.17%	
# observations	49		49		49		49		49	

*Note: 2006 – 2016 year-end data are obtained from Bloomberg Terminal for all the control variables apart from the total word count. Total word count and the degree of ERM implementation are extracted from the annual report by the text-based method. All p-values for the corresponding variables are placed in square brackets below the coefficient. *stands for the significance at the 10% level, **stands for the significance at 5% level, and *** stands for the significance at 1% level. The percentage of marginal effects are for the category AAA or AA, A, BBB, below BBB from top to bottom, respectively. More detailed information can be seen in the main text*

4.2 LASSO Regression Results

In order to find out the predictor variables that are significantly related to the ERM implementation, Lasso has been employed due to the fact that it incorporates the regularization coefficient, which in turn removes irrelevant variables, increasing predictive performance and decreasing model complexity.

In the Lasso regression, there are 83 explanatory variables that represent the keywords for the ERM implementation, and the dependent variable is banks' responses from the survey. Firstly, Lasso regression is performed for both Chinese banks and Nordic banks separately. In this case, 30 predictor variables are chosen out of 83 dimensions for Chinese banks, and 35 predictor variables are picked for Nordic banks out of 83 explanatory variables. Due to the fact that running the regression for only one iteration may lead to overfitting, the best solution is to run the Lasso regression 100 times to pinpoint out the variables that are related to the ERM implementation. Here, 44 dimensions are picked for Chinese banks, while 50 dimensions are employed for Nordic banks.

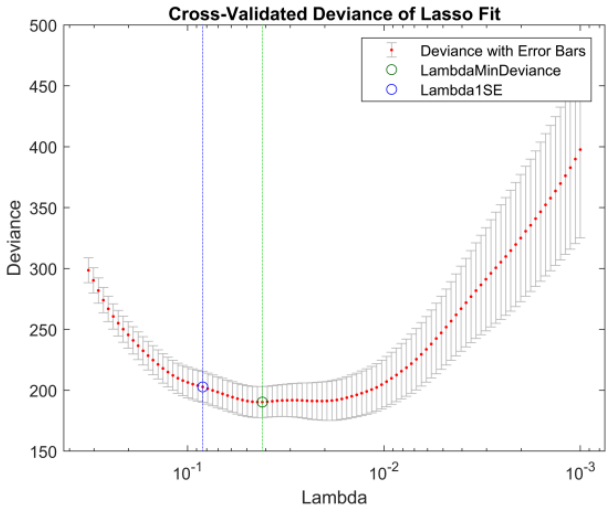

Figure 4.1 Lasso regression result for Chinese banks (one time).

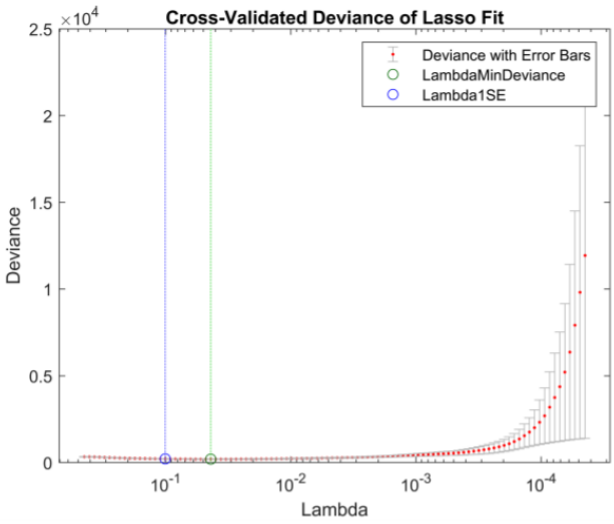

Figure 4.2 Lasso regression result for Chinese banks (100 repetitions).

The forecast errors (Deviance) of lambda that minimizes the forecast error (0.04164) is circled in green when running the regression for one iteration (see Figure 4.1). The forecast errors (Deviance) of lambda that minimizes the forecast error (0.02069) is also circled in green when running the regression for one hundred times iteration (see Figure 4.2). The blue dots in both figures stand for the sensitivity of lambda from the data. The data is considered to be more stable if the gap between green dot and blue dot is getting smaller. From the result, the deviance of lambda is smaller when running the regression for 100 times, which indicates that it provides with a small shrinkage and make it more explainable after 100 repetitions.

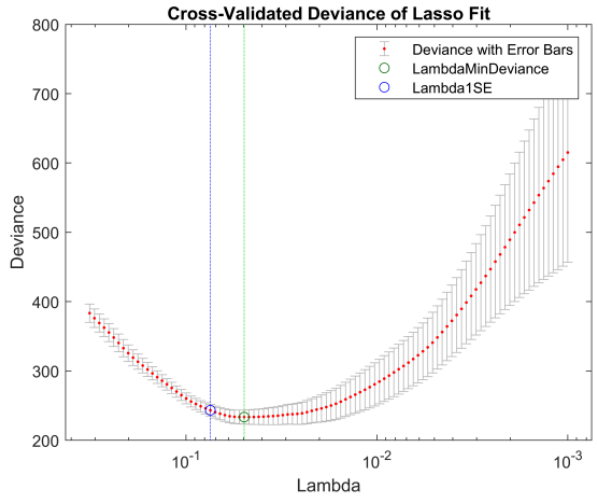

Figure 4.3 Lasso regression result for Nordic banks (one time).

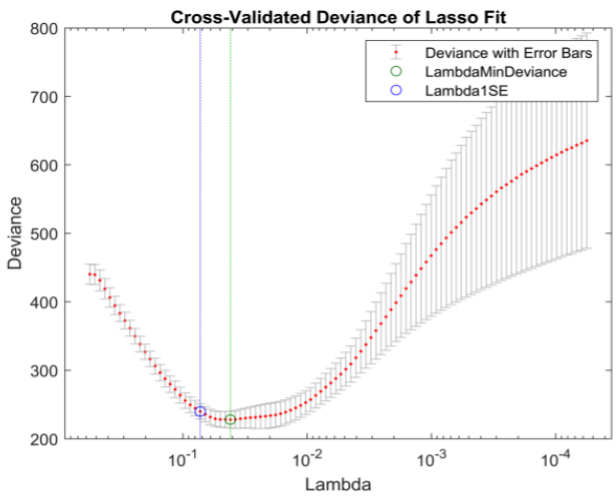

Figure 4.4 Lasso regression result for Nordic banks (100 repetitions).

The forecast errors (Deviance) of lambda that minimizes the forecast error (0.03299) is circled in green when running the lasso regression for one iteration (see Figure 4.3). The forecast errors (Deviance) of lambda that minimizes the forecast error (0.02164) is circled in green as well when running the lasso regression for one hundred times iteration (see Figure 4.4). The blue dots stand for the sensitivity of lambda from the data in these two figures. The smaller the interval between blue dot and green dot, the more stable the data will be. For Nordic banks, the deviance of lambda is also smaller when running the regression for 100 times, which shows that it gives a small shrinkage and make the data more explainable after 100 repetitions.

The results are different in terms of the iterations for Chinese banks. Running the Lasso regression for one iteration shows that this method relies on 30 variables, and the coefficients of the 2 variables are fairly high compared to other 28 variables, which indicates that these two variables play an essential role in implementing the ERM. Table 4.3 shows the information regarding the predictor variables that are related to ERM implementation.

- *Data management.* The first variable that is significantly related to ERM implementation is data management. Enterprises face many risks from different aspects, which are discovered after analyzing the data, helping enterprises to take more effective countermeasures and avoid these risks in the early stage of risk formation. Thus, data management can be regarded as a crucial part of when implementing enterprise risk management. Using data management and analysis methods to perform enterprise risk management enables enterprises to identify, manage, and reduce risks with a more strategic perspective. For example, the application of data management in banks is essential, because

the banks can use basic cardholder information, credit card necessary information, financial transaction history, combined with intelligent rules engine for real-time transaction anti-fraud analysis.

- *Technology risk.* The second variable that is highly associated to enterprise risk management implementation is technology risk according to the result. ERM covers many areas, including privacy and security, information technology and governance control, etc. If banks have the consideration of technology risk, banks can better manage, address information technologies related risks and ensure early warning mechanisms are in place through providing comprehensive information technologies related risk consulting services for all the customers.

Besides these two explanatory variables, there still exist 28 variables that are relevant to the ERM implementation to some extent. Detailed information is presented in Table 4.5.

Table 4.5 Lasso regression result – Chinese banks (one time)

No.	°ERM Dimensions	Coefficient
1	Data Management	0.7465
2	Technology Risk	0.5123
3	Access Capital Market	-0.1836
4	Approval of the Strategy by Board	0.2837
5	Assess Risk Manage Independent Assess Risk Manage External	-0.1281
6	Assess Risk Manage Internal	0.0440
7	Authorization	0.4110
8	Board Responsibilities	-0.1041
9	Business Objective	-0.1305
10	CEO Responsibilities	0.4867
11	Chief Risk Officer	-0.2419
12	Communication with Customer, External Parties and Vendor	0.4430
13	Communication to breaches of Laws, Regulations or other Improprieties	0.4997
14	Compensation Policies to Align Interest of Managers with Shareholders	-0.1158
15	Competition	-0.1057
16	Compliance Industry Code	0.0264
17	Contingency Plan Disaster Recovery	0.3951
18	Document Control Record Control	0.1690
19	Economic Risk	0.0181
20	Ethic	0.3533

21	Financial Risk	-0.0248
22	Interest Rate	0.0345
23	Key Risk Indicator	0.0404
24	Process Manage Risk	-0.0901
25	Process Monitor	0.0323
26	Review Function Control Review Effective Control	0.1306
27	Risk Owner	0.0485
28	Segregation of Duties	0.3194
29	Update Risk Information	-0.2576
30	Written Guideline Manage Risk	0.2392

Furthermore, 44 predictor variables are picked by running the Lasso regression 100 times for Chinese banks. Meanwhile, 9 explanatory variables show evidence that they are highly related to ERM implementation because their value of coefficients is fairly high compared to other variables. Table 4.6 presents the information regarding the variables that are related to ERM implementation for Chinese banks by running the Lasso 100 times.

- *Approval of the strategy by the board.* The company's board of directors is the highest decision-making level for risk management. It is not only responsible for formulating risk management strategies and risk management policies but also determining risk management principles and continually testing the effectiveness of risk management policies per changes in the business environment. Moreover, the board needs to consider whether the strategy is consistent with the company's risk appetite and how it will drive the company to set goals and ultimately make a persuasive allocation of resources. Therefore, the board's approval of strategy might be significantly related to the company's ERM implementation and help the enterprise make a potent strategy to control the risk.

- *CEO responsibilities.* According to COSO, it is known that has all company levels have specific responsibilities for enterprise risk management. Chief Executive Officer (CEO) has primary responsibilities and assume the CEO possesses the ownership. Although every employee has the responsibilities, the management team is responsible for determining the tone of risk management at the top of the company, which affects employee ethics and values in the company's internal environment. Senior management further assigns responsibilities for formulating more specific risk management policies and procedures to employees of the company to conduct risk management. Overall, the CEO responsibilities are highly relevant to ERM implementation.

- *Compensation policies to align interest of managers with shareholders.* Freeman (2017) claims that incentive compensation plans are going to lead to suspicious employee behavior, which will seriously damage the company's reputation. Incentives are clearly the key instruments for companies to achieve their goals. Nevertheless, these incentive

compensation plans are still likely to bring more risks to the company and eventually make it relevant to the ERM implementation.

- *Compliance Corporate Governance.* Manab, Kassim, and Hussin (2010) claim that corporate compliance is thought of as a basic content, objective, and guarantee of internal control of an enterprise. Besides, corporate compliance is also the core content of comprehensive risk management of an enterprise. China Banking Regulatory Commission stipulates that compliance management is a core risk management activity of commercial banks. Commercial banks are requested to consider the correlation between compliance risks and credit risks, market risks, operational risks, and other risks to ensure the consistency of various risk management policies and procedures.

- *Customer concentration.* Customer concentration is significantly correlated with enterprise risk, since the higher the customer concentration, the more conducive to reducing business risk. If banks possess a strong customer base, it will help them gain confidence in their clients and cope with the enterprise risk with ease.

- *Privacy Information Customer.* Companies need to safeguard the private information of customers. The leakage of clients' private information will cause many problems. For instance, it will lead to the evaporation of the company's market value and some punishments, as well as reduced credibility. Therefore, the consideration of the privacy of information held on customers is relevant to the ERM implementation.

- *Segregation of duties.* Risk management is a process that requires the participation and close cooperation of all levels of the company. The company establishes a risk management organization system that is under the overall responsibility of the board of directors and then closely coordinated by relevant functional departments and offices. As the specific risk management department, the company's audit and internal control department is mainly responsible for the organization, guidance, and coordination of the firm's comprehensive risk management. So, it is obvious to see that the segregation of duties in the company playa an essential role in implementing the ERM.

- *Senior manager with responsibility to oversee risk.* The senior management team (senior managers) is responsible for presiding over the daily work of comprehensive risk management and reporting to the board of directors for the effectiveness of enterprise risk management. The awareness of overseeing the risk by senior managers will undoubtedly have an impact on the ERM implementation.

- *Training educational programs.* Employees are considered as an important part of the company. Also, the employee's awareness of risk information exchange is an integral part of risk management. Therefore, some educational training programs help employees acquire the general idea of ERM and the way to implement ERM. That is the reason why training educational programs are highly related to ERM implementation.

Apart from the 9 explanatory variables that are highly correlated with ERM implementation, there remain 35 variables that are related to ERM implementation to a significant extent. Table 4.6 captures the relationship between these variables and ERM implementation.

Table 4.6 Lasso regression result – Chinese banks (one hundred times repetition)

No.	°ERM Dimensions	Coefficient
1	Approval of Strategy by the Board	0.6763
2	CEO Responsibilities	0.6542
3	Compensation Policies to Align Interest of Managers with shareholders	0.8332
4	Compliance Corporate Governance	0.5784
5	Customer Concentration	0.7191
6	Privacy Information Customer	0.5734
7	Segregation of Duties	0.5854
8	Senior Manage Risk	-0.6007
9	Training Educational Programs	-0.6282
10	Assess Risk Manage Independent Assess Risk Manage External	0.1044
11	Audit Committee Responsibilities	-0.0241
12	Benchmark Result	0.4293
13	Budget Internal Audit	-0.1733
14	Business Cycle	-0.0369
15	Business Objective	-0.0597
16	Central Risk Manage	0.0871
17	Charter of Board	-0.0402
18	Chief Risk Officer	0.0161
19	Code Conduct Code Ethic	-0.4202
20	Communication Risk Manage	0.3958
21	Communication to breaches of Laws, Regulations or other Improprieties	0.0122
22	Complete Information Valid Information Accurate Information	-0.0271
23	Computer System	0.3210
24	Contingency Plan Disaster Recovery	0.1065
25	Document Control Record Control	-0.0610
26	Ethic	-0.0382

27	Health Safety	-0.0380
28	Hiring and Firing of Board Members and Management	-0.3382
29	Independent Verification Procedures	0.4184
30	Individual Performance Target	-0.3361
31	Key Performance Indicator	-0.1577
32	Key Risk Indicator	-0.1320
33	Long Term Debt	-0.2607
34	Physical Control	-0.2254
35	Process Manage Risk	0.2627
36	Reputation Risk	-0.1740
37	Review Function Control Review Effective Control	0.3328
38	Risk Appetite	0.2218
39	Risk Manage Philosophy	-0.1450
40	Risk Owner	-0.1250
41	Risk Response Plan	0.1402
42	Sale Control	0.3905
43	Technology Risk	0.1818
44	Training in Ethical Values	0.0507

Within the Nordic banks, the results are different in regards to the number of regressions that are conducted. Running the Lasso regression once shows that 35 variables are chosen by Lasso, and 3 variables are significantly related to the ERM implementation because the absolute value of coefficients is fairly high. Table 4.7 illustrates the information in terms of the variables that are related to ERM implementation.

- *Charter of the board.* The shareholders of the bank clearly state in the charter of the board that risk management is the responsibility for the board of directors. Therefore, the charter of the board establishes basic risk management guidelines and provides directions and measurements for enterprise risk management.

- *Cost of capital.* According to the Institute of Certified Public Accountants (2011), the ultimate goal of analyzing the cost of capital is to make the optimal capital structure decision for the enterprise. Some risk related elements are considered to affect the capital structure. For instance, the business risk of the company's future strategy and the company's attitude towards enterprise risk. Under this circumstance, the cost of capital does have an impact on the implementation of ERM.

- *Independent verification procedures.* Jiang (2018) points out that an internal audit is a useful tool for risk management, and it participates in the entire process of enterprise management. The internal audit needs to cooperate with the verification procedures, so it is necessary to establish an independent verification department for internal rating and monitoring in the company.

There are still 32 variables that are correlated with ERM implementation apart from these three variables, which can be seen from Table 4.7 below.

Table 4.7 Lasso regression result – Nordic banks (one time)

No.	°ERM Dimensions	Coefficient
1	Charter of Board	0.8266
2	Cost of Capital	-0.5084
3	Independent Verification Procedures	0.6536
4	Access Capital Market	0.0092
5	Acquisition Aggressiveness	0.0322
6	Approval of Strategy by the Board	-0.0513
7	Authorization	0.3339
8	Benchmark Result	0.3529
9	Board Responsibilities	0.0202
10	Budget Internal Audit	-0.0274
11	Business Cycle	-0.2120
12	CEO Responsibilities	-0.4191
13	Code Conduct Code Ethic	0.0012
14	Communication to breaches of Laws, Regulations or other Improprieties	0.2301
15	Compensation Policies to Align Interest of Managers with shareholders	-0.3667
16	Compliance Industry Code	-0.1610
17	Compliance Risk	-0.0691
18	Correlation Risk Portfolio Risk	0.0033
19	Data Management	0.3540
20	Economic Risk	-0.2388
21	Environment	-0.1585
22	Ethic	0.2681
23	Internal Audit	0.4553
24	Key Performance Indicator	-0.0878

25	Litigation	-0.2815
26	Physical Control	-0.0296
27	Process Monitor	0.2432
28	Remuneration Policy for Board Members and Management	0.2966
29	Reputation Risk	-0.0531
30	Review Function Control Review Effective Control	0.1145
31	Risk Manage Philosophy	-0.2178
32	Risk Tolerance	-0.1013
33	Training Educational Programs	-0.2574
34	Training in Ethical Values	0.4877
35	Written Guideline Manage Risk	0.1283

The same process is conducted again for Nordic banks by running the Lasso regression for 100 times. At this time, Lasso picks 8 variables that are most relevant to the ERM implementation. In addition, 42 explanatory variables show evidence that they are correlated with the implementation of ERM in some way. Detailed figures and chosen variables are shown in Table 4.8.

- *Acquisition aggressiveness.* Acquisitions can create competitive advantages for enterprises and expand the scale of operations, but there are also huge risks behind this attempt. Thus, the aggressiveness of acquisition is highly related to ERM implementation.

- *Business cycle.* Geiger and Kulfenko (2016) argue that the business cycle refers to a phenomenon in which economic expansion and economic contraction alternate and repeat in the economic operation. It is highly related to enterprise management since the economic downturn will lead to credit risk, operational risk, and industry risk. For banks, the economic downturn will be a significant test for commercial banks in risk control and management. Thus, the business cycle is highly correlated with ERM implementation.

- *Competition.* According to different sources of enterprise risk by COSO, they can be divided into external risks and internal risks. Competitor risks belong to external risks. The analysis of competitors' future goals helps predict competitors' current market position and financial status. Competition between firms can help the management team always reflect on themselves, find the gap between themselves and an excellent enterprise in order to strengthen the manager's ability to implement ERM and improve the level of risk management.

- *Compliance industry code.* Formulating scientific compliance management goals among industries is essential for implementing ERM. If a company makes overall compliance risk assessments regularly, it will help promote the continuous improvement of compliance management level through industries.

- *Correlation Risk Portfolio Risk*. Portfolio management means that after formulating the company's business management framework, the company needs to integrate the risk exposure of each perspective to reduce the risk of the entire portfolio and achieve diversification.

- *Cost of capital.* According to the Institute of Certified Public Accountants (2011), the objective of analyzing the cost of capital is to make the enterprise's optimal capital structure decision. One of the main factors affecting the capital structure can be some risk related elements that are difficult to quantify, for instance, the business risk of the company's future strategy, the company's attitude towards enterprise risk, and the risk of the whole bank industry. Under this circumstance, the cost of capital does have an impact on the implementation of ERM.

- *Economic Risk.* Wang and Zhang (2006) state that economic risk generally refers to various related factors caused by poor management, changes in prices, and changes in consumption requirements during the production and exchange of commodities. Therefore, it is vital to know the economic risk for companies. If companies have a comprehensive understanding of the expected risk of economic behavior, they will have more opportunities to minimize risks and increase returns.

- *Ethic.* According to COSO, the internal environment is the foundation of all enterprise risk management components, providing rules and structure for other components. Furthermore, ethics is an essential part of the internal environment. Bank industry has the characteristics of high investment, high risk, and long cycle; it integrates technology, management, finance, and investment altogether. Thus, having some expert managers and employees with good professional ethics is quite crucial for banks' development. On the contrary, uncertainty about the professional ethics of employees will cause certain risks as well. That is the reason why ethics are highly related to ERM implementation.

Table 4.8 Lasso regression result – Nordic banks (one hundred times repetition)

No.	°ERM Dimensions	Coefficient
1	Acquisition Aggressiveness	-0.5707
2	Business Cycle	0.9850
3	Competition	1.0393
4	Compliance Industry Code	0.7629
5	Correlation Risk Portfolio Risk	-0.8013
6	Cost of Capital	0.5981
7	Economic Risk	0.9925
8	Ethic	-0.5461
9	Approval of Strategy by the Board	-0.4549
10	Audit Committee Responsibilities	0.0732

11	Board Responsibilities	-0.2862
12	CEO Responsibilities	-0.0993
13	Charter of Board	-0.1185
14	Chief Risk Officer	0.3807
15	Code Conduct Code Ethic	-0.1334
16	Communication with Customer, External Parties and Vendor	-0.0464
17	Communication to breaches of Laws, Regulations or other Improprieties	-0.3291
18	Compensation Policies to Align Interest of Managers with Shareholders	0.3545
19	Compliance Regulation	-0.1479
20	Compliance Risk	-0.1422
21	Computer System	0.2580
22	Customer Concentration	0.4082
23	Data Management	0.3860
24	Document Control Record Control	-0.2611
25	Environment	0.1644
26	Health Safety	-0.3243
27	Independent Verification Procedures	0.4068
28	Individual Performance Target	0.0427
29	Inflation	-0.0850
30	Interest Rate	-0.1149
31	Internal Audit	-0.2527
32	Key Performance Indicator	-0.1266
33	Key Risk Indicator	0.0966
34	Liquidity	0.1311
35	Litigation	0.3519
36	Long Term Debt	0.1984
37	Mission	-0.4027
38	Product Expansion	0.1749
39	Report Board Risk Manage	-0.0720
40	Reputation Risk	-0.0937
41	Risk Appetite	0.1983

42	Risk Committee Board Committee Risk Manage	0.0750
43	Risk Manage Philosophy	-0.3998
44	Risk Response Plan	-0.4568
45	Risk Tolerance	-0.4030
46	Sale Control	-0.1475
47	Segregation of Duties	0.3141
48	Senior Manage Risk	-0.1652
49	Training Educational Programs	-0.1026
50	Written Guideline Manage Risk	-0.0541

Comparing the results above for Chinese and Nordic banks, Lasso picked different variables for the ERM implementation in terms of the regions and the number of regressions. However, there are still 5 explanatory variables that are chosen regardless of the regions and number of regressions, which indicates that these variables are significantly related to the implementation of ERM. These variables are *Approval of the strategy by the board; CEO responsibilities; Communication to breaches of laws, regulations, or other improprieties; Compensation policies to align interest of managers with shareholders* and *Ethic*. It can be assumed that these variables might give some evidence in operating the ERM in a generally accepted way.

- *Approval of the strategy by the board.* The company's board of directors is the highest decision-making level for risk management. It is not only responsible for formulating risk management strategies and risk management strategies, but also for determining risk management principles and continuously testing the effectiveness of risk management strategies. In addition, the board of directors needs to consider whether the strategy is consistent with the company's risk tolerance and how it will drive the company to set goals and ultimately make a realistic allocation of resources. Therefore, the approval of the strategy by the board of directors may have a significant relationship with the implementation of the company's enterprise risk management and help the company to develop an effective strategy to control risks.

- *CEO responsibilities.* The chief executive officer (CEO) has extensive guidance on the formulation of risk control and risk measurement. CEO will also approve the risk related strategies and cooperate with the Chief Financial Officer to optimize financial decisions and establish a robust risk management culture. Overall, the responsibilities of the CEO are highly relevant to the implementation of enterprise risk management.

- *Communication to breaches of laws, regulations or other improprieties.* The most important way to implement enterprise risk management is to have a complete risk communication mechanism. The communication in the enterprise includes the information exchange between superiors and subordinates, and the communication between different departments due to the regulations and improprieties.

- *Compensation policies to align interest of managers with shareholders.* Companies should develop a rule that clearly states how incentives will be used to compensate employees since it will significantly influence risk management in the whole enterprise and help control the risk.

- *Ethic.* Bank institutions are becoming more abundant, financial products are becoming more diversified, and operation risks are highly valued by banks recently. From the perspective of the global banking industry, operational risk is an integral part of the risk management of banks. The unawareness of ethical concepts for employees is one of the key factors that cause the operational risk. Therefore, having employees with good professional ethics is essential for banks' development. That is the reason why Lasso picks Ethic as an essential variable for both Chinese and Nordic banks.

In conclusion, Lasso picks different explanatory variables in terms of the regions and the number of regressions conducted. It helps reduce the 83 dimensions and find out the most significant variables that highly relate to the degree of ERM implementation. It provides precise and accurate results of the implementation of ERM for banks regarding the different regions. Therefore, it is recommended that fewer dimensions will be chosen for operating the ERM implementation in the future.

However, due to the time constraints, 83 dimensions are still included in the panel data regression, and it can be considered as a future research improvement point. If there is enough time, instead of including all the 83 dimensions, the variables selected by lasso should be added to the panel data regression.

5 Conclusion

This paper discussed the relationship between the degree of ERM implementation and default risk both in China and Nordic banks. In order to measure the degree of ERM implementation, two methods were employed. First, a text-based search method is conducted to measure the ERM implementation under 83 dimensions. Searching the different word combinations with these dimensions gives the final result for each bank-year sample. Secondly, a survey-based method is used to get the responses from sample banks regarding the degree of ERM they had already implemented by a specific question. Moreover, the hiring of a Chief Risk Officer is regarded as the treatment effect to see the validity of the measure. In the meantime, a difference-in-difference method is used to test the validity of the measure. Two default risk estimators, CDS Spread and credit ratings, are involved in estimating the relationship with ERM implementation in two target markets. Bank-wise control variables and corporate governance variables are included to fix the cross-sectional effect.

As for methodology, panel regression and ordinal probit are the two econometric approaches used to explore the detailed information for the topic. According to the result, it shows shreds of evidence that the degree of ERM implementation is significantly related to the CDS Spread for both banks in China market and Nordic market. For banks in China market, the degree of ERM implementation is significant at all specifications, and it is negatively related to the CDS Spread because when the degree of ERM implementation becomes higher, the CDS spread drops showing more unlikely for banks to default. Similar case applies to the Nordic banks as it also shows a negative correlation between ERM implementation and CDS Spread. In addition, the coefficient of determination implies our results are acceptable and meaningful. Geographically, the degree of ERM implementation has a stronger influence on the CDS spread in China than in Nordic countries due to the functioning comprehensiveness, the capacity of hedging risks, and the history of the providing advanced financial services.

This paper provides a comprehensive assessment of using credit ratings as dependent variables to probe the relationship between the degree of ERM implementation and the default risk as well. The regression outcomes support that the degree of ERM implementation has a significant effect on the credit ratings of the banks as well as when CDS spread acts as the default risk indicator. The enforcement and improvement of the ERM implementation can help banks at AAA or AA category maintain their current ratings, assist banks at A category, BBB category, non-investment grade category to get rid of their current grade, and be escalated to a higher and better credit ratings level. This situation applies to both markets, in particular, China market. In line with the results of CDS spread, ERM implementation has more critical the most representative emerging market, China, comparatively, has a more moderate predominance in the Nordic market. One point that needs to be further discussed is that the coefficients of the determinations for all specifications do not meet up with the general acceptance and validation in social sciences.

Lasso regression was then applied to pick the variables that significantly associated to the ERM implementation. Lasso chose different variables in terms of the regions and the number of regressions conducted. For Chinese banks, it helps reduce the dimensions from 83 to 30 (one iteration) or 44 (100 iterations). What's more, for Nordic banks, Lasso selects 35 (one iteration) or 50 variables (100 iterations) out of the 83 dimensions. This result provides a reference for selecting the dimensions that represent ERM implementation in a way. It offers some accurate and precise dimensions that can be chosen according to the company's region to discover its relationship with ERM implementation. Additionally, there are few variables, for example, the CEO responsibilities and the ethic that are picked by Lasso regardless of market or repetition, which indicates that they are highly relevant in relation to ERM implementation regardless of the location.

A further direction would be to adopt the Lasso-picked dimensions as the evaluation of the degree of the ERM implementation to perform the panel regression on CDS spread and ordinal probit regression on credit ratings rather than all 83 dimensions to confirm the effect of ERM on reducing default risks and the geographical influence on the two markets. The disturbance of not significant r-squared values in credit ratings as dependent variables remains unclear. Additionally, more information on the ERM implementation is needed to help establish a greater degree of accuracy on this subject since we believe that testifying the negative relationship is not the only way to explore the essential role of ERM implementation for default risk. If the discussion and research are to be moved forward, a better understanding of that relationship will be developed.

From another perspective, China and the Nordic Countries are two important and growing markets within the global finance sector, and the banks in these two markets are facing their characteristic regional challenges, a natural progression of this work would also help the banks in these two markets to implement ERM so as to achieve a broadly applicable approach to enhance the capability to confront with risks.

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Appendix A: Definition of Variables

Variables	Defination
ERM	Degree of the Enterprise Risk Management, measured by the keyword hits, range from 0 to 83.
wordcount	Number of words in each annual report. Measured in thousands.
Total Assets (TA)	Total assets, including all current assets and non-current assets
Return On Assets	Return on Assets ratio, calculated by dividing net income by average total assets * 100%
Tier 1 Ratio	Tier 1 Capital Ratio / Total Risk-Weighted Assets
Nonperforming loans/ TA	Non-performing loans / Total assets
Provision for loan losses/ TA	Provision for loan losses / Total assets
Institut Owner % Shares Out	The percentage of institutional ownership on the total amount of outstanding shares

Appendix B: LASSO Regression Results – Combined Table

No.	°ERM Dimensions	China (One time result)	China (100 times repetition result)	Nordic Countries (One rime result)	Nordic Countries (100 times repetition result)
1	Access capital market	-0.1836		0.0092	
2	Acquisition aggressiv			0.0322	-0.5707
3	Approv strategy board approv strategies board	0.2837	0.6763	-0.0513	-0.4549
4	Assess risk manage independ assess risk manage external	-0.1281	0.1044		
5	Assess risk manage internal	0.0440			
6	Audit committee responsibilit		-0.0241		0.0732
7	Authorization authorisation	0.4110		0.3339	
8	Benchmark result		0.4293	0.3529	
9	Board responsibilit	-0.1041		0.0202	-0.2862
10	Budget internal audit		-0.1733	-0.0274	
11	Business cycle		-0.0369	-0.2120	0.9850
12	Business objective	-0.1305	-0.0597		
13	Central risk manage		0.0871		
14	CEO responsibilit chief executive officer responsibilit	0.4867	0.6542	-0.4191	-0.0993
15	Charter board		-0.0402	0.8266	-0.1185
16	Chief risk officer	-0.2419	0.0161		0.3807
17	Code conduct code ethic		-0.4202	0.0012	-0.1334
18	Communica risk manage		0.3958		
19	Communicat customer communicat external communicat vendor	0.4430			-0.0464
20	Communicat law communicat improp communicat regulation	0.4997	0.0122	0.2301	-0.3291
21	Compensation align interest remuneration align interest	-0.1158	0.8332	-0.3667	0.3545
22	Competition	-0.1057			1.0393
23	Complete information valid information accura information		-0.0271		

24	Compliance corporate governance		0.5784		
25	Compliance industry code	0.0264		-0.1610	0.7629
26	Compliance regulation				-0.1479
27	Compliance risk			-0.0691	-0.1422
28	Computer system		0.3210		0.2580
29	Contingency plan disaster recovery	0.3951	0.1065		
30	Correlation risk portfolio risk			0.0033	-0.8013
31	Cost of capital			-0.5084	0.5981
32	Customer concentrat		0.7191		0.4082
33	Data management	0.7465		0.3540	0.3860
34	Document control record control	0.1690	-0.0610		-0.2611
35	Economic risk	0.0181		-0.2388	0.9925
36	Environment			-0.1585	0.1644
37	Ethic	0.3533	-0.0382	0.2681	-0.5461
38	Financial risk	-0.0248			
39	Health safety		-0.0380		-0.3243
40	Hiring board hiring manage firing board firing manage		-0.3382		
41	Independent verification independent verif		0.4184	0.6536	0.4068
42	Individual performance target		-0.3361		0.0427
43	Inflation				-0.0850
44	Interest rate	0.0345			-0.1149
45	Internal audit			0.4553	-0.2527
46	Key performance indicator		-0.1577	-0.0878	-0.1266
47	Key risk indicator	0.0404	-0.1320		0.0966
48	Liquidity				0.1311
49	Litigation			-0.2815	0.3519
50	Long term debt long term debt		-0.2607		0.1984
51	Mission				-0.4027
52	Physical control		-0.2254	-0.0296	
53	Privacy information customer		0.5734		
54	Process manage risk	-0.0901	0.2627		
55	Process monitor	0.0323		0.2432	

56	Product expan				0.1749
57	Remuneration board remuneration manage compensation board compe			0.2966	
58	Report board risk manage				-0.0720
59	Reputation risk		-0.1740	-0.0531	-0.0937
60	Review function control review effectiv control	0.1306	0.3328	0.1145	
61	Risk appetite		0.2218		0.1983
62	Risk committee board committee risk manage				0.0750
63	Risk manage philosophy		-0.1450	-0.2178	-0.3998
64	Risk owner	0.0485	-0.1250		
65	Risk response plan		0.1402		-0.4568
66	Risk tolerance			-0.1013	-0.4030
67	Sale control		0.3905		-0.1475
68	Segregat duties segregat duty	0.3194	0.5854		0.3141
69	Senior manage risk		-0.6007		-0.1652
70	Technolog risk	0.5123	0.1818		
71	Train educat coach		-0.6282	-0.2574	-0.1026
72	Train ethic		0.0507	0.4877	
73	Update risk information	-0.2576			
74	Written guideline manage risk	0.2392		0.1283	-0.0541