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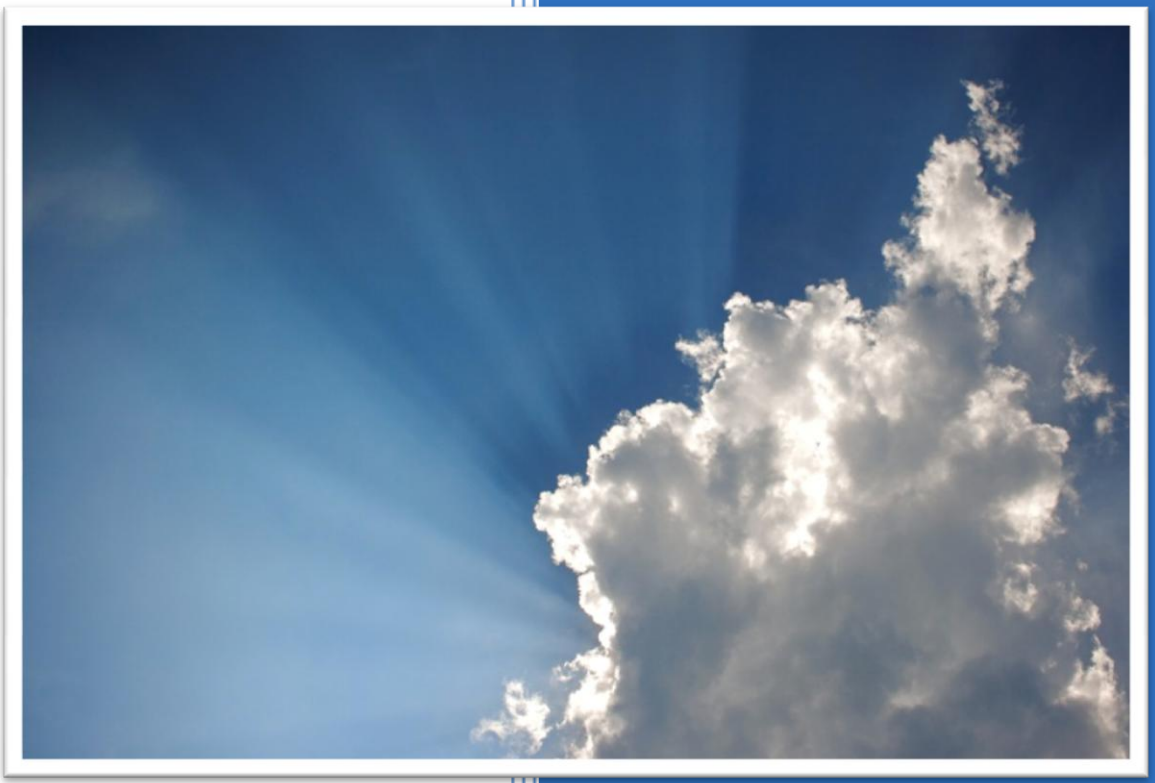

ENTERPRISE RISK MANAGEMENT AND BANK PERFORMANCE DURING A FINANCIAL CRISIS

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SUMMARY

Since the last financial crisis, risk management at banks has received much attention. It is assumed that banks fell into problems because they took too much risk. Therefore, there is more pressure for regulations towards risk management at banks. However, there is no clear consensus about whether the implementation of more risk management leads to better performance. In other words, it is not proven that more risk management is effective in helping banks survive a financial crisis. This leads to the following research question:

How does ERM implementation affect bank's performance before, during and after a financial crisis?

Risk management tries to decrease the negative outcomes of uncertainty, and this could be done in different approaches. First, there is traditional risk management, which handles risk in different separate classes. Further, there is enterprise risk management (ERM), which uses a holistic approach. This approach bundles all the risks and only hedges or insures the residual risks. ERM also focuses on non-financial risks, whereas traditional risk management only focuses on financial risks.

ERM could still be beneficial for banks, although they do not face much non-financial risk. However, by taking a holistic approach, different risks could better be managed and the knowledge of these risks becomes more sophisticated. An important ERM model is developed by COSO. This framework helps to achieve an organization's objectives in a risk-adjusted way.

Several researches have been conducted towards the relation between ERM and firm performance. Under normal conditions, it is assumed that ERM is valuable for banks, since it enhances performance (Baxter *et al.*, 2011) and increases value (Liebenberg & Hoyt, 2011; McShane *et al.*, 2011). However, this depends on the quality of the ERM programs and it is suggested that ERM is only valuable up until a certain level (McShane *et al.*, 2011).

During a financial crisis, risk management lowers risk (Ellul & Yerramilli, 2010), and leads to better performance McShane *et al.* (2011), it could be argued that it will be valuable for stakeholders, if the company has a further extent of ERM implemented during a financial crisis. From these propositions, several hypotheses were developed.

These hypotheses assumed that ERM implementation will lead to an improve in performance, in both normal conditions and during a financial crisis. However, this improvement in performance will only hold up until a certain extent. This means that when a banks implement ERM above that level, it will no longer contribute to better performance.

In determining the effect of ERM on performance, also several control variables are taken into account. These are efficiency, leverage, diversification, tier 1 capital ratio and credit quality. These control variables are expected to have a positive effect on performance.

Measurement took place in the years 2005-2010, and the banking crisis is defined in the years 2007 and 2008. This means that all the periods, before, during and after, are two years. A sample was selected from Dutch banks which have an individual annual report, which led to a sample of 38 banks.

The regression that was used to test the hypothesis, did not show support for the hypotheses. The effect of the ERM indices is ambiguous, which means that different results are found. It indicates that ERM implementation does not automatically lead to better firm performance.

For validity, the model has to be improved. At this moment, only a small part of the variation of the performance measures is explained by the variables used. Further, the residuals are not normally distributed. Since this is one of the assumptions of a regression, the estimates of these regression are not valid and cannot be used to draw conclusions.

These results are contradicting most of the previous research, which argued that ERM positively affects performance. The fact that the results for this research are different, could be because of another measure for ERM implementation, that was used in the previous researches. When looking at the results for Aebi *et al.* (2011), who developed the ERM index that was used in this research, it could be found that the effects of their ERM index also did not find significant results. Therefore, it still remains an unsolved issue whether ERM implementation actually leads to better performance.

All taken together, it could be stated that this research is contradicting most of the previous research. It did not find a significant effect for ERM implementation and firm performance. This means that more regulations on risk management and ERM specifically do not automatically help banks to survive a next financial crisis.

FOREWORD

In order to prove that I have acquired the exit qualifications of the MSc-programme of Business Administration, this thesis was written. My purpose was to write a relevant thesis, about a topic that receives attention at this moment. I think I achieved this personal goal very well, when writing on the financial crisis that has just past and the assumed origination of that crisis.

Now that my thesis is finished, I would like to thank some people. First, I would like to thank KPMG Enschede, for offering the opportunity to write this thesis at their organization. Further, the advices, comments and support of my coach Rick ten Elzen during my thesis helped me to improve this thesis and be more critical about my own work. Many thanks also go to my University supervisors, mrs. Huang and mr. Roorda. Thanks to their critical view and support, I was able to finish this thesis in time.

Finally, I would like to thank the people in my private environment. I would like to thank my family and friends, by offering support when I needed it. Without them, I would have never been able to succeed my studies.

Many thanks to you all.

Lisette Geessink
Beltrum, July 14, 2012

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1. INTRODUCTION

1.1 RESEARCH PURPOSE

The purpose of this research is to define the relationship between ERM implementation and firm performance of Dutch banks during a financial crisis.

1.2 RESEARCH PROBLEM

As a result of the global credit crisis and the role banks had in the origination of that crisis, the Dutch Bankers Association (NVB) developed a code to regulate themselves in terms of corporate governance, risk management, audit and remuneration policy (Nederlandse Vereniging van Banken, 2009). This code was made effective since 2010, and will be incorporated into law to be more effective. This is only one example of the attention risk management receives the last couple of years at the banking and insurance industry, especially after the global credit crisis, in order to help banks survive another crisis.

Traditional risk management consists of insurance and hedging every risk class. However, this leads to inefficiencies, because sometimes, risks could be double counted and thus double insured or hedged. To that problem, enterprise risk management (ERM) offers a solution. This approach handles risk in a holistic approach, which can create natural hedges. Natural hedges exist when a company invests in two different financial instruments, whose performance tends to cancel each other out. Further, it leads to a better understanding of risk, which enhances growth opportunities. This better risk insight enhances growth opportunities by risk responses that are better aligned with the corporate strategy (Abrams, von Känel, Müller, Pfitzmann, & Ruschka-Taylor, 2007), which could lead to better performance.

This holistic approach was developed into a framework, the COSO[1] integrated framework for risk management (2004). This framework has been adopted by companies throughout the world. According to COSO, enterprise risk management could best be defined by 'a process, effected by an entity's board of directors, management and other personnel, applied in strategy setting across the enterprise, designed to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives' (p. 2). The purpose of risk management in general is to effectively deal with uncertainty and enhance the capacity to build value for stakeholders (COSO, 2004).

There are several researches that try to find a relationship between the adoption and implementation of ERM and firm performance and value (for example Baxter, Bedard, Hoitash & Yezegel, 2011; Beasley, Pagach & Warr, 2008; Gordon, Loeb & Tseng, 2008). Another part of research focuses on risk management-related corporate governance mechanisms and board

[1] Committee of Sponsoring Organizations of the Treadway Commission

characteristics, and the effects on performance during a financial crisis (Minton, Taillard & Williamson, 2010; Aebi, Sabato & Schmid, 2011).

However, these researches used data only up until 2008. Now that data is available for the years after the banking crisis, a more precise answer could be given to the question how ERM implementation affects firm performance. Furthermore, this research could prove the effectiveness of ERM implementation, since this is seen as one of the solutions to help banks survive a next financial crisis.

Problem statement. Since the last financial crisis, there is more pressure for regulation towards risk management at financial companies in the Netherlands, just as in other countries, in order to decrease the consequences of a future crisis. However, there is still no clear consensus about whether the implementation of ERM leads to better performance in general and also during a financial crisis. In other words, it is not proven that more regulations on risk management are effective in helping banks survive a financial crisis. Therefore, research is needed to address the relationship between ERM adoption and performance during a financial crisis.

2. RESEARCH QUESTIONS

Based on this problem statement and the theoretical framework, the following research question could be defined:

How does ERM implementation affect bank's performance before, during and after a financial crisis?

Several steps need to be taken to answer this research question. First of all, the definition of risk needs to be given and the risks that occur at (financial) companies should be defined, to have a better understanding of what risk management is and why firms should use it. Then, enterprise risk management needs to be discussed and the differences it has with traditional risk management. This will be done based on the foundations and goals of the both types of risk management. This is needed to create a fuller understanding of the topic 'enterprise risk management', and leads to the following sub questions:

1. *What is risk and how could this be managed?*
2. *What is the difference between traditional risk management and enterprise risk management?*

Based on this description of ERM, it is discussed how in theory ERM could enhance firm performance, both during an inter-crisis period and during a financial crisis. This analysis will provide a possible solution to the research question and has to be empirically tested, and will be based on the following question:

3. *How could enterprise risk management enhance performance?*

Finally, it needs to be researched how banks perform outside a financial crisis, and whether ERM affects that performance. This than can be compared with the performance of the same banks during a financial crisis, to show differences between further ERM implementation and ERM implementation in a less extent, and performance during a financial crisis and outside a financial crisis. Together, this will lead to an answer to the question whether ERM adoption will lead to better firm performance of banks during a financial crisis. This leads to the following questions, which provide the final step in answering the research question:

4. *Is there a relationship between ERM implementation and overall firm performance?*
5. *Is there a difference in performance of banks that have further implemented ERM, compared to those banks who have a less implemented ERM program, under normal conditions?*
6. *Is there a difference in performance of banks that have further implemented ERM, compared to those banks who have a less implemented ERM program, during a financial crisis?*

In answering these sub questions and the research questions, several control variables need to be taken into account. These factors could also affect firm performance, and therefore could give an alternative explanation for changes in firm performance.

This research is further structured as follows. Next, previous literature on risk and risk management will be discussed, and enterprise risk management is introduced. Further, this literature review will also provide previous research on the influence of enterprise risk management and performance. From that literature review, several hypotheses are developed, that will be tested during this research. After the financial research, the conceptual model is introduced. This model will show which relations are expected and will be tested. How this conceptual model will be tested, is discussed in the methodology part. In that part, the methodological classification is discussed, from which the steps that need to be taken can be derived. Further, the variables are operationalized and research boundaries are set up. Also the data collection techniques are discussed. Following is the execution of the methodology and a presentation of the results. With these results, the hypotheses will be tested. The validity of these results is discussed afterwards. This research will end with conclusions and the answer to the research question, research limitations and directions for further research, and a personal reflection.

3. LITERATURE REVIEW

In this literature review, several issues are discussed concerning risk management and firm performance. First, a definition of risk is given and the relevance of managing risks is discussed. Then, two different approaches towards risk management are discussed: traditional risk management and enterprise risk management. Further, a theoretical explanation is given about how enterprise risk management could enhance performance. Then prior research on ERM implementation and firm performance is discussed, and in this part, hypotheses are being developed. The final part of this theoretical framework consists of discussing several control variables.

At the end of this theoretical framework, it should be clear what enterprise risk management is, how this could add value and which empirical results support these theoretical explanations. Furthermore, the developed hypotheses will show what actually is expected on the influence of ERM implementation on firm performance, under normal conditions and during a financial crisis.

3.1 DEFINITION OF RISK AND RISK MANAGEMENT

First, it needs to be defined what risk exactly is and what role risk management could play here. According to the dictionary Van Dale, risk could be defined as 'danger of damage or loss'. Lhabitant & Tinguely (2001) define risk as the exposure to uncertainty, where uncertainty is defined as the possibility of occurrence of one or several events. This definition could be broadened by Kaplan & Garrick (1981), who argue that risk is not only uncertainty, but that the consequences this uncertainty could have, should also be taken into account.

Although these consequences could also be beneficial, it is more important for companies to take the possible negative outcomes into account. When these uncertainties become reality, the outcomes could harm the company. There are different sources of uncertainty and risk, which will be explained now.

In general, banks face two risk categories: financial and non-financial risk (Ai & Brockett, 2008). First, the financial risks are discussed, followed by a description of non-financial risk. According to McNeil, Frey & Embrechts (2005), market risk and credit risk are the most common financial risks at banks. Market risk is 'the risk of change in the value of a financial position due to a change in the value of the underlying components of which that position depends' (McNeil *et al.*, 2005, p. 3), like for example commodity prices and interest rates. Further, credit risk is 'the risk of not receiving the promised repayments on outstanding investments, because of default of the borrower' (McNeil *et al.*, 2005, p. 3). Another financial risks at banks are liquidity risk, which is caused by a lack of marketability of an investment, in order to prevent or minimize a loss. In general, these risks are managed using financial instruments, like derivatives.

Non-financial risk could also be further separated into hazard risk, operational risk and strategic risk (Ai & Brockett, 2008). Hazard risk are external risks, like for example natural disasters, theft and liability claims. These risks could best be managed by buying insurances. Operational risks are caused by failing of internal processes, people and systems. Strategic risks are directly related to the bank's overall strategy and includes among others reputation risk. These risks are difficult to insure or hedge, and should be minimized using qualitative information.

In order to prevent these risks to give negative outcomes, banks engage into risk management. The general purpose of risk management is to reduce the volatility of firm value (Nance, Smith, & Smithson, 1993) and to eliminate the lower-tail outcomes (Stulz, 1996). This means that it should reduce the expected costs of financial distress, but it should still enable companies to gain a competitive advantage in risk-bearing. There are two basic approaches to risk management, traditional risk management (TRM) and enterprise risk management (ERM). These approaches will be discussed in the next part, after discussing the overall benefits of risk management.

3.1.1 BENEFITS OF RISK MANAGEMENT

According to the modern portfolio theory, risk management is irrelevant for value, since shareholders can easily diversify and thereby decrease the risk they have (Markowitz, 1952). This means that for shareholders, risk management would destroy value. However, since shareholders are not the only stakeholders for a company, it could be beneficial for a company to use risk management. Another factor could be that markets are not as efficient as the modern portfolio theory assumes.

This latter part is discussed by Nance, Smith & Smithson (1993). They argue that because of tax regulations, lower expected costs of financial distress and the underinvestment problem, hedging can be beneficial for companies.

Hedging could be beneficial in convex tax regulations. In such regulations, a higher tax percentage is paid by firms with a higher profit. If hedging reduces the variability of the pre-tax firm value, then the expected corporate tax liability is reduced. This reduction comes from the fact that a lower percentage needs to be paid and there is more certainty about firm value. Therefore, also the expected post-tax value of the firm is increased, as long as the costs of the hedge are lower than the increase of value (Smith & Stulz, 1985).

The underinvestment problem exists when shareholders have incentives to forego a net positive value project. This could happen when the wealth that is created by that project, is going to the debt holders, who require a fixed payment every period. Therefore, wealth is being decreased or even destroyed, when the debt payments are higher than the wealth created. This

problem could be solved when companies use hedging to restrict the states in which the firm would default on bond payments. In that case, less wealth is being decreased by debt payments.

Furthermore, since hedging reduces the probability of financial distress by reducing the variance of earnings and firm value (Nance *et al.*, 1993), the expected costs of financial distress are also reduced. This is because financial distress could lead to bankruptcy, reorganizations or liquidation, which all cause direct legal costs. It is less likely that these costs occur when hedging is used.

Now that it is clear why risk management could be beneficial, two different approaches are discussed.

3.2 TRADITIONAL RISK MANAGEMENT AND ENTERPRISE RISK MANAGEMENT

Traditionally, risk management happened in a silo-based way, where each risk was hedged or insured separately. Also, it only focused on financial risks, such as credit, market and liquidity risks (McShane *et al.*, 2011). This kind of approach leads to inefficiencies when relations between risks are not seen. Although banks' main concern are the financial risks, it is still relevant for them to adopt enterprise risk management. This will be discussed later, after a short introduction to this risk management approach.

Enterprise risk management offers a solution to the problems traditional risk management faces. This approach handles risks in a coordinated way, in which risks are taken together in a portfolio, where the residual risk is hedged. This portfolio approach will decrease risk, when the modern portfolio theory is used. This theory assumes that a portfolio with different assets is able to absorb extreme directions. This means that it is assumed that when one assets moves in a negative direction, this will be absorbed by an assets which moves in a positive direction. This decreases the risk of a portfolio. It also increases efficiency, by only hedging the real risk. Another difference between traditional risk management and ERM is that ERM also focuses on operational and strategic risks.

Furthermore, since the different risks are aggregated into a portfolio, it is possible to see interdependencies between risks, which leads to a better comprehension of risk (Nocco & Stulz, 2006). Therefore, management is better able to objectively allocate resources because there is a higher risk-adjusted rate (Meulbroek, 2002), which enhances capital efficiency and return on equity (Liebenberg & Hoyt, 2003).

According to the Committee of the Sponsoring Organizations of the Treadway Commission (COSO), ERM could best be defined as follows (COSO, 2004, p. 2):

'Enterprise risk management is a process, effected by an entity's board of directors, management and other personnel, applied in strategy setting and across the enterprise, designed

to identify potential events that may affect the entity, and manage risk to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives'.

This framework is often used by companies and is used as a guideline for regulations, like the Dutch Corporate Governance Code (Code Tabaksblat) and the Code Banken, which was developed by the Dutch Banking Association. The purpose of this code was to regulate banks in terms of corporate governance, risk management, audit and remuneration policy (NVB, 2009). Therefore, this framework will be discussed now.

3.2.1 COSO ERM – INTEGRATED FRAMEWORK

To provide companies a guideline in how to implement ERM, COSO developed a framework, the Enterprise Risk Management – Integrated Framework in 2004. This framework is an extension of the initial framework of 1994 and is shown in Figure 3.1.

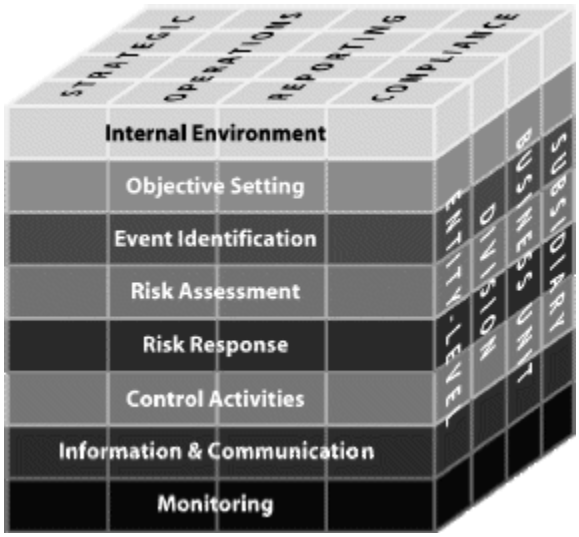

Figure 3.1: COSO ERM - Integrated Framework (COSO, 2004)

The ultimate goal of ERM is to help to achieve an organization's objectives (COSO, 2004). These objectives are listed at the top of the cube: strategic, operations, reporting and compliance. The strategic objectives should help the company to achieve its mission. These objectives should be achieved using resources effectively and efficiently, in order to enhance the company's value, which is shown by the operational objectives. Further, every company should have reliable reporting and comply with applicable laws and regulations, to also prove its value to the outside stakeholders. These four objectives are overlapping, which shows the holistic approach of risks by this framework. The four levels on the right-hand side of the cube show the levels in which ERM should be present. The eight ERM components, as are listed at the front of the cube, show what is needed to achieve these objectives.

As was argued before, the ultimate goal of ERM is to help achieve an organization's objectives. This is done by handling all the risks in a holistic approach. This offers opportunities

for companies to respond to their risks in alignment with their corporate strategy. Although banks face mainly financial risks, it could help them by integrating all these risks into one portfolio, instead of hedging each different class. This could help to solve possible inefficiencies in risk management.

3.3 ENTERPRISE RISK MANAGEMENT IMPLEMENTATION

There are several signals that show that companies are implementing ERM. Earlier research on ERM and firm performance use the appointment of a Chief Risk Officer (CRO) as an indicator that ERM is implemented (Liebenberg & Hoyt, 2003; 2011; Beasley *et al.*, 2008). They argue that a CRO is responsible for the management of all the risks and the oversight over these risks. A weakness of this measure is however, that the news of an appointment of a CRO might not be the initial appointment of a CRO. Further, an even greater weakness is that the appointment does not say anything about the extent to which ERM is implemented.

Further, the presence of a risk committee that oversees all the company's risk is a signal that a bank is engaged in ERM. This is acknowledged by Aebi *et al.* (2011), who argue that such a committee indicates a stronger risk management. These authors also argue that more information about a risk committee is needed to draw relevant conclusions.

In the recent years, three measures for ERM implementation in banks have been developed. These three measures, by Aebi *et al.* (2011), Ellul & Yerramili (2010), and Baxter *et al.* (2011) will be discussed now.

First, Baxter *et al.* (2011) developed an index for ERM quality at banks, to find which factors are related with a high S&P's ERM quality rating. Therefore, they use factors to define complexity, financial risk/resources and corporate governance, which are argued to have an effect on the ERM quality rating given by S&P's. However, it is not this research's purpose to find factors that cause ERM implementation, but factors that measure implementation. Therefore, this index is not usable.

Further, Ellul & Yerramili (2010) also defined a ERM implementation index for banks. This index is focused on the aspects of the organization structure of the risk management function. It is composed of factors concerning the position of the CRO, the experience of the supervisory board and the risk committee. An advantage of this measure is that it uses many different aspects of the risk management organization. A disadvantage is the payments of the CRO and the CEO. This is not always easy to find for Dutch banks, when the CRO is not in the executive board. What makes it even more disadvantageous, is that these measures show to be the most important components in the index. However, the parts that are applicable could still be used.

Finally, Aebi *et al.* (2011) decided to extend the ERM implementation measure by Ellul & Yerramili (2010), in order to measure the effect of corporate governance on risk management practices. These authors base their index on the best practices for risk management, defined by

Mongiardino & Plath (2010). They argue that each bank should have a dedicated board-level risk committee, of which a majority is independent, and that the CRO should be in the executive board. Further, they use the common recommendation to 'put risk high on the agenda' and the different sources that have give an indicator for that. These indicators are also used in measuring ERM implementation.

However, these authors do not compose an index out of the different variables. This makes it difficult to draw conclusions on the effects of the whole measure on firm performance. Right now, it is only possible to draw conclusions on the effect of a single measure. Also the collinearity between the different measures is not taken into account, which could also change the results. These disadvantages could be solved, when the different measures are put into an index in this research.

Since the measurements of Aebi *et al.* (2011) are derived from the index developed by Ellul & Yerramili, and all the information that is needed for the first measurements is readily available, it is decided to use the measurements of Aebi *et al.* (2011). In a later stadium from this research, it is shown how the different factors are formed into a single variable, to develop an ERM index.

Aebi *et al.* (2011) use ten different indicators for their risk management measure, which will be briefly discussed now. First, the presence of a CRO in the executive board, and the presence of a risk committee on the board level are taken into account. It is argued that the presence of these factors defines whether banks implemented ERM. As was stated before, a CRO is responsible for managing all the business risk and this should lead to a holistic approach. A risk committee on the board level is responsible to oversee all the risks, and this makes it possible to see interdependencies. Further, it is argued that board size, board independence and financial expertise have an influence on ERM implementation. Third, several characteristics of the risk committee are taken into account. These are the number of risk meetings, the number of directors and the independence of these directors. Finally, the reporting lines are taken into account. These consist of the reporting from the CRO to the supervisory board, and the direct reporting from the CRO to the CEO.

A more complete overview of the different variables and how they are measured, will be given in the part on variables, which starts at page 22.

3.4 ENTERPRISE RISK MANAGEMENT AND PERFORMANCE

In the next part, empirical results on ERM and firm performance and value are discussed, to give an hypothesis about the effect of ERM on bank performance outside a financial crisis. As discussed before, ERM can add value or enhance companies' performance.

Several authors have empirically tested this relation for financial companies. They used different proxies for ERM adoption and implementation, and firm performance and value. These researches will briefly be discussed, from which a hypothesis will be defined.

Based on the modern portfolio theory from Markowitz (1952), risk management is not valuable for shareholders. This is because shareholders can easily diversify their own risk, and therefore only the systematic risk is important. In that case, every risk management practice is a negative net present value project and should not be undertaken. This argument is agreed by Aebi *et al.* (2010), who argue that risk management could lower the risk, but that this is paid for with lower returns for shareholders.

Beasley *et al.* (2008) empirically investigated this argument. They related ERM implementation and share prices during the announcement period for both financial and non-financial firms. ERM implementation is measured as the appointment of a Chief Risk Officer (CRO), and the market reaction to it as the accumulative abnormal return. The authors only find an insignificant negative relation between the accumulative abnormal returns and the appointment of a CRO. Therefore, it could be concluded that the implementation of ERM is not valued by shareholders, which supports the argument of the modern portfolio theory.

Further, Pagach & Warr (2010) measured the effect of ERM implementation on different firm factors which are argued to be affected by ERM implementation. These factors are risk, financial, asset and market characteristics of the firm. It is argued that ERM implementation, measured as the appointment of a CRO, should lower the risk. For financial characteristics, leverage, cash availability and profitability are taken into account, whereas asset characteristics should tell something about the firm's assets are likely to be impaired in financial distress. Finally, equity markets should react on a firm's decrease in expected costs of financial distress, when it has implemented ERM. The authors found no significant relationship for these variables, which leads to the conclusion that ERM implementation has no influence on performance, for both non-financial and financial firms.

However, there are findings that suggest that ERM implementation enhances firm performance of financial companies in general. An example is the paper by Liebenberg & Hoyt (2011), who investigate the relation between ERM adoption and firm value at insurance companies. These authors also use CRO appointment as indicator for ERM implementation, but use firm value as dependent variable. Firm value is measured as Tobin's Q. This measure defines value as the ratio between market and book value of equity and liabilities. Their results show that ERM significantly enhances firm value in general, however this effect is rather small. The authors also find a difference in Tobin's Q for firms that have implemented ERM and those who have not, and also this relationship is significant. This indicates that ERM does enhance firm value in general.

When using another measure for ERM implementation, namely the Standard & Poor's risk management rating, as was done by McShane, Nair & Rustambekov (2011), a more accurate answer could be given to the question whether ERM leads to better firm value for banks. The S&P's rating does not only indicate if ERM is adopted, but also to what extent. It could therefore be derived if more sophisticated ERM leads to even higher firm value. In this research, firm value is measured by Tobin's Q. The results show that ERM is significantly positively related to firm value, controlled for other factors. There is also a significant relationship between poor ERM quality and firm value. However, there is no significant relations between high ERM quality and firm value, which suggests that ERM is valued only up until a certain level of sophistication.

Baxter, Bedard, Hoitash & Yezegel (2011) further extend this relation by relating high quality ERM programs, firm performance and market reactions towards revisions of ERM quality by the rating agency. They find, contradicting to McShane *et al.* (2011) that high ERM program quality is positively associated with firm performance and value. For value, they also use Tobin's Q, whereas performance is measured by return on assets (ROA). These authors also examine whether ERM quality ratings lead to market reactions. They measure market reactions as accumulative average abnormal returns, and only find partial support. This suggests that markets do value ERM quality, but that this is already incorporated in the share price. However, market reactions are positively associated with ERM quality rating revisions.

It could be argued that the adoption of ERM is valuable for banks, since it enhances performance (Baxter *et al.*, 2011) and increases value (Liebenberg & Hoyt, 2011; McShane *et al.*, 2011). However, this depends on the quality of the ERM programs and it is suggested that ERM is only valuable up until a certain level (McShane *et al.*, 2011). Based on these results, the following hypotheses could be developed:

H1a. *Under normal conditions, ERM implementation increases firm performance.*

H1b. *ERM implementation only increases firm performance under normal conditions, up until a certain extent.*

3.5 ENTERPRISE RISK MANAGEMENT AND PERFORMANCE DURING A FINANCIAL CRISIS

The purpose of more regulation on risk management is to help banks survive a financial crisis of the size that emerged in 2007. Therefore, it could be assumed that banks that have higher ERM quality programs perform better during a financial crisis, than banks that have lower ERM quality programs, because ERM should lower the risk.

Ellul & Yerramilli (2010) tested whether the latter is the case. Although this research is not focused on ERM, this research and its outcomes are still applicable. This is because the authors focus on corporate governance, which is also a part of ERM. They found that risk management

lowers enterprise risk, which is also assumed by regulators. However, risk management also claims to be valuable for stakeholders. Ellul & Yerramilli (2010) do not find a relation between lower enterprise risk and stock market valuations.

However, according to the results of Baxter *et al.* (2008), after the financial crisis, the stock market started to value ERM implementation. They did not find significant higher market returns for high ERM quality programs prior and during the crisis. Only after the crisis, it shows that ERM quality is positively related to market returns. This suggests that high ERM quality programs enabled firms to respond to the crisis, which leads to easier regain of market value afterwards.

Since ERM should not only deliver value to shareholders, also value and performance in general need to be discussed, so that the added value for other stakeholders could be described. Aebi *et al.* (2011), Beltratti & Stulz (2010) and Minton *et al.*, (2010) focus on the effect of risk management structure, when measuring the effect on bank performance during a financial crisis. The results they find are mixed. For example, Beltratti & Stulz (2010) focus on excessive risk taking and share-holder friendliness of the bank's board. They did not find any significant results. Minton *et al.* (2010) focus on board independence and financial expertise, since these factors are usually mentioned when improvements of risk regulations are discussed. It is argued that independent board members are less likely to engage in excessive risk taking, since they do not have incentives to do so. Minton *et al.* (2010) find that board independence does not influence stock performance during the crisis. Board independence was also measured by Aebi *et al.* (2011), and they find a significant negative association with performance, which is different from Minton *et al.* (2010). Minton *et al.* (2010) found a significant negative association between financial expertise and firm value, which suggests that financial experts tend to take more risk which leads to lower firm value.

A research that completely focuses on ERM quality and bank performance during a financial crisis, is the article of McShane *et al.* (2011). They focus their research on 2008, the year in which the credit crisis was at its highest. This is supported by other researches, who also use 2007 and 2008 as crisis period (Beltratti & Stulz, 2010; Fahlenbrach & Stulz, 2011; Aebi, Sabato & Schmid, 2011). As mentioned before, McShane *et al.* (2011) find that high quality ERM is associated with better performance and value. This provides evidence that firms that adopt high quality ERM perform better during a financial crisis.

Since it was measured that risk management lowers risk (Ellul & Yerramilli, 2010), and that it leads to better performance (McShane *et al.* (2011). According to these authors, it could be argued that it will be valuable for stakeholders, if the company has implemented ERM during a financial crisis. Therefore, the following hypothesis could be defined:

H2a. *ERM implementation improves firm performance during a financial crisis.*

H2b. *ERM implementation only increases firm performance during a financial crisis, up until a certain extent.*

Since also other variables could affect firm performance, these factors are discussed in the next part.

3.6 FACTORS AFFECTING FIRM PERFORMANCE

Besides ERM implementation, firm performance could be affected by several other variables, the so called control variables. These factors need to be taken into account in this research, because it is likely that they also explain differences in firm performance. Since this research will focus on banks in one country, industry-specific and country-specific determinants of firm performance do not have to be taken into account, since they are the same for all the banks in this sample. The firm-specific control variables, who are thought to be different for the sample, will be discussed now.

3.6.1 SIZE AND EFFICIENCY

In 1959, Baumol developed a hypothesis about the effect of firm size on profitability. He argues that large firms have all the options like small firms, but have certain investment possibilities because of their scale. These economies of scale increase the earnings per dollar invested. This argument is tested a lot of times (Weis & Hall, 1967; Marcus, 1969; Staikouras *et al.*, 2007; McShane *et al.*, 2011), but in general, no significant relationship could be found. For banks, some evidence for Baumol's hypothesis was found by Goddard, Molyneux & Wilson (2004). These authors argue that this effect is caused by more efficiency at large banks, and that not the size itself creates better performance.

This is also found by Athanasoglou, Brissimis & Delis (2008), who focus on determinants of banking profitability, and they find that efficiency is an important factor. In that same research, it was found that size is not significantly related to firm performance. These authors used operating expenses to total assets as efficiency measure, which gives a negative relationship. This means that when the ratio goes up, efficiency goes down and so should performance.

3.6.2 LEVERAGE

Another factor that is found significantly affecting performance positively, is leverage (Athanasoglou *et al.*, 2008). Different explanations could be given for this factor. On the one hand, leverage could lead to a decrease in the agency costs, which means that managers cannot invest in sub-optimal projects. This argument is supported by Hoyt & Liebenberg (2011) and Staikouras *et al.* (2007), and is tested by Berger & Bonaccorsi di Patti (2006), who found empirical support for this argument.

Although more leverage could also lead to higher costs of financial distress (Staikouras *et al.*, 2007; Hoyt & Liebenberg, 2011), it was also found that those firms respond faster to financial distress (Jensen, 1989). This could be explained by the fact that there is more at risk at higher leveraged firms. Therefore, it could be concluded that higher leveraged firms might have higher costs of financial distress, but that these companies are able to manage these risks better than lower leveraged firms.

This empirical evidence means that it could be expected that higher leveraged firms perform better, both outside and during a financial crisis.

3.6.3 DIVERSIFICATION

Diversification takes place when the firm expands to make and sell products or a product line having no market interaction with each of the firm's other products (Rumelt, 1982). According to Liebenberg & Hoyt (2011), diversification could lead to higher agency costs when conflicts are not resolved, and also find empirical evidence for this argument. They found that diversification is negatively related to firm value.

The contrary argument is that diversification will lead to higher performance, but only when it is related to the core business. This argument is extensively empirically supported (Palepu, 1985; Grant *et al.*, 1988; Palich *et al.*, 2000; Li & Greenwood, 2004).

One way to measure diversification, is to measure the functional diversification (Baele, De Jonghe, & Vennet, 2007). In this measure, the non-interest incomes as a part of the total operating income are used to indicate diversification. These authors argue that a bank's main source of income should be interest, since these institutions should offer possibilities to save and borrow. Nowadays, banks also engage in other functions, like securitization and insurances, which provide other types of income, like provisions.

For this measure, a negative relationship is expected, which means that if a bank has a large part of revenues from non-interest, it is non-related diversifying from its core business, which is negatively related to firm performance.

3.6.4 BANK SPECIFIC VARIABLES

TIER-1 CAPITAL RATIO

Aebi *et al.* (2011) argue that tier-1 capital ratio is a core measure of bank's financial strength, from a regulator's point of view. Tier-1 capital is defined as 'going-concern capital', and exists of common equity and additional capital (Bank for International Settlements, 2011). This ratio measures the capital buffer and therefore, banks with a higher Tier-1 capital ratio would suffer less from the debt shortage problem that develops during a financial crisis, and would be able to respond more flexible to adverse shocks. The debt shortage problem exists when it is difficult for

a company, in this case banks, to extract additional money from the market. In that case, tier 1 capital should offer a solution.

CREDIT QUALITY

Besides tier-1 capital, credit quality also provides an indicator for a bank's ability to survive a crisis. When the quality is high, it is less likely that the credit will decrease in value. This is also argued and empirically tested by Athansoglou *et al.* (2008), who find that there is a significant negative relationship, and further extended Dietrich & Wanzenried (2011), who find no significant relation before the crisis, but this turns into significantly negative during the crisis, which implies that credit quality especially becomes important in a crisis.

Since other possible factors could be ruled out or are also used to explain differences in firm performance, a more precise answer could be given to what extent ERM implementation affects firm performance. Otherwise, it could be given a wrong explanatory power.

In this theoretical framework, a theoretical basis is given for this research. In general, it could be expected that a positive relation exists between ERM implementation and firm performance, under normal conditions and during a financial crisis. These expectations are shown in a conceptual model, which is discussed in the next part.

4. CONCEPTUAL MODEL

In this conceptual model, the relations defined in the theoretical framework will be shown. Based on this conceptual model, the research method will be developed and the data collection will be discussed.

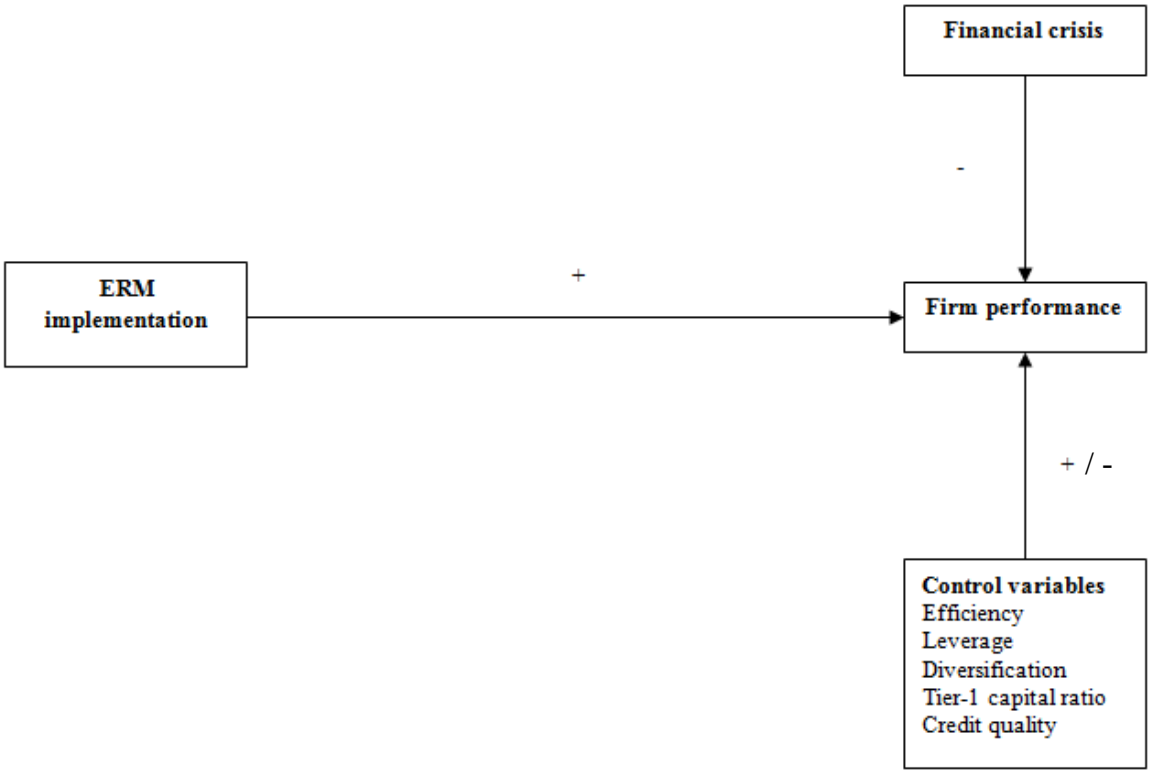

Figure 4.1: Conceptual model

From this conceptual model, the following equation (1) could be developed.

(1) Firm performance$_i$ =

$$\beta_1 ERM_{i\ lagged} + \beta_2 ERM_i^2{}_{lagged} + \beta_3 EFFICIENCY_i + \beta_4 LEVERAGE_i + \beta_5 DIVERSIFICATION_i + \beta_6 TIER\text{-}1\ CAPITAL\ RATIO_i + \beta_7 CREDIT\ QUALITY_i + \beta_8 CRISIS_{dummy} + \beta_9 AFTERCRISIS_{dummy} + \beta_{10} (ERM_i * CRISIS_{dummy}) + \beta_{11} (ERM_i^2 * CRISIS_{dummy}) + \beta_{12} (ERM_i * AFTERCRISIS_{dummy}) + \beta_{13} (ERM_i^2 * AFTERCRISIS_{dummy}) * \varepsilon_i$$

From the previous parts, estimations about the forms of β could be given. Since it is argued that ERM could increase capital efficiency, return on equity and return on assets, it is expected that β_1 and β_2 are positive. In this model, the lagged measurements are used. This is to improve the conclusions about causality. When measuring cause and effect at the same moment, causality is more difficult to find.

Efficiency is likely to have a positive effect on banking performance, and therefore β_3 is expected to be positive. For leverage, the expectation is also positive, which gives a positive β_4. This expectation also goes for β_5 for diversification. Further, tier-1 capital ratio is seen as a buffer against financial distress and this leads to the expectation that β_6 is positive. Credit quality is measured as the ratio of bad loans to total loans. This means that if this ratio goes up, credit quality decreases. Therefore, β_7 is expected to have a negative influence on firm performance.

The crisis is expected to have a negative influence on performance, which leads to a negative β_8. After the crisis, performance is expected to recover, which leads to a positive expectation for β_9. As was discussed before, ERM implementation is expected to have a positive effect on performance during the financial crisis. This is measured in β_{10} and β_{11}, and is therefore expected to be positive. After the crisis, firms that have implemented ERM, are thought to recover faster, and the effect for β_{12} and β_{13} will therefore be positive.

Before these expectations could be tested, several steps have to be taken. First, a methodological classification has to be chosen, from which the different methodological steps could be derived. Further, the different variables have to be operationalized and discussed. This will be discussed in the next part.

5. METHODOLOGY

In this part, it is discussed how the conceptual model will be tested. This will start with a choice for a methodological classification. Based on that classification, the empirical steps could be described. Furthermore, the different steps will be elaborated, so that at the end of this part, it is clear what and how will be measured to give an answer to the research question.

5.1 METHODOLOGICAL CLASSIFICATION

For measuring the effect of ERM implementation on firm performance, a cross-sectional research method is most suitable. Using such a research method, the relation between different variables is tested over time, and could be controlled for other variables.

In a cross-sectional research, the causal relationship between two variables is measured. Therefore, the relationship first needs to be defined. In this case, this is done by developing the hypotheses in the literature review, which argue that ERM implementation has a positive but nonlinear relationship with firm performance under normal conditions. In a financial crisis, it is argued that ERM implementation will also have a positive relationship with performance. As could be seen, these hypotheses also show the form of the relationship and the economic conditions under which the relationship holds. The relation between ERM implementation and firm performance is also being controlled for several control variables, as was discussed before.

5.2 DESCRIPTION OF WORK

Now the conceptual framework and the methodological classification are discussed, the next step is to define what work needs to be done to answer the research question. In overall, it is assumed that ERM implementation has a positive effect on firm performance. However, also other factors have an effect on firm performance, which are defined as control variables and the financial crisis. The predictions made in the literature review and the conceptual model, lead to the following steps.

First, the variables need to be operationalized, so that they can be measured. These measurements need to be done in a certain time period, which will then be described, followed by the sample selection method and the requirements used. Then, the collection of the data is described, and a short description is given from each data source. In the methodology part, the different methods that are used to relate the different measurements, are discussed. It is also shown how the hypotheses will be tested and what criteria need to be met to accept or reject a hypothesis. Finally, the validity of the results needs to be discussed, in order to draw relevant conclusions on this research and its results.

5.2.1 VARIABLES

First, the different variables need to be defined and operationalized. This will be done in the next part. A complete overview of these measures could be found in Appendix I: Overview of measurements.

This part will start by discussing the dependent variable, firm performance. Then the independent variable is discussed, which is ERM implementation. Finally, the different control variables are operationalized.

DEPENDENT VARIABLE: FIRM PERFORMANCE

Before firm performance can be measured, it needs to be defined what performance is. According to the Business Dictionary, performance is 'the accomplishment of a given task measured against preset known standards of accuracy, completeness, costs, and speed'. This could be measured in different ways, like for example shareholder value, Tobin's Q and return on assets.

Since not all banks in our sample, which will be discussed later, are stock-listed, it is not possible to use shareholder value as performance measure. Therefore, also Tobin's Q is not applicable, since that also takes into account the market value of equity. This is only known for stock-listed companies. This leaves this research with the accountancy-based measures, which can be drawn from the financial statements.

It was argued that ERM could affect firm performance in terms of capital efficiency and return on equity (Liebenberg & Hoyt, 2003). However, according to Bonin, Hasan & Wachtel (2003), return on equity is non-comparable for banks, because it is sensitive for writing off bad loans. This is also measured by credit quality, which is used as a control variable in this research. Therefore, these factors should be correlated and the sensitivity should be shown. According to the IMF (2002), an analysis of ROE omits the greater risks associated with high leverage. Since leverage is used as a control variable for performance, these risks are incorporated into the model.

Therefore, return on assets (ROA) and return on equity (ROE) are used to determine firm performance. This is in accordance with among others Bonin *et al.* (2003), Aebi *et al.* (2011) and Baxter *et al.* (2011). From the latter two, the measures for ROA are also used in this research. Aebi *et al.* (2011) also defined a measure for ROE, which is shown in Appendix I: Overview of measurements.

This variable is expected to be influenced by ERM implementation, whereas other variables also influence this. First, the ERM implementation variable is now shown, followed by the control variables.

INDEPENDENT VARIABLE: ERM IMPLEMENTATION

As was discussed before, different authors developed a measure for risk management implementation at banks. The measures used by Aebi *et al.* (2011) are used to develop the ERM index in this research. This is based on the fact that they have extended the measure from Ellul & Yerramili (2010) and build upon the best practices developed by Mongiardino & Plath (2010). Originally, there is no index developed by Aebi *et al.* (2011), and therefore, this needs to be done

later, using a principal component analysis. This analysis is more fully described in part 5.3.1, on page 27. This analysis makes it possible to weigh the different variables.

In the next part, the different measures are more fully described.

MEASUREMENT OF ERM IMPLEMENTATION INDICATORS

All indicators for ERM implementation are measured at the supervisory board, unless otherwise stated. To clarify the distinction between the supervisory board and the executive board, a sample of an organization chart is given in Appendix II: . In that figure, it is shown that the supervisory board is at the top of the organization chart. This board has the final say in the company and monitors the executive board. This board is shown with CEO, CFO and CRO. The reason that CRO is in parantheses, is because this shows the possible places a CRO could have. In the figure, also the different indicators are shown.

When a bank has a CRO in its executive board, the dummy variable CROBOARD will be set to 1. When there is a risk committee on the board level, RISKCOMMITTEE will be set to 1. For this research, it does not matter whether the risk committee is called Risk Committee or Audit and Risk Committee. This is derived from Aebi *et al.* (2011). Further, for board size, the natural logarithm is used. To specify the board independence, the percentage of outside directors on the supervisory board is measured. A director is seen as independent when it has no relation with the company except the board seat. Also for the financial expertise, a percentage is used. A director is considered financial experienced when it has experience (present or past) as executive in a bank or insurance company. The number of risk meetings and risk directors are taken from the annual report, without changes. Risk committee independence is also defined as a percentage. When the CRO reports directly to the supervisory board, or to the CEO, these dummy variables will be set to 1.

The different measures for ERM implementation will be found in the annual reports. However, banks were not obliged to mention their risk management process until 'Basel II' was implemented into Dutch regulations, in 2008. Besides the capital requirements, this guideline requires a transparent disclosure of the bank's risk management. This means that in the years before that, banks could choose to omit their risk management practices in their annual report.

In order to solve this problem, it is assumed that when a bank does not provide information about the different ERM measures that are used in this research, this measure does not exist. This is based on the argument of Standard & Poor's, who argue that companies with a strong risk management culture will have a very transparent risk management process within the company and with other interested parties through their public communications (Standard & Poor's, 2007).

Since the presence of a risk committee is a condition for the measures for risk meetings, risk directors and independency, it is important to mention what happens if there is no risk

committee. In that case, the research of Aebi *et al.* (2011) is followed. They set these measures to 0, if the measure for risk committee is also 0. In that case, there are no missing values.

CONTROL VARIABLES

The relation between ERM implementation and firm performance will be controlled for by several other factors, who are believed to also affect firm performance. As discussed before, these variables are efficiency, leverage, diversification, tier-1 capital ratio and credit quality. The measures for these variables are now being discussed.

EFFICIENCY

As was discussed before, Athanasoglou *et al.* (2008) use operating expenses management as an indicator for banking efficiency. This measure is also used in this research and could be defined as the total operating expenses over total assets. Operating costs could be defined as the costs that incur directly from business operations, like personnel costs.

LEVERAGE

McShane *et al.* and Staikouras *et al.* differ in their measure for leverage. They both use the same variables, assets and equity, but there is a small difference. McShane *et al.* use the return on those variables as the measure. However, since return on assets and equity are also the performance measure, it is not possible to use the same measure in one of the other variables. Therefore, a standard measure for leverage is used, which is also defined by Leach & Melicher (2012).

DIVERSIFICATION

According to Baele, De Jonghe & Vennet (2007), a bank's functional diversification could best be measured by the ratio of non-interest income to total operating income. This information could be drawn from annual reports. When the non-interest income or the total income is negative, this ratio will turn into negative. A percentage above 100% could occur when the non-interest income is higher than the total income.

TIER-1 CAPITAL RATIO

Aebi *et al.* (2011) define tier-1 capital ratio as the ratio of tier-1 capital to total risk-weighted assets. This measure is also used by the Bank of International Settlements (BIS) and most of the regulatory supervisors. This measure is given in annual reports.

CREDIT QUALITY

Athanasoglou *et al.* (2008) and Dietrich & Wanzenried (2011) define credit quality as the ratio of loan loss provisions to the total loans. This is given in the notes to the financial statements. Since the loan loss provisions should be as low as possible to enhance performance, the expected sign is negative.

FINANCIAL CRISIS

In this research, a distinction is made between three periods: before, during and after the financial crisis. The years 2005 and 2006 are defined as the period before the crisis, and 2007 and 2008 are the crisis-years. Finally, 2009 en 2010 are the after-crisis period. In the total sample, these different periods are measured as subsamples. To define the variables for the measurement periods, the average is computed. This means that for each period, each bank has one measure for each variable.

5.2.2 MEASUREMENT PERIOD

Further, the measurement period needs to be defined, to bound this research. Following Beltratti & Stulz (2010), Fahlenbrach & Stulz (2011) and Aebi, Sabato & Schmid (2011), the crisis period is defined to last from July 1, 2007, to the ending of 2008. However, data is only available on a yearly basis, and therefore the whole of 2007 will be defined as 'financial crisis'.

Before a conclusion can be drawn about the effect of ERM implementation on performance, it needs to be defined whether the performance is actually different for different extents of implementation and outside a financial crisis. Therefore, also measurements need to take place outside a financial crisis. It could be argued that ERM implementation during the years prior to the crisis could explain performance during the crisis and that there could be differences in recovery from the financial crisis.

This leads to a measurement period from 2005-2010, which means that there are two prior-crisis years, two crisis years and two post-crisis years. By also adding the period after the crisis, it could be concluded whether ERM implementation leads to faster recovery after the crisis. This is also an indicator of performance enhancement by ERM implementation.

Observations during these periods are then averaged and this will lead to one bank measure for each period. This means that the observations during 2005 and 2006 will averaged, and together, these will form the pre-crisis period. The same will happen with the observations during the other periods.

5.2.3 SAMPLE SELECTION

Third, a sample needs to be selected. As was mentioned before, this research will focus on Dutch banks. To select the sample, it is observed which companies have got a banking license and are considered 'banks' by the Financial Supervision Act in the Netherlands. From these banks, only the banks that are under direct supervision of the Dutch National Bank (DNB) are taken into account.

This led to an original sample of 64 banks, which are considered Dutch banks. However, some of these banks do not have their own annual report, since they are part of another bank. Therefore, these banks could not be taken into account. These requirements lead to a sample of 38 banks, for which all the information needed is available. For the full sample, see Appendix III: Sample.

5.2.4 DATA COLLECTION

Now that the different variables are explained, and the measurement period is determined and the sample is selected, the data collection can start. During the data collection, the different variables are measured for the sample during the measurement period. This is done with use of several sources. Most of the information that is needed for the measurements could be drawn from annual reports that are provided by the banks. These annual reports could be found at the company website, company.info, and the Company Profiling and Selection Tool (CPST), provided by KPMG. The CPST tool provides further information about annual reports. Further, for information about the board structure, the BoardEx database is used.

Based on the measurement specifications and the data collection, the hypotheses will be tested using the sample. This will be done by using Pearson's correlation, followed by a multivariate regression (McShane *et al.*, 2011). These methods will be explained in the next part.

5.3 METHODOLOGY

In this part, the different methods that are used to measure the relation between ERM implementation and firm performance are discussed. First, the ERM index needs to be developed, since it is a composite variable. Then, descriptive statistics need to be shown, which will be briefly discussed. These descriptive statistics will give an overview of the sample. When this is completed, the different measures could be related to each other. This will be done using Pearson's correlation, followed by a multivariate regression. This is based on McShane *et al.* (2011). From this multivariate regression, the hypotheses could be tested and conclusions could be drawn. Finally, before final conclusions could be drawn about the research questions, the validity needs to be tested and discussed. How this is done, will be discussed in the final part of this section.

5.3.1 ERM INDEX

The ERM index is a so-called composite variable, which is a variable that is build up from different measures. To be able to compute such a composite variable, the method of Ellul & Yerramili (2010) is used. These authors use a principal component analysis to determine the ERM index. This analysis is done with use of SPSS, a statistical program.

However, first the measures need to be standardized. This is because at this moment, these outcomes cannot be compared because of the difference in scales. For example, CROBOARD is a dummy variable, with 0 and 1 as the only possible scores. BOARDINDEP is a percentage, which means that the scores vary between 0 and 1. Further, BOARDSIZE is a natural logarithm, which could have different scores, and even higher than 1. This means that the different measurements need to be standardized in order to be compared. By transforming all the observations on ERM implementation into standardized z-scores, every measure is on the same scale and this makes it possible to compare the different measures. This enables a principal component analysis, which will be discussed now.

Following Ellul & Yerramili (2010), a principal component analysis will be conducted. In SPSS, several tables are shown when conducting a principal component analysis. First, a rotated component matrix is shown. This table shows the correlation between the variables and the component. This table shows the importance of each variable for that component. The component score will then be computed by taking the weightings of the relevant variables, and multiply these by the observations.

To simplify interpretation, a rotation technique is used. Since the component which explains most of the variation will be used to develop the ERM index, this component should be independent of the other components. Therefore, the varimax rotation technique is appropriate.

5.3.2 DESCRIPTIVE STATISTICS

To give an overview of the sample, descriptive statistics will be given. First, the total number of bank observations in each period will be given, and the total number of observations in the sample. Then, the overall average and standard deviations of the different measures will be given for the entire period. Further, these numbers will also be given for each measurement period.

5.3.3 CORRELATION MATRIX

A first step in measuring the relation between ERM implementation and firm performance, is to determine the correlation between these two variables. Based on McShane *et al.* (2011), Pearson's correlation coefficient will be used in this research, which is used for normally distributed samples.

The correlation measures to what extent there is a relationship between two variables, which in this case will be ERM implementation and firm performance, and firm performance and the control variables. Also the correlations between the control variables will be measured, to count for multicollinearity, which could affect the conclusions about the effects of those measures and variables. Furthermore, since some of the control variables could also affect ERM implementation (Liebenberg & Hoyt, 2003; 2011), the control variables also need to be related to the ERM index.

Since correlations do not tell anything about causality and cannot tell whether the relation is non-linear, another test should be done to measure this.

5.3.4 MULTIVARIATE REGRESSION

Following McShane *et al.* (2011), a multivariate regression is used to determine the causality. A regression describes the dependency of the dependent variable, in this case firm performance, to the independent variable, ERM implementation (Moore & McCabe, 2008). In this research, we use more variables to explain firm performance, and therefore, a multivariate regression is needed.

This regression will take place for the three measurement periods, as was described previously. In that case, the relation between ERM implementation, firm performance and the different control variables could be defined for every period, and a answer could be given to the research questions. Following McShane *et al.* (2011), who also measured the nonlinear effect of ERM on performance, both the original measure and the squared term measure will be used in the model.

This multivariate regression will be conducted using SPSS. The regression analysis will give the β as defined in the previous section. These β show to what extent variable *i* has an influence at firm performance. When the β is high, the variable has more impact on firm performance than when the β is low. Also the form of β is important; when it is positive, performance enhances with the increase of that variable and vice versa. However, when β is negative, performance decreases with the increase of that variable.

HYPOTHESES TESTING

In statistics, two types of hypotheses are developed. First, a null hypothesis is developed, in which the effect of the independent variable on the dependent variable is stated 0. In this case, this would mean that the null hypothesis would be that ERM implementation would not affect firm performance. Then, as alternative hypothesis, it is argued that the effect of the independent variable and the dependent variable is not 0. In this research, this alternative hypothesis is defined as an effect that is larger than 0, which means that ERM implementation is expected to have a positive effect on firm performance.

When testing these hypotheses, the null hypothesis is being supported, until it is significantly rejected (Moore & McCabe, 2005). This means that until the alternative hypothesis could be supported, the null hypothesis cannot be rejected. For this research, this means that the hypotheses are only supported, when there is significant evidence for that. In the case that the results are not significant, the null hypothesis is supported. For this research, this means that if there is no significant evidence for a positive effect of ERM implementation on firm performance, the null hypothesis is supported that it does not have an effect.

With the results of the regression models, the hypotheses could be tested. The test used to determine whether the hypotheses are accepted or not, is called the t-test. In such a test, it is determined whether the sample mean is significantly different from the hypothesized mean, in this case > 0, based on a certain confidence level. A confidence level gives an indication about how much of the total population will fall into that sample. When a confidence interval of 5% is used, 95% of all observations that are done within that population will find the same conclusion.

In this case, a confidence interval of 5% is used, based on other researches (e.g. Liebenberg & Hoyt, 2003; McShane *et al.*, 2011). In this case, the first hypothesis in this research will be accepted when the β for ERM and performance is > 0, within the confidence interval of 5%.

Further, the hypothesis for the nonlinearity will be accepted when the β for ERM^2 and performance is > 0, within the confidence interval of 5%. The same goes for the influence of the financial crisis on ERM and performance, which is accepted when β is > 0 between ERM and performance, when the financial crisis dummy counts 1. This hypothesis testing will be done using SPSS.

5.3.5 VALIDITY

Before a final conclusion could be drawn about the results from the correlations and the regressions, the validity must be tested. According to Shadish, Cook & Campbell (2002, p. 34), something is valid when there is sufficient evidence that supports the proposition. There are three types of validity, which will briefly be discussed now. After the research, a more elaborated discussion of this research's validity will be given.

R^2

The R^2 measures whether the independent variable and the control variables count for variations in the dependent variable. With this test, it could be concluded whether the model is able to explain differences in performance. Further, when the R^2 is high enough, the conclusions drawn from this model and its results are more reliable.

NORMALITY OF ERROR TERM

In the conceptual model, an error term is taken into account. This error term is shown by ε_i. This error term measures all other factors that influence the dependent variable, other than the independent variables used in the model. An assumption of a regression model, is that the residuals are independent and normally distributed with a mean of 0. When this is not the case, the estimates of the model are not valid.

The normality of the residuals could be tested using a normal p-plot. This plots the observed cumulative probability against the expected cumulative probability. In the case the residuals are normal, this expected and observed cumulative probability should be equal to each other. When this is not the case, the residuals are not normally distributed.

Further, the normality of the residuals could also be numerically tested. In SPSS, the Shapiro-Wilk and the Kolmogorov-Smirnov tests for normality could be used. When the sample is larger than 50, the Shapiro-Wilk test is less appropriate and the Kolmogorov-Smirnov test needs to be used. Since this research consists of 38 firms that are observed during 6 years, this sample is larger than 50. Therefore, the Kolmogorov-Smirnov test is most appropriate. When the value for this test is significant at 0.05, this provides good evidence that the dependent variable is not normally distributed.

In Appendix IV: Research design, an overview of the description of work is given. In the next part, the results of the data collection will be discussed. This will be followed by an analysis of these results, in which the hypotheses will be tested.

6. RESULTS

In this part, the results of the data collection will be given. This will start with the development of the ERM index, and the descriptive statistics. Further, a correlation matrix will be given, in order to give some information about the different relations between the variables.

6.1 ERM INDEX

Since the ERM index is composed out of different measures, it is needed to develop this index before the sample could be described or analyzed. As was discussed before, this is done using a principal component analysis (PCA) in SPSS. This has several outputs.

First, descriptive statistics are shown for each variable taken into account the PCA. These descriptives are shown in Appendix V: Initial principal component analysis. In order to be able to explain some variance in the data, the standard deviation should high. When the standard deviation is small, this means that there are little differences among the observations. When this is the case, it could be that that variable should be removed, in order to explain more variance in the data.

From Table A.2, it could be found that for FINBACK, the standard deviation is very small, comparing this to the mean. The mean of this indicator is 0,77, with a standard deviation of only 0,22. This means that all 106 observations are very close to the mean. This clustering could then lead to a small explanation of total variance for that variable.

Before the interpretation of the PCA could start, the Kaiser-Meyer-Olkin (KMO) measure for sampling adequacy should be interpreted. This test measures whether the variables used in the principal component analysis have enough in common, to find relevant components. Values could vary from 0 to 1. In the initial test, a value of 0,769 is found. This is sufficient, and the test will continue.

Further, a table 'total variance explained' is shown in Table 6.1 below. On the left, the total components are shown. In this case, this is 10. This side of the table shows the eigenvalues, the percentage variance explained and the cumulative percentage explained. As could be seen, in total this is 100%, which it should be. This percentage is highlighted in the table.

In the right-hand side of the table, the rotation sums of squared loadings are shown. These are the eigenvalues after rotation, which simplifies interpretation, and three principal components are found. Together, these components explain 74,22% of total variance in the data. This is less than Ellul & Yerramili (2010) found in their PCA. These authors find a first principal component, which already explains 88% of the variance in the data. However, this is because these authors only use five indicators to measure ERM. When using less indicators, it is more likely to find principal components who explain a larger part of the variance.

Explained variance PCA, SPSS

Component	Initial eigenvalues			Rotation sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	4,34	43,42	43,42	3,55	35,48	35,48
2	1,76	17,60	61,03	2,43	24,30	59,78
3	1,16	11,56	72,59	1,28	12,81	72,59
4	,83	8,28	80,86			
5	,73	7,31	88,17			
6	,50	5,02	93,19			
7	,25	2,54	95,73			
8	,23	2,31	98,03			
9	,15	1,50	99,54			
10	,05	,46	**100,00**			

Table 6.1: Explained variance, SPSS

Further, a scree plot is presented, which could be seen in Figure A.3 in Appendix VI: Scree plot. In a scree plot, all the different components and their eigenvalues are plotted in descending order. This makes that the plot has a steep line, followed by an almost horizontal line. The point at which this reversal takes place, the number of components that should be taken into account is shown. In this case, this should be two.

Although these results are contradicting, this does not influence this research. This could be explained by the fact that the third component has an eigenvalue just above 1. Further, it shows in the rotated component matrix that the third component only has two variables loaded on to it. This rotated component matrix is also shown in Appendix V: Initial principal component analysis. For a component to be relevant, this should be minimal 3. Therefore, this leads to the conclusion that there are only two relevant principal components.

Therefore, the PCA is conducted again, and only two principle components are conducted. This leads to a change in Table 6.1. The two principle components explain more of the variance now. For the first principal component, this becomes 37,13% and for the second one, this becomes 23,89%. Together, these principle components explain 61,02% of total variance in the data. This principle component analysis will now continue with the outputs for this second PCA.

After the table with the total explained variance, SPSS shows the rotated component matrix, which shows the correlations between the different variables and the component. When these correlations are higher than 0,30, this is considered as a sufficient loading and this means that the variable will be taken into account in that component. In this table, the scores above 0,30 are highlighted. The rotated component matrix is shown in Table 6.2 below. From this table, it could be seen which variables are correlating with that component and are taking in to account for the components.

Rotated component matrix

	Component 1	Component 2
CROBOARD	,356	**,821**
RISKCOMMITTEE	**,965**	,118
BOARDSIZE	,145	**,543**
BOARDINDEP	**,308**	,249
FINBACK	,150	**-,392**
RISKMEETING	**,921**	,153
RISKDIRECTORS	**,894**	,231
RISKINDEP	**,899**	,000
CROREP	,216	**,784**
CROCEO	,126	**,707**

Table 6.2: Rotated component matrix with two components, SPSS

As could be seen, BOARDINDEP and FINBACK have much lower loadings on one of the components, than the other variables. For FINBACK, this could already be expected when looking at Table A. in the appendix. It was discussed before that the standard deviation for FINBACK could be too low to explain some of the variance. For BOARDINDEP, such explanation could not be found. The mean for this indicator is 0,39, and the standard deviation is 0,33. However, it could be that there are some extreme values that could affect the standard deviation. This could be shown with a histogram. This histogram is shown in Figure A.4, at page IX of the appendix. From this histogram, it could be found that BOARDINDEP is almost equally distributed among the sample, but that there is a high frequency of boards with 0% independent members. Therefore, it could be concluded that there is not enough variation in the sample, and this variable will be removed.

In order to enhance the results, a new principal component is conducted, in which these variables are removed. This new PCA shows better results. First, a higher KMO-value is found. This value has now increased to 0,803. Also the two components find higher eigenvalues, and thus explain more of the variance. The first principle component now explains 43,22%, and the second one 30,57%. Together, these components are able to explain 73,89% of total variance. This is almost the same percentage as was found for three components. For this PCA, the following rotated component matrix could be found.

Rotated component matrix

	Component 1	Component 2
CROBOARD	**,315**	**,854**
RISKCOMMITTEE	**,957**	,210
BOARDSIZE	,192	**,525**
RISKMEETING	**,914**	,255
RISKDIRECTORS	**,865**	**,375**
RISKINDEP	**,912**	,036
CROREP	,158	**,814**
CROCEO	,027	**,781**

Table 6.3: Rotated component matrix excl. BOARDINDEP and FINBACK, SPSS

As could be seen, the loadings have larger differences now and the higher scores have increased. CROBOARD and RISKDIRECTORS are loaded onto both components. In this case, it is decided to put the variable into the component in which the loading is higher. Since the lower loadings for these variables are close to 0,30, these are not as relevant for that component, as for the other. This means that CROBOARD will be taken into component 2, while RISKDIRECOTRS is used in component 1. When looking at the variable itself, this also makes more sense. One could see that component 1 mainly considers the existence and characteristics of the risk committee, while component 2 mainly considers the place of the CRO in the organization. Therefore, component 1 will now be called ERMRC, and component 2 will now be called ERMBOARD.

These correlations are then used to weigh the different scores for the variables. The component scores are now computed by taking the highlighted weightings and multiply these by the standardized observation values. Because of this standardization, the components of ERM implementation could also be negative. This means that for that observation, the implementation is lower than for the total sample. A positive value for ERM implementation means that the extent of implementation is higher than the total sample average.

Now that the ERM index is developed, the overall sample could be described. This is needed to give an overview of the sample.

6.2 DESCRIPTIVE STATISTICS

The general purpose of descriptive statistics is to give the reader an overview of the sample. These statistics show the mean and standard deviation of all the measures for the overall sample, Also the total sample size is given. This is shown in Table 6.4, on the next page.

As was discussed before, 38 banks were taken into the sample. However, not all banks existed throughout all the periods. For example, the Anadolubank was founded in the

Netherlands in 2008. This means that for the period before the crisis, no data is available. Further, some banks were incorporated into their mother company, like for example Bank Insinger de Beaufort and Kempen & Co, who respectively formed into BNP Paribas and Van Lanschot Bankiers. This leads to the fact that not 228 observations are taken into account, but 164.

Further, the benchmark period is defined as the period before the crisis. Since the effect of ERM is measured as a lagged variable, the observations of 2005 on ERM will be used in 2006, and so on. Therefore, no observations are used in 2005. This leads that the benchmark period only consists of the observations in 2006. This explains the lower number of observations in this benchmark period.

Since the ERM index is based on standardized measures, the mean is 0 and the standard deviation is 1 (Moore & McCabe, 2008). The total sample standardized average does not say anything about the extent of ERM implementation for the total population, but it makes it easier to compare the different observations within this sample. A negative value on ERM implementation does not automatically mean that ERM is not implemented, but that this is less than the total sample.

Descriptive statistics

	Total sample		**Benchmark***		**Crisis = 1**		**After crisis = 1**	
N =	*164*		*34*		*67*		*62*	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
ROA	1,10	4,10	1,67	2,74	1,01	2,34	,89	5,87
ROA_2	,84	3,12	1,76	3,56	,74	1,98	,43	3,75
ROE	5,45	64,59	15,05	13,91	11,29	20,05	-6,27	101,85
ERM RC	,05	1,50	-,22	1,27	-,05	1,39	,32	1,71
ERMBOARD	,06	,74	-,13	,60	,08	,75	,15	,80
$ERMRC^2$	2,24	3,96	1,61	3,41	1,89	3,52	2,98	4,59
$ERMBOARD^2$	,55	,83	,36	,71	,56	,79	,65	,91
EFFICIENCY	2,39	4,97	3,22	8,01	-,05	1,39	2,01	2,78
LEVERAGE	91,17	9,81	91,56	9,47	2,30	4,51	90,71	10,26
DIVERSIFICATION	47,53	113,75	44,94	31,22	91,39	9,70	44,19	33,32
TIER-1 CAPITAL RATIO	25,20	32,55	31,16	48,76	51,97	174,34	22,67	18,32
CREDIT QUALITY	,56	1,63	,47	1,33	24,42	32,50	,57	1,43

** Benchmark period is the period before the crisis, where both the crisis and after crisis dummies are 0.*

Table 6.4: Descriptive statistics, SPSS

Since the ERM index is based on standardized measures, the mean is 0 and the standard deviation is 1 (Moore & McCabe, 2008). The total sample standardized average does not say anything about the extent of ERM implementation for the total population, but it makes it easier

to compare the different observations within this sample. A negative value on ERM implementation does not automatically mean that ERM is not implemented, but that this is less than the total sample.

As can be seen, return on assets is declining during the financial crisis, as was expected. However, recovery does not show after the financial crisis. It also shows that the standard deviation after the crisis is much larger than before the crisis, and that it declines during the financial crisis. This indicates that most banks face bad performance during the crisis, but that some banks recover from that crisis faster than others, who face even worse performance during the crisis.

Return on equity is also declining during the different periods, with also an increasing standard deviation. This means that the differences between banks are increasing, which was also indicated by the scores an return on assets. In the period after the crisis, it could be seen that the standard deviation is much larger than before. This could also indicate several outliers.

The variables for ERM implementation shows an increase over the periods. Before and during the crisis, it shows that these are below the total sample average on ERM, which automatically leads to a positive value afterwards. This increase of the ERM index indicates that banks are further implementing ERM over time. During the financial crisis, the differences among the sample are increasing compared to the period before the crisis. This could indicate that during the crisis, some banks start seeing the importance of risk management and rapidly implement it. Other banks do not use risk management to survive the crisis, maybe because they do not really suffer from the crisis. The variables for ERM implementation are still increasing after the crisis, and also show a higher standard deviation. This means that the differences between banks are further increasing.

Efficiency and tier-1 capital show the same change as performance during the periods. Leverage increases over time, while the ratio for bad credit increases during the financial crisis and stays at approximately the same level afterwards, but with a smaller standard deviation. This means that the credit quality is increasing, and that the differences among banks are decreasing.

Since there are several measures that show the same or an opposite change during the measurement periods, this could indicate a relation between these variables. This will be further investigated with a correlation matrix, which will be discussed during the next part.

6.3 CORRELATION MATRIX

In a histogram made with use of SPSS, it is shown that the sample is normally distributed, which means that Pearson's correlation could be used to determine the correlations between the variables. These correlations will be determined for the entire measurement period and the three subsamples. In the correlation matrices, all the variables are correlated to each other, including ERM^2. The correlations show whether the variables are related to each other, which is a first step

in determining whether ERM implementation affects firm performance. When a significant correlation is found between variables, several explanations could be given. First, it could be that variable A is causing variable B, or the other way around. The final explanation is that both variables are explained by third variable, C.

Because of the size of the tables, only the correlation matrix for the total sample is shown here, in Table 6.5. The other tables could be found in Appendix VIII: Correlation matrices.

From Table 6.5, at the next page, it could be seen that both measurements of return on assets (ROA_1 and ROA_2) are highly correlated, as could be expected. This is caused by the fact that they use approximately the same variables. The measures for return on assets and return on equity do not correlate with each other, which could be expected. These measures define different parts of performance.

Since the ERM indices are lagged variables, it is possible to tell more about causation from these correlation tables. Lagged variables are observed before the other variables. This means that for the year 2006, ERM implementation was observed in 2005. It is therefore possible to tell what effect ERM has on performance, based on the correlation matrix. Since ERM implementation was there before performance, it is not possible for performance to affect ERM implementation. It shows that ERMRC and $ERMRC^2$ have little negative correlations with the performance measures, and these are insignificant. This indicates that implementing ERM as a risk committee decreases performance.

ERMBOARD does not show significant correlations with any performance measure. However, the coefficients are also negative, which provides a further indication that ERM is not enhancing performance, but could actually decrease it. For $ERMBOARD^2$, the same directions are found, although the coefficients are more close to 0. This means that there is no correlation between these variables. This indicates that it does not matter for performance if a bank has high or low values on ERM board characteristics.

Further, the control variables do not correlate with performance, except for leverage. This control variable is negative correlating with return on assets. This could indicate that leverage leads to lower performance, or higher performance leads to lower leverage. However, it could also be that some other variable causes this effect.

The effects for the other control variables are not only insignificant, but also very small. The correlation between return on equity and tier 1 capital is 0, which indicates that there is no relation between these variables.

Correlation matrix, n = 164

	ROA	ROA_2	ROE	RC	BOARD	RC^2	$BOARD^2$	EFF	LEV	DIV	TIER1	CRED
ROA	1											
ROA_2	,882 **	1										
ROE	,565 **	,700 **	1									
RC	-,068	-,063	,017	1								
BOARD	-,054	-,027	,043	,360 **	1							
RC^2	-,066	-,065	,013	,979 **	,346 **	1						
BOARD	-,073	-,066	,000	,239 **	,841 **	,233 **	1					
EFF	,161 *	,136	-,065	-,130	-,121	-,132	-,092	1				
LEV	-,437 **	-,416 **	-,061	,101	,110	,106	,050	-,251 **	1			
DIV	-,012	-,011	-,084	-,085	,093	-,096	,020	,146	-,015	1		
TIER1	,096	,085	,000	,106	-,120	,106	-,082	,046	-,578 **	-,093	1	
CRED	-,055	-,039	,038	-,084	,126	-,074	,024	,008	,118	,081	-,099	1

**. Correlation is significant at the 0.01 level (2-tailed).
Total observations in sample: 106.
Performance is measured by return on assets (ROA, ROA_2) and return on equity (ROE). ERMRC is indicated as RC, ERMBOARD is indicated as BOARD. Efficiency, leverage, diversification, tier-1 capital ratio and credit quality are mentioned as EFF, LEV, DIV, TIER1 and CRED.

Table 6.5: Correlation matrix total sample, SPSS

The control variables also show some correlations with each other. This goes for leverage and efficiency, and leverage and tier 1 capital. Since leverage is also affecting performance, it could be that this is caused by the effect of efficiency or tier 1 capital. However, this cannot be concluded from the correlation matrix. The fact that some control variables are also correlating, is an indication for multicollinearity. This does not affect the direction of the effect, but could affect the size found. Therefore, it could affect the conclusions.

In the next part, the most important results for the different periods are discussed. These tables are due to space considerations not included in the text, but are presented in Appendix VIII: Correlation matrices, which starts at page VII of the appendix.

6.3.1 CORRELATIONS BEFORE THE FINANCIAL CRISIS

The complete correlation matrix could be found in Table A.4, in Appendix VIII: Correlation matrices. The most important results will be discussed now. In this period, it shows that both ERM indices do not correlate with each other. This could mean that the implementation of these indicators happens randomly at banks. This could be explained by the fact that banks are performing well in this period, and do not consider ERM as necessary. ERM implementation could be seen as additional, and will be implemented when banks have superfluous resources.

It shows that the presence and the characteristics of a risk committee, do not significantly affect performance. Although the effects are negative, these are very small. This also counts for the squared term of this measure. For that measure, the effects are even becoming smaller, although they are still negative. The ERM indicator for the board, ERMBOARD, also shows negative but insignificant correlations. These correlations show a comparable coefficient.

It shows that tier 1 capital is positively correlating with ERMRC and $ERMRC^2$. This could be explained by the fact that tier 1 capital ratio is seen as a buffer against negative outcomes. Since risk management is implemented with the same idea, it explains why these variables correlate. However, it does not say which variable causes the other, or about the existence of a possible third variable.

Further, several control variables find significant correlations. First, it was found that leverage is negatively correlating with return on assets. This is in line with the total sample results. Also diversification is significantly correlating with return on assets. It was found that return on equity and credit quality are positively correlated.

Also some of the control variables is significantly correlating. These are diversification and efficiency (positive) and leverage and tier 1 capital (negative). This leads to an indication of multicollinearity between these variables. This means that since the control variables affect each other, the effect of these variables on performance could be changed. Multicollinearity does not change the direction of the effect, but it could change the size of the effect.

Concluding, the ERM implementation indices do not correlate significantly with performance. Further, some other correlations are found which could be further extended. However, this is out of the scope of this research and therefore, this extension should be done in future research.

6.3.2 CORRELATIONS DURING THE FINANCIAL CRISIS

The complete matrix could be found in Table A.5, in Appendix VIII: Correlation matrices. Below, the most important outcomes are discussed.

Also during the financial crisis, it shows that both ERM indicators are not significantly correlating. The coefficients in the correlation matrix during the crisis, are almost the same as before, when looking at the ERM indicators and performance. ERMRC shows very little effects, which are mostly negative for the standard ERMRC measure, but turn into positive for $ERMRC^2$. However, these effects are negligible.

It shows that diversification and return on equity are negatively correlating, which is also found for leverage and return on assets. This are the only significant correlations between the control variables and the performance measures. Tier 1 capital ratio and leverage are negatively correlating, which indicates multicollinearity.

Also during this period, the control variables do not find significant relations with each other or performance. This leads to an indication that the variables do not explain firm performance. When this is confirmed, this means that no real conclusions could be drawn.

6.3.3 CORRELATIONS AFTER THE FINANCIAL CRISIS

In this part, the results of Table A.6 in Appendix VIII: Correlation matrices are being discussed.

In this period, it could be seen that the ERM indicators are positively correlated. This indicates that ERM implementation happens more completely now. When a risk committee is settled, also the board characteristics change, or the other way around. This could be due to more regulations, or better awareness.

The ERM indicators still do not significantly correlate with any performance measure. It further shows that leverage and ERMRC are positively correlating, while diversification and the same ERM indicator are negatively correlated. Further, it shows that tier 1 capital is negatively correlating with leverage and diversification. This could explain the existence of a third variable in the relation between ERMRC and leverage and diversification. However, extending this relationship is not in the scope of this research.

6.4 INITIAL CONCLUSIONS

With these descriptive statistics, an overview of the sample is given and a first indication for the results from the regression are shown. In general, performance declined over the periods, with also an increasing standard deviation. This indicates that the differences between banks are increasing. Some banks recover from the crisis, whereas other banks even perform worse during the crisis. ERM implementation increases over the different periods. This could be expected, because of more regulations and better awareness of the relevance of risk management. However, also the standard deviation increases. This indicates that the differences in implementation are increasing. One would expect, because of the better awareness and more regulations, that these differences would decline and there would be an overall increase. However, it seems that this is not the case.

The correlation matrices showed a first indication of the relations between the different variables. Several control variables correlate significantly with each other, which means that they could affect the conclusions. This happens before the financial crisis, when diversification and efficiency and leverage and tier 1 capital are significantly correlating, and afterwards, when leverage and diversification correlate with efficiency. Further, in that period, tier 1 capital is also correlating with leverage and diversification. Further, before the crisis, leverage and diversification correlate with return on assets. During the financial crisis, leverage and diversification are correlating with different measurements of performance.

For the overall sample, no significant correlations are found the ERM indices and the performance measures. However, this will further show in the regression results. These regressions will be discussed in the next part. With these results, the hypotheses will be tested. The validity of these results happens afterwards. Based on this validity discussion, final conclusions could be drawn about the effect of ERM implementation and performance.

7. ANALYSIS

In this part, the relations found in the correlation matrices will be further extended by a regression. This should show whether performance is affected by the different variables, and to what extent. With the outcomes of the regressions, the hypotheses will be tested and initial conclusions will be drawn. However, before these conclusions could be definite, the validity of the results needs to bested. The validity will show whether the results are sufficiently supported. After this analysis, final conclusions will be drawn. These conclusions will be incorporated with research limitations and directions for further research.

7.1 MULTIVARIATE REGRESSION

In a regression, it is possible to define the relation between a dependent variable and several independent variables. For this research, the regression is used to determine the effect of ERM implementation and efficiency, leverage, diversification, tier 1 capital and credit quality on bank performance. ERM implementation is measured as ERMRC and ERMBOARD, as the PCA has shown. To see the effect of the crisis on the relation between ERM implementation and performance, an interaction variable is introduced. For an overview of all the variables taken into account, see the conceptual model at page 20.

To test the first hypothesis, whether ERM implementation leads to better performance under normal conditions, one should look at the variables ERMRC and ERMBOARD. Further, also the interaction variable for the period after the crisis needs to be taken into account. The hypothesis that ERM implementation is only valued up until a certain extent, is tested by the variables $ERMRC^2$ and $ERMBOARD^2$, and the interaction variables for the after-crisis period.

The hypothesis about the crisis period, which state that ERM implementation will lead to better firm performance during the crisis, are determined by the interaction variables for the crisis period. The hypothesis that ERM implementation only leads to better performance up until a certain extent of implementation, is tested by the squared term of the ERM implementation indices.

In the regression tables, the effects of the different variables on firm performance are shown. In the upper row, the performance measure is mentioned, and the different results are shown. In the first two rows under each performance measure, the effect of ERM is measured. In the most left column, which is in plain text, the β is shown. For this research, these should be positive to support the hypotheses. In italics, in the column on the right, the significance is shown. This should be lower than 0,05 in order to be significant for the hypotheses formulated in this research. The meaning of the intercept is in this case the estimation of performance, when all the other variables are 0.

The coefficients in the regression tables should be interpreted as follows. When, for example, an effect of 0,800 is found between an independent variable and the dependent variable, this

means that if the independent variables increases with one standard deviation, the dependent variable increases with 0,800. In the following table, the results of the regressions are shown.

Regression results, SPSS

	Firm performance					
	ROA_1		ROA_2		ROE	
	β	*t*	β	*t*	β	*t*
Intercept	25,566 **	*,000*	20,215 **	*,000*	139,384	*,077*
ERMRC	-1,672	*,535*	-1,762	*,386*	-16,641	*,727*
ERMBOARD	1,088	*,625*	1,296	*,439*	7,334	*,852*
$ERMRC^2$	,594	*,551*	,571	*,445*	5,463	*,756*
$ERMBOARD^2$	-,953	*,594*	-1,298	*,335*	-8,627	*,785*
ERMRC_CRISIS	1,318	*,671*	2,039	*,383*	17,995	*,743*
ERMBOARD_CRISIS	-,782	*,753*	-,540	*,772*	3,682	*,933*
$ERMRC^2$_CRISIS	-,461	*,692*	-,696	*,427*	-6,824	*,740*
$ERMBOARD^2$_CRISIS	,354	*,864*	,518	*,739*	-1,501	*,967*
ERMRC_AFTERCRISIS	1,739	*,544*	2,016	*,350*	28,552	*,573*
ERMBOARD_AFTERCRISIS	,170	*,946*	-,384	*,840*	10,981	*,806*
$ERMRC^2$_AFTERCRISIS	-,561	*,593*	-,595	*,450*	-8,240	*,656*
$ERMBOARD^2$_AFTERCRISIS	-,181	*,929*	,602	*,696*	-1,719	*,962*
Efficiency	,016	*,800*	-,010	*,835*	-1,324	*,238*
Leverage	-,258 **	*,000*	-,198 **	*,000*	-1,303	*,070*
Diversification	-,002	*,542*	-,002	*,455*	-,055	*,257*
Tier 1 capital	-,034 **	*,006*	-,027 **	*,005*	-,224	*,306*
Credit quality	-,034	*,859*	-,016	*,912*	1,703	*,613*
$CRISIS_{dummy}$	-,079	*,977*	,019	*,993*	8,721	*,857*
AFTER $CRISIS_{dummy}$	-,088	*,972*	-,835	*,659*	-10,071	*,820*

***. Significant at the 0.01 level (two-tailed).*

**. Significant at the 0.05 level (two-tailed).*

Total number of observations = 164.

Table 7.1: Regression results, SPSS

7.1.1 PERFORMANCE UNDER NORMAL CONDITIONS

This research tries to answer the question how ERM implementation affects firm performance of banks before, during and after a financial crisis. From there, hypotheses are developed, who define this relationship under normal conditions and during a financial crisis. These normal conditions are best described by the periods before and after the financial crisis. For testing these hypotheses, one should look at the normal ERM indicators, and the interaction variables for after the crisis. In this part, the results for these variables are discussed.

When looking at the after crisis dummy variable, it could be seen what effect the period after the crisis has on firm performance. It shows that for all performance measures, negative effects are found. However, these effects are not significant. This means that the effects found, are not found in 95 or 99% of the observations.

It shows that the ERM indices find mixed results, but that these results are insignificant. For the first measure for return on assets, it is found that ERMRC and ERMBOARD show contradicting results. ERMRC shows a negative effect, whereas ERMBOARD is positive. This indicates that ERM implementation is not always positive for performance, but that this depends on the parts of ERM that are implemented. It shows that characteristics as board independence are positively affecting performance, whereas the presence of a risk committee decreases performance. For the interaction variables for the period after the crisis, it shows that there are positive effects. This means that ERM implementation after the crisis leads to better results for return on assets.

The second measure for return on assets finds similar results for the original ERM indices, compared to the first measure for return on assets. However, some differences appear in the after crisis variables. For the RC index, it shows positive effects, contradicting the BOARD index. This index finds a negative effect. This means that the presence of a risk committee and its characteristics have a positive effect on return on assets, whereas the direct reporting lines of the CRO to the CEO and the board have a negative effect.

Return on equity finds the same directions in the effects of ERM implementation as the first measure for return on assets. However, these effects are much larger, although they are still insignificant. Since the t-statistic for these effects are close to 1, it indicates that this model is not valid. This is because it seems if the variables used are not able to explain return on equity.

Also for the nonlinearity of the effect between ERM implementation and firm performance, no significance is found. This indicates that it does not matter for the extent of implementation, which effect on performance is found. However, also for these quadratic terms, mixed results are found. What needs to be noticed, is that these results are opposing the effects found for the original ERM indices. For the squared terms, ERMRC is positive, and ERMBOARD is negative for the first measure for return on assets. In the after-crisis period, both indices are now negative instead of positive. The second measure for return on assets finds the same results as the first measure in the period before the crisis, and also finds opposite results in the period afterwards. This means that $ERMRC^2$ is positive, whereas $ERMBOARD^2$ is negative. For return on equity, $ERMRC^2$ is now positive instead of negative, and $ERMBOARD^2$ shows the opposite. In the period after the crisis, two negative signs are found.

7.1.2 PERFORMANCE DURING A FINANCIAL CRISIS

As was discussed before, it is argued that ERM implementation will lead to better performance during a financial crisis. This was formulated into a hypothesis and this hypothesis will now be tested. This will be done when looking at the interaction variables for the financial crisis. In this part, these results are being discussed.

The crisis dummy shows what effect the crisis has on performance. It shows that the first measure on return on assets find negative effects, as was expected. However, these effects are positive for the other return on assets measure and return on equity. Although these effects are not significant, they indicate a contradiction in the expectation. With the effects found for the after crisis dummy, it could be that the crisis is not over yet, and banks are recovering or even face worse performance now, after the banking crisis is over.

When looking at the ERM indices, no significant results could be found. Further, the results found are also contradicting each other. ERMRC finds positive effects on both return on assets measures, whereas ERMBOARD finds negative ones. This means that during a financial crisis, the presence of a risk committee leads to better performance, whereas board independence and the reporting lines of the CRO could negatively affect performance. For return on equity, both indices are positive.

The squared terms of the ERM indices, which would count for a possible nonlinear effect of ERM implementation, find opposing results when comparing these with the original ERM indices. $ERMRC^2$ now turns negative for the return on assets measures, whereas $ERMBOARD^2$ turns positive. For return on equity, both the squared indices are negative. However, also those signs are not significant.

7.1.3 CONTROL VARIABLES

When looking at the effect of the control variables on performance, it could be seen that all these effects are negative, when looking at return on assets. For leverage and tier 1 capital, these effects become significant. This is contradicting the expectations. It was argued that leverage would improve performance, because of the agency problem. Further, tier 1 capital is seen as a buffer against adverse shocks, and would therefore be positive. However, it shows that these are both significantly negative for return on assets. Since the other control variables are not significant, it could only be indicated that the expectations for these control variables are not met, except for credit quality.

For return on equity, different effects are found for credit quality. This was negative for return on assets, which is in line with the expectations. However, for return on equity, this becomes positive. This indicates that when a bank has more bad loans, it performs worse, which is hard to believe. These effects are also not significant, so that no real conclusions could be drawn.

Before definite conclusions could be drawn on the effects of ERM implementation on performance, the validity needs to be tested. This will be done using R^2 and testing the normality of the residuals, using a normal probability plot and the Kolmogorov-Smirnov test.

7.2 VALIDITY

As was discussed before, the final conclusions could only be drawn, after the validity has been tested. The results are valid when there is sufficient evidence that supports the propositions from those results (Shadish *et al.*, 2002). In this part, the different tests that have been discussed in part 0, on page 30, will be executed and discussed. After these tests have been executed, it could be determined whether the results found are valid. Based on the conclusions from this part, the final conclusions can be drawn.

7.2.1 R^2

The R^2 measures whether the independent variable and the control variables count for variations in the dependent variable. SPSS determines R^2 for each regression model, and gives in that case two types of R^2. The first one is the original R^2, the second one is the adjusted R^2. The adjusted R^2 takes into account the number of variables. One could understand that if more variables are taken into account, more variance could be explained. Therefore, to be able to have comparable R^2s, the adjusted R^2 is used.

R^2 could have values between 0 and 1, in which 0 in this case means that 0% of the variation of firm performance is explained by the independent and control variables. When R^2 is 1, this means that 100% of the variation of firm performance is explained by the independent and control variables. It is therefore needed to have a R^2 that is as high as possible. In Table 7.2, the scores on R^2 are shown for all the regression models. These scores will be discussed now, and will also be compared with the R^2 of previous studies.

Results for R^2

Performance measure	R^2
ROA_1	,163
ROA_2	,185
ROE	-,051

Table 7.2: R^2 for all regression models, SPSS

As could be seen, these values are very close to 0. In the case of ROE, R^2 is even negative. This is because the adjusted R^2 tries to allow for the fact that two variables that are completely unrelated, show some relationship here just by luck. Therefore, the adjusted R^2 reduces the original R^2 by this luck. In this case, the original R^2 is smaller than the relationship found that is caused by luck. This indicates that the variables are not related to return on equity.

Further, for the return on assets, the values for R^2 are very low. The variation in the first measure is only for 16,5% explained by the variables used. For the second measure this increases

to 18,5%, but this still is very low. These low values indicate that these models are not valid. This means that the conclusions drawn from these models are not truthful enough. However, this has to be also confirmed by the lack of normality of residuals. This will happen in the next part.

7.2.2 NORMALITY OF RESIDUALS

A residual is a point in the regression plot that is off the regression line. These residuals should be normally distributed around the regression line, in order for the regression line to be valid. This normal distribution is one of the assumptions of a regression.

The normality of the residuals could be graphically tested, and using mathematical tests. First, the graphical test is explained. A normal P-P plot plots the observed cumulative probability against the expected cumulative probability. In the case the residuals are normal, this expected and observed probability should be equal to each other and show a straight line. When this is not the case, the residuals are not normally distributed.

Further, the normality of the residuals could also be numerically tested. In SPSS, the Shapiro-Wilk and the Kolmogorov-Smirnov tests for normality could be used. When the sample is larger than 50, the Shapiro-Wilk test is less appropriate and the Kolmogorov-Smirnov test needs to be used. Since this research consists of 164 observations, this sample is larger than 50. Therefore, the Kolmogorov-Smirnov test is most appropriate.

When the value for this test is significant at 0.05, this provides good evidence that the dependent variable is not normally distributed.

NORMAL P-P PLOT

Due to space considerations, the normal P-P plots are shown in Appendix IV: Normal P-P Plots, which starts at page XIII of the appendix. As could be seen from these plots, these do not follow the straight line that it should. This straight line is also shown in the plots. For these variables, the residuals show a S-shaped line. This means that first, the observed cumulative probability is lower than the expected one, while at some point, this becomes the other way around. In this latter part, the observed cumulative probability is higher than the expected one. This means that the residuals are not normally distributed, which means the model is not valid. With these models, the estimates shown in Table 7.1 are not correct.

This graphical test needs to be further enhanced by a mathematical test. In this research, the Kolmogorov-Smirnov test is used. This test will be explained and interpreted in the following part.

KOLMOGOROV-SMIRNOV TEST

A Kolmogorov-Smirnov test tests whether the distribution of the sample is different from a normal distribution. It tests the null hypothesis that these are equal. When the test finds a

significant difference, the alternative hypothesis is confirmed, and the sample is not normally distributed.

In Table 7.3, the results for the Kolmogorov-Smirnov test are shown. As could be seen in the significance column on the right, this is lower than 0.05. This means that the dependent variable is not normally distributed. This was also shown in the normal P-P plots.

Tests of normality, SPSS

	Kolmogorov-Smirnov		
	Statistic	**df**	**Sig.**
ROA_1	,289	164	,000
ROA_2	,285	164	,000
ROE	,368	164	,000

Table 7.3: Tests of normality, SPSS

Concluding, it could be said that the model at this moment is not able to give valid conclusions. This is based on the fact that the R^2 is very low and the residuals are not normally distributed. One way to improve this validity, is to identify and remove outliers. This will happen in the next part.

7.3 OUTLIERS

Outliers could be found when developing a stem-and-leaf plot. Such a plot consists of a stem, which defines the first digit and a leaf, which defines the observations with that particular digit. Ideally, such a stem-and-leaf plot has the form of a pyramid. It could be that some observations disturb this, or that these observations are too far away from the middle leaf. These observations are then identified as outliers. In SPSS, this is indicated by 'extremes'. In the following table, the different extreme values are given for each performance measure and for each period. These values indicate from which value, the observation is considered as an outlier.

Outcomes stem-and-leaf plot, SPSS

	Extreme values	
	≤	≥
ROA_1	-1,4	2,9
ROA_2	-1,3	2,6
ROE	-16	30

Table 7.4: Outcomes stem-and-leaf plot, SPSS

By removing these extreme values, the following sample sizes will remain. With these new sample sizes, the same regressions will be conducted, and these results will be compared with the initial ones. Further, validity is tested again for these models.

Sample sizes excl. outliers

	Sample size
ROA_1	151
ROA_2	148
ROE	143

Table 7.5: Sample sizes excl. outliers

7.3.1 REGRESSION RESULTS

In this part, the regression results for the samples without the outliers are being discussed. The regression results could be found in Table 7.6 below. These results will be discussed below, and this will happen in the same way as for the original sample.

Before this discussion will start, a general comparison is made between these results and the results for the original sample. In general, the sizes of the effects found are much smaller in this regression, than in the original sample. This could be caused by the fact that outliers caused these large effects, which are now removed.

Further, some variables have changed in the direction of their effect on performance. These are highlighted in the table. Further, ERMRC_CRISIS on ROA_2 does not show a change in the direction of the effect, but in the size. In the original sample, this effect was 2,039. This has dropped to only 0,062 in this sample. An even greater differences appears in ERMRC_CRISIS and ROE. In the original sample, this effect was 3,682. Now, when the outliers are excluded, this has turned into -3,026.

In the original sample, tier 1 capital was significantly negatively affecting return on assets. In this sample, the effect is no longer significant, but also turned into almost 0. Since tier 1 capital could be seen as some form of risk management, since it is a buffer against adverse shocks, this could indicate that there is no effect of risk management on performance.

The crisis shows now a negative effect on performance, as could be expected. This was not found in the original sample, but it is now. This could mean that this sample is better reflecting reality than the original sample did.

Now that some comparison is made between the original sample results and these results, the results for this sample could be discussed more in detail. This will happen from the next page.

Regression results excl. outliers, SPSS

	Firm performance					
	ROA_1		ROA_2		ROE	
	β	*t*	β	*t*	β	*t*
Intercept	10,319 **	*,000*	9,573 **	*,000*	3,996	*,667*
ERMRC	-,784	*,231*	-,378	*,506*	-2,095	*,669*
ERMBOARD	,397	*,452*	,274	*,502*	-,789	*,851*
$ERMRC^2$	,207	*,385*	,090	*,658*	,496	*,783*
$ERMBOARD^2$	-,453	*,288*	-,314	*,336*	-,322	*,925*
ERMRC_CRISIS	,569	*,445*	,062	*,924*	-3,026	*,602*
ERMBOARD_CRISIS	-,331	*,577*	-,207	*,652*	,161	*,973*
$ERMRC^2$_CRISIS	-,147	*,595*	,008	*,974*	,919	*,674*
$ERMBOARD^2$_CRISIS	,295	*,549*	,137	*,715*	,512	*,897*
ERMRC_AFTERCRISIS	,725	*,299*	,471	*,416*	,039	*,994*
ERMBOARD_AFTERCRISIS	-,351	*,560*	-,188	*,688*	3,354	*,482*
$ERMRC^2$_AFTERCRISIS	-,176	*,485*	-,119	*,562*	,172	*,928*
$ERMBOARD^2$_AFTERCRISIS	,392	*,422*	,224	*,550*	-1,793	*,645*
Efficiency	-,022	*,184*	-,022	*,217*	-,232	*,057*
Leverage	-,100 **	*,000*	-,093 **	*,000*	,052	*,544*
Diversification	,001	*,668*	,000	*,126*	,025	*,071*
Tier 1 capital	-,002	*,539*	,000	*,960*	,008	*,735*
Credit quality	-,011	*,810*	,007	*,845*	,060	*,874*
$CRISIS_{dummy}$	-,259	*,692*	-,368	*,511*	-2,448	*,637*
AFTER $CRISIS_{dummy}$	-,475	*,431*	-,364	*,455*	-2,718	*,556*

***. Significant at the 0.01 level (two-tailed).*

**. Significant at the 0.05 level (two-tailed).*

Total number of observations ROA_1 = 151, ROA_2 = 148, ROE = 143.

Table 7.6: Regression results excl. outliers, SPSS

PERFORMANCE UNDER NORMAL CONDITIONS

When looking at the after crisis dummy, it shows that this effect is now almost as large and negative as for the crisis dummy. This indicates that in the period after the banking crisis, banks still are not fully recovered and suffer losses. However, these effects are not significant.

For performance under normal conditions, one should look again at the original ERM indices and the squared terms, and the interaction variables for the period after the crisis. These variables do not show significant effects on the performance measures. Further, the results found are mixed. ERMRC is negatively affecting performance, while ERMBOARD is positively affecting performance before the crisis, when looking at return on assets. Return on equity finds negative signs for both measures. For the period after the crisis, these signs show the opposite. This

indicates that there is not one answer to whether ERM implementation leads to better performance under normal conditions.

For the variables to measure whether the valuation of ERM implementation only holds up until a certain extent, again mixed results are found. These results show the opposite signs, when comparing these with the original measures. However, also these effects are not significant.

Concluding, it could be said that there is no indication that ERM implementation leads to better performance under normal conditions. Therefore, no support is found for the first hypotheses. However, since the insignificant effects that are found are mixed, it also indicates that there is not one answer to whether ERM implementation leads to better firm performance. The fact that the signs are different for the different periods, it could also depend on economic circumstances.

PERFORMANCE DURING A FINANCIAL CRISIS

To test the hypotheses that concern the effect of ERM implementation during a financial crisis, one should look at the interaction variables for the financial crisis. These are indicated with _CRISIS in the regression table.

Again, no significant effects for ERM implementation and performance could be found. Further, these effects are also mixed. For return on assets, ERMRC is positive, while ERMBOARD is negative. For return on equity, the opposite signs are found. This means that for return on assets during a financial crisis, it is better to have a risk committee since this improves performance. Board independence and direct reporting lines between the CRO and the CEO and the board are decreasing performance, and should therefore not be implemented. However, for return on equity, this should be the other way around.

The squared terms for ERM implementation, more unambiguous effects are found. For the first measure for return on assets, the results are still mixed. However, for the other two measures, these effects are positive. This means that when ERM is implemented to a further extent, performance will increase to a less extent. This indicates that ERM implementation only leads to better performance up until a certain extent. However, since these effects are not significant, this cannot be concluded with a sufficient level of certainty.

CONTROL VARIABLES

When looking at the effects of the control variables on performance, it could be seen that only little effects could be found. Only leverage finds significant effects for return on assets, which are negative. This is contradicting the expectations formulated before. Diversification, tier 1 capital and credit quality only find very small effects on performance. This indicates that it does not matter for performance what values these variables have, which was not suggested in previous literature.

Based on these results, it could be concluded that there is no support for the hypotheses formulated in this research. However, before this could be definite conclusions, the validity has to be tested. This is done using the R^2 and testing the normality of the residuals. This has also been done for the regression for the original sample. The R^2 measures the part of the variation in the dependent variable, that is explained by the independent variables. In this case, this measures the part of variation in firm performance, that is caused by ERM implementation and the control variables.

The normality of the residuals has to be tested, in order to test one of the assumptions of a regression. These residuals have to be normally distributed around the regression line, in order for the regression line to be valid. Just as in the original sample, this will be done using a graphical test, the P-P plot, and a mathematical test, the Kolmogorov-Smirnov test.

Based on this discussion on validity, final conclusions will be drawn and an answer to the research question will be formulated.

7.3.2 VALIDITY

Validity will be tested using R^2 and the normality of the residuals. The results on these tests will be shown and discussed below. In the following table, the R^2 for these regressions are compared to the R^2s of the original sample. Again, the adjusted R^2 is used.

Results for R^2, compared to original sample

Performance measure	R^2	R^2 original sample
ROA_1	,284	,163
ROA_2	,257	,185
ROE	,026	-,051

Table 7.7: Results for R^2, SPSS

When these values are compared, it could be seen that R^2 is increased for the sample where the outliers are excluded. At this moment, ROA_1 is now explained for 28,4% by the other variables, whereas ROA_2 is explained for 25,7%. Return on equity was not explained by the variables in the original sample, but now is explained for 2,6%. This is very low, and it could therefore be concluded that the model for return on equity is not valid. However, since also the values for return on assets are still very low, these models are not valid too.

To finalize the discussion on the validity of the results, the normality of the residuals was tested. This is done using the normal P-P plot and the Kolmogorov-Smirnov test. First, the P-P plot will be discussed, and the discussion on the normality of the residuals will end with the mathematical Kolmogorov-Smirnov test.

Due to space considerations, the normal P-P plots are shown in Appendix V: Normal P-P Plots sample excluding outliers, which starts at page XVI of the appendix. It shows that the S-

shaped line becomes less clear for ROA_1, but the line still does not follow the straight line it should. Therefore, the residuals for the first measure for return on assets are still not normally distributed. This means that the model for ROA_1 is not valid, when looking at the distribution of the residuals. Further, ROA_2 shows a better line, but this still is not sufficient to be considered as a normal distribution. Looking at the normal P-P plot for return on equity, it could be seen that the observed cumulative probability is almost equal to the expected cumulative probability. It is therefore concluded that this distribution could be considered as normal.

Looking at the normal P-P plots, it could be concluded that the models for return on assets are not valid. This is because the residuals are not normally distributed around the regression line. This means that the estimates given in Table 7.6 for ROA_1 and ROA_2 are not valid. For return on equity, the normal P-P plot shows a normal distribution, and this means that the estimates for return on equity are valid.

These conclusions for the normal P-P plots will be mathematically tested, using a Kolmogorov-Smirnov test. The results for this test are shown in the following table, table …, and these are also compared with the original values.

Tests of normality, SPSS

	Kolmogorov-Smirnov					
	Sample excl. outliers			Original sample		
	Statistic	df	Sig.	Statistic	df	Sig.
ROA_1	,146	151	,000	,289	164	,000
ROA_2	,127	148	,000	,285	164	,000
ROE	,101	143	,001	,368	164	,000

Table 7.8: Tests of normality, SPSS

As could be seen, all significance levels are still under 0.05, which means that the residuals in the samples in which the outliers have been excluded, are still not normally distributed. This means that the models are not valid, and no real conclusions could be drawn for the effect of ERM implementation and performance.

Combining the results for the validity tests, it could be concluded that the models for return on assets are not valid. This has shown in the graphical test in the normal P-P plots, and the mathematical test in the Kolmogorov-Smirnov test. The plot shows a S-shaped curve, whereas the mathematical test also shows that the distribution in this sample is significantly different from a normal distribution.

However, for return on equity, it was concluded based on the graphical test, that the residuals could be seen as normally distributed. In the Kolmogorov-Smirnov test, no further evidence is provided for this conclusion. It is therefore concluded that the graphical test does not provide

sufficient evidence on its own to conclude normality of the residuals. This makes also the model for return on equity not valid.

In the following part, the conclusions are drawn. These conclusions are based on the results of the regressions on the samples in which the outliers have been removed. It has shown that for these samples, the results are more valid than for the original samples. In these conclusions, the result for the hypotheses will be presented. However, it needs to be noticed that these results are not valid, and therefore not representative for the total population. After the conclusions, the answer to the research question will be given. Finally, contributions, limitations and directions for further research will be given.

8. CONCLUSIONS

The final conclusions will incorporate the discussions on validity. Further, the research question and its sub questions will be answered. In the next part, this research' contributions and limitations are discussed, and directions for further research are proposed.

8.1 CONCLUSIONS

In this part, a conclusion for the hypotheses and the answer to the research question will be given. The conclusions will start with the rejection or support of the hypotheses. The discussion of the hypotheses will be based on the periods the hypotheses concern. First, the hypotheses for normal conditions are discussed. These normal conditions are in the periods before and after a financial crisis. The second part is based on performance during a financial crisis. Based on these conclusions, an answer to the research question is formulated.

8.1.1 PERFORMANCE UNDER NORMAL CONDITIONS

Performance under normal conditions was argued to be improved by the implementation of ERM. Further, it was argued that this improvement of performance only holds up until a certain extent. These arguments are formulated in the following hypotheses:

H1a. *Under normal conditions, ERM implementation increases firm performance.*

H1b. *ERM implementation only increases firm performance under normal conditions, up until a certain extent.*

These hypotheses were tested using regression models for two measures for return on assets and one measure for return on equity. In these regression models, two ERM indices were used, ERMRC and ERMBOARD. These indices measure ERM implementation. To test for the second hypothesis, these indices were transformed into squared terms. Further, to also see the effect of the period after the crisis, a interaction variable was introduced. This interaction variable multiplies the indices with the dummy variable for the period after the crisis.

From the results on these regression models, it could be seen that ERM implementation does not significantly affect performance before and after a financial crisis. Further, the effects found are mixed. It shows that ERMRC is negatively affecting return on assets, while ERMBOARD is positively affecting return on assets. For return on equity, both indices have negative signs. For the period after the crisis, the opposite signs are found.

The squared terms of these indices also find mixed results. These results show the opposite signs, when looking at the original indices. However, also these effects are not significant.

Since no significant effects are found, there is not sufficient evidence to reject the null hypothesis. This null hypothesis assumes that there is no effect of the independent variable on the dependent variable. The alternative hypothesis is formulated in this research, and indicates

that there is a positive effect between these variable. However, since there is no support for this alternative hypothesis, the null hypothesis needs to be supported. Further, since the models are not significant, it cannot be said what effect ERM implementation has on firm performance, and in that case, also the null hypothesis remains supported.

This leads to the final conclusion that ERM implementation does not increase firm performance under normal conditions. Further, there is also no support for the hypothesis that there is a quadratic relation between ERM implementation and firm performance.

H1a. *Under normal conditions, ERM implementation increases firm performance.*
Not supported.

H1b. *ERM implementation only increases firm performance under normal conditions, up until a certain extent.*
Not supported.

8.1.1 PERFORMANCE DURING A FINANCIAL CRISIS

It was found in previous literature that ERM implementation tends to have a positive effect on firm performance during a financial crisis. Further, it was also found that this effect only holds up until a certain extent of implementation. This was formulated as follows:

H2a. *ERM implementation leads to better firm performance during a financial crisis.*

H2b. *ERM implementation only increases firm performance during a financial crisis, up until a certain extent.*

These hypotheses were tested using the same regression models for two measures for return on assets and one measure for return on equity. To test for the hypotheses for the financial crisis, one should look to the interaction variables for the financial crisis. In this variable, the ERM indices are multiplied with the dummy variable for the crisis period. With these interaction variables, it is possible to see the effect of the financial crisis on the effect of ERM implementation on firm performance.

From the results from Table 7.6, it could be seen that also in this period, the effect of ERM implementation on performance is insignificant. Further, these effects are also mixed. For the measures for return on assets, ERMRC is positive, while ERMBOARD is negative. For return on equity, the opposite signs are found. This indicates that the effect of ERM implementation is ambiguous.

For the squared terms for the ERM indices, the results are less ambiguous. For the second measure for return on assets and return on equity, the effects of the squared terms are positive. This means that when ERM is implemented to a further extent, performance will increase to a

less extent. However, since these effects are not significant, this cannot be used to support the second hypotheses.

The insignificant effects found for all ERM indices and the lack of validity, means that also in this case, the null hypotheses cannot be rejected. There is not enough support for the alternative hypotheses, and this means that the null hypotheses remain supported.

This leads to the final conclusion that ERM implementation does not lead to better performance during a financial crisis. There is also no support for a quadratic effect of ERM implementation.

H2a. *ERM implementation leads to better firm performance during a financial crisis.*
Not supported.

H2b. *ERM implementation only increases firm performance during a financial crisis, up until a certain extent.*
Not supported.

Now that the hypotheses are tested and conclusions are drawn, the research question can be answered. This will happen in the next part.

8.2 ANSWER TO RESEARCH QUESTION

Since the last financial crisis, risk management at banks has received much attention. It is assumed that banks fell into problems because they took too much risk. Therefore, there is more pressure for regulations towards risk management at banks. However, there is no clear consensus about whether the implementation of more risk management leads to better performance. In other words, it is not proven that more risk management is effective in helping banks survive a financial crisis. This leads to the following research question:

How does ERM implementation affect bank's performance before, during and after a financial crisis?

Risk management tries to decrease the negative outcomes of uncertainty, and this could be done in different approaches. First, there is traditional risk management, which handles risk in different separate classes. Further, there is enterprise risk management (ERM), which uses a holistic approach. This approach bundles all the risks and only hedges or insures the residual risks. ERM also focuses on non-financial risks, whereas traditional risk management only focuses on financial risks.

ERM could still be beneficial for banks, although they do not face much non-financial risk. However, by taking a holistic approach, different risks could better be managed and a better understanding of these risks could be achieved. An important ERM model is developed by COSO. This framework helps to achieve an organization's objectives in a risk-adjusted way.

Several researches have been conducted towards the relation between ERM and firm performance. Under normal conditions, it is assumed that ERM is valuable for banks, since it enhances performance (Baxter *et al.*, 2011) and increases value (Liebenberg & Hoyt, 2011; McShane *et al.*, 2011). However, this depends on the quality of the ERM programs and it is suggested that ERM is only valuable up until a certain level (McShane *et al.*, 2011).

During a financial crisis, risk management lowers risk (Ellul & Yerramilli, 2010), and leads to better performance McShane *et al.* (2011), it could be argued that it will be valuable for stakeholders, if the company has a further extent of ERM implemented during a financial crisis. From these propositions, several hypotheses were developed.

These hypotheses assumed that ERM implementation will lead to an improve in performance, in both normal conditions and during a financial crisis. However, this improvement in performance will only hold up until a certain extent. This means that when a banks implement ERM above that level, it will no longer contribute to better performance.

In determining the effect of ERM on performance, also several control variables are taken into account. These are efficiency, leverage, diversification, tier 1 capital ratio and credit quality. These control variables are expected to have a positive effect on performance.

Measurement took place in the years 2005-2010, and the financial crisis is defined in the years 2007 and 2008. This means that all the periods, before, during and after, are two years. A sample was selected from Dutch banks which have an individual annual report, which led to a sample of 38 banks.

The regression that was used to test the hypothesis, did not show support for the hypotheses. The effect of the ERM indices is ambiguous, which means that different results are found. It indicates that ERM implementation does not automatically lead to better firm performance.

For validity, the model has to be improved. At this moment, only a small part of the variation of the performance measures is explained by the variables used. Further, the residuals are not normally distributed. Since this is one of the assumptions of a regression, the estimates of these regression are not valid and cannot be used to draw conclusions.

These results are contradicting most of the previous research, which argued that ERM positively affects performance. The fact that the results for this research are different, could be because of another measure for ERM implementation, that was used in the previous researches. When looking at the results for Aebi *et al.* (2011), who developed the ERM index that was used in this research, it could be found that the effects of their ERM index also did not find significant results. Therefore, it still remains an unsolved issue whether ERM implementation actually leads to better performance.

All taken together, it could be stated that this research is contradicting most of the previous research. It did not find a significant effect for ERM implementation and firm performance. This means that in extreme, more regulations on risk management and ERM specifically do not automatically help banks to survive a next financial crisis.

This research will be completed by giving research contributions, limitations and directions for further research. This will happen in the next part.

9. REMARKS AND FURTHER RESEARCH

This research will end by discussing the specific contributions of this research to the existing research on ERM in banks. Further, the research limitations of this particular research are outlined and the consequences these limitations have. Further, several directions for further research are given.

9.1 RESEARCH CONTRIBUTIONS

This research has contributed to existing literature in several ways. First, since this research was able to use more recent data, also the period after the crisis could be taken into account when measuring the effect of ERM implementation on performance. It is important to also take this period into account, because it was argued that ERM implementation could help companies to recover from the crisis faster (Baxter *et al.*, 2008).

Second, this research showed that performance is determined by different factors over time. It was suggested by the results of this research that it depends on perhaps the economic situation, which determinants are most important. These findings could add to the current literature, because it could help in defining determinants of banks' performance. It was found in this research, that there is no clear consensus of what determines performance.

Finally, this research' purpose was to conclude whether ERM implementation could help a bank survive a financial crisis. It was shown that this does not significantly matter. Therefore, it also could be concluded that more regulations on risk management are not necessary to avoid a next financial crisis. However, since the results from this research are contradicting previous researches, it does not help in finding consensus about the effect of ERM implementation.

9.2 RESEARCH LIMITATIONS

Except for these contributions, also several research limitations need to be mentioned. First, this was the fact that the model developed was not valid. Therefore, no clear conclusions could be given on the effect of ERM implementation.

One explanation of the lack of validity is the performance measure. In this research, return on assets and return on equity are used as performance measures. This was derived from previous researches, like Baxter *et al.* (2011). However, banks would then be penalized for taking less risk. Lower risk leads to lower returns, and this could noise the outcomes. Therefore, it could be beneficial to take a risk adjusted rate of return for banks. Such measure takes into account the risk taken, and the return that is made after adjusting for that risk. In such a measure, it is better possible to compare bank's performance.

Further, it was difficult to find a clear measure for ERM implementation. It was found that different authors use very different measures. Therefore, a clear consideration was needed in

determining a good measure. Most ideally, different measures were taken into account, but because of the time considerations, this was not possible.

Due to company boundaries, data was collected from annual reports. In these annual reports, only information was given on the corporate governance side of ERM. This made the index used in this research very general. Most ideally, one should look into a particular organization, to see what really happens on ERM. With use of annual reports and other outsider data, it is difficult to get a close look on how risk is actually managed within a company, especially in a short time period.

Finally, this research only used Dutch banks with have an individual annual report, which lead to a sample of 38 banks. However, this is a rather small number to explain the entire population of banks. To enhance the robustness of the results, one should expand this sample. With a larger sample, the results found are more representative for the entire population of banks.

Together, these contributions and limitations lead to directions for further research.

9.3 DIRECTIONS FOR FUTURE RESEARCH

The results found, this research' contributions and limitations provide directions for future research, which will be proposed now.

First, since no significant results for ERM implementation could be found in this research, it could be that the effect of ERM implementation is long term. Since Liebenberg & Hoyt (2011) use information on the appointment of CRO between 1995 and 2005, and the effects of performance for a longer period. These authors are able to find a significant effect of ERM implementation on firm performance. Although lagged variables are used for ERM implementation in this research, it could be that the effect is even more long-term.

Second, it was often found that both ERM indices have opposite effects on performance. Although these effects are not significant, it could be that these different indices have a different effect on performance. This would be difficult to interpret, since it is expected that these indices are both measuring ERM implementation, and are enhancing performance.

Further, it is needed to find a valid research model to measure the effect of ERM implementation on firm performance. In that case, a more complete answer could be given to the research question formulated in this research.

One limitation of this research was the lack of a clear ERM measure. A more in-depth research would be needed to determine how ERM implementation could be measured. One way to do so is to look into companies, to see what actually happens on ERM and compare that to

some kind of ideal-type. This ideal-type could be the COSO framework, or the index developed by Standard & Poor's.

Standard & Poor's only have an ERM index for insurers at this moment, but this is extended to other companies at the moment. This index incorporates several parts of ERM at companies, and looks at the policies, infrastructure and methodology of ERM. With policies, one looks at role and structure of the ERM function, quality and compensation of the function, risk tolerance and the control process. Further, S&P's looks at the disclosure of these companies. For infrastructure, the agency looks at risk technologies and back-office operations. For methodology, one looks at the valuation techniques and risk metrics. Standard & Poor's develop best practices for these areas, and give a number to the sophistication of each area. Together, these numbers form an index. By using this index, also the extent of implementation could be taken into account. However, this should be more elaborated in future research.

The final part of this research is a personal reflection, which is written in the next part. In this reflection, the process of writing the thesis is reflected.

10. PERSONAL REFLECTION

In this personal reflection, I will look back on the process of writing this thesis. This reflection will contain of the personal learning goals and an overall progress.

Before I wrote this thesis, I developed some personal learning goals. These contained planning, self-criticism and accepting help. In this reflection, I will reflect on the achievement of these goals, and the overall progress and execution of this research.

Previously, I often found myself hurrying for a deadline, because I did not stay with my own planning. However, during this thesis, I always kept this planning in the back of my mind and tried to keep this planning. Thanks to thinking ahead and the fact that I didn't offer myself the opportunity to lack the planning, I was able to finish this thesis in the time that I planned it for.

Another learning goal was to be more critical about the work I did. During this research, I tried to be critical about what I did and what the results of these actions were. Therefore, I tried to link my own actions to those of others. This could be in terms of results I found, or when correcting what one of my supervisors did. By doing so, I found that it was easier to improve my work. By comparing my own actions and thought with those of others, it was easier to find possible improvements. However, I often find that I only start critically thinking after I did something, instead of making clear considerations before. This could still be improved.

This also connects to the last personal learning goal, which was accepting help. During this research, I often searched for contact with one of my supervisors, so that they could give their opinion. This made writing this easier a lot easier.

Next to these learning goals, something is now said about the overall progress of execution of this research. In general, this went smoothly. Sometimes it was difficult to find the information I needed, but this was always solved. However, I found that after writing my literature review, I got stuck in my believes that the hypotheses I developed were true. It was therefore a bit frustrating when I found that these hypotheses were not supported.

However, in general I dare to say that writing this thesis was not that bad. I certainly learned how to implement my research skills and refreshed my memory on statistics. The topic still interests me, and I am satisfied that this research has contributed to this research field.

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APPENDICES

APPENDIX I: OVERVIEW OF MEASUREMENTS

Dependent variable: firm performance		
RETURN ON ASSETS	Baxter *et al.* (2011)	$\frac{\text{EBIT}}{\text{total assets}}$
	Aebi *et al.* (2011)	$\frac{\text{Net income}_{t}}{\text{total assets}_{t-1}}$
RETURN ON EQUITY	Aebi *et al.* (2011)	$\frac{\text{Net income}_{t}}{\text{total equity}_{t-1}}$
Independent variable: ERM implementation		
CROBOARD	Aebi *et al.* (2011)	Dummy variable, 1 if there is a CRO on the executive board, 0 if not
RISKCOMMITTEE		Dummy variable, 1 if there is a risk committee, 0 if there is none or if the audit committee is seen as the risk committee
BOARDSIZE		Natural logarithm of number of directors on the board
BOARDINDEP		% of independent outside directors
FINBACK		% of directors with a financial background in banking or insurance
RISKMEETING		Number of meetings by risk committee
RISKDIRECTORS		Number of directors in risk committee
RISKINDEP		% of independent directors on risk committee
CROREP		Dummy variable, 1 if the CRO reports directly to the board of directors
CROCEO		Dummy variable, 1 if the CRO reports directly to the CEO
Control variables		
SIZE	Athanasoglou *et al.* (2008)	$\frac{\text{total operating expenses}}{\text{total assets}}$
LEVERAGE	Leach & Melicher (2012)	$\frac{\text{total debt}}{\text{total assets}}$
DIVERSIFICATION	Baele *et al.* (2007)	$\frac{\text{non-interest income}}{\text{total operating income}}$

TIER-1 CAPITAL RATIO	Aebi *et al.* (2011)	$\frac{\text{tier-1 capital}}{\text{total risk weighted assets}}$
CREDIT QUALITY	Athanasoglou *et al.* (2008); Dietrich & Wanzenried (2011)	$\frac{\text{loan loss privisions}}{\text{total loans}}$
BEFORE		Dummy variable, set to 1 if measurements take place in 2005-2006
DURING		Dummy variable, set to 1 if measurements take place in 2007-2008
AFTER		Dummy variable, set to 1 if measurements take place in 2009-2010

Table A.1: Overview of measurements

APPENDIX II: SAMPLE OF ORGANIZATIONAL CHART

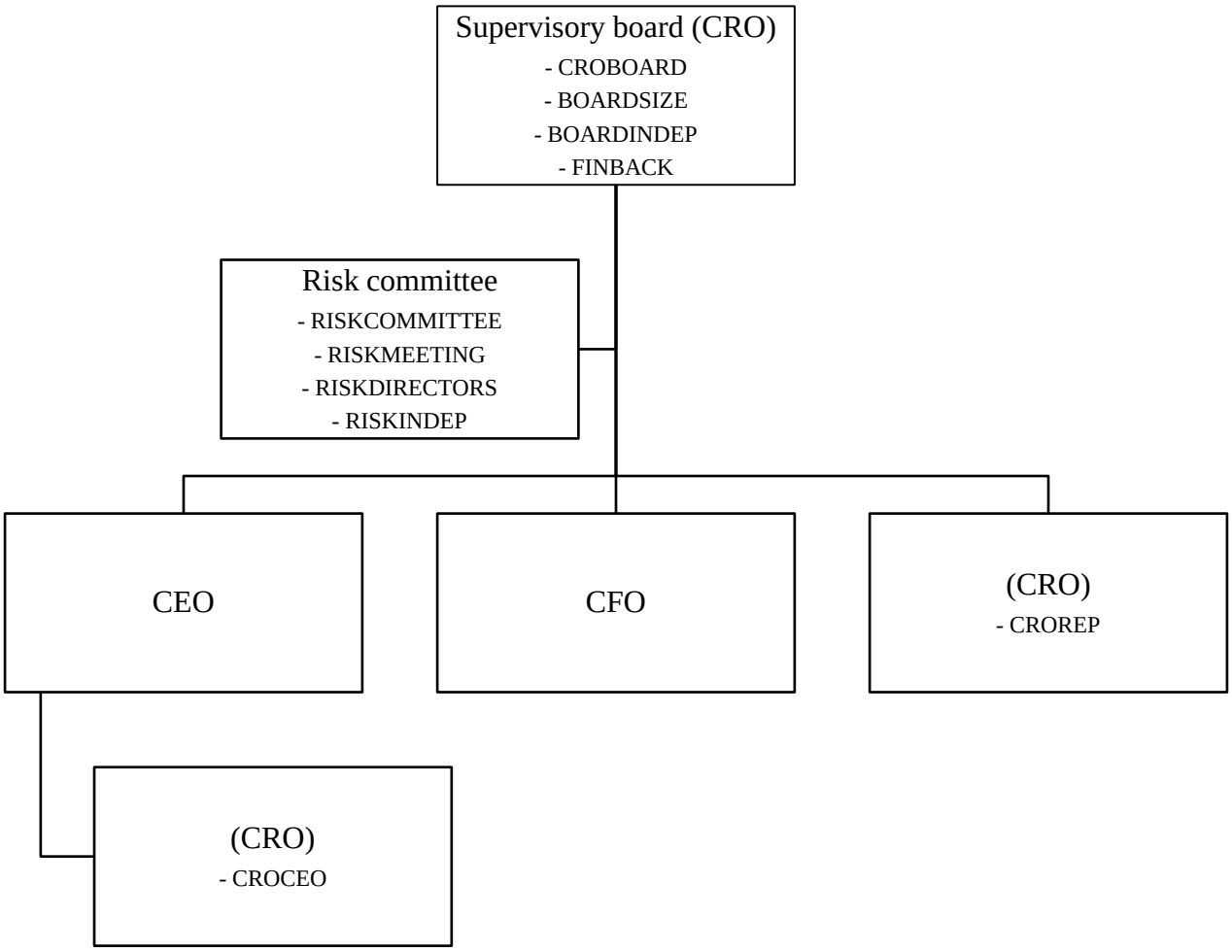

Figure A.1: Sample of organization chart

APPENDIX III: SAMPLE

ABN AMRO Bank N.V.
Achmea Bank Holding N.V.
AEGON Bank N.V.
Akbank N.V.
Allianz Nederland Asset Management B.V.
Amsterdam Trade Bank N.V.
Anadolubank Nederland N.V.
ASN Bank N.V.
Financieringsmaatschappij Welstand B.V.
Bank Insinger de Beaufort N.V.
Bank Mendes Gans N.V.
Bank of Tokyo-Mitsubishi UFJ N.V.
Bank Ten Cate & Cie. N.V.
Bank voor de Bouwnijverheid, N.V.
Banque Artesia Nederland N.V.
BinckBank N.V.
Citco Bank Nederland N.V.
Coöp. Rabobank B.A.
Credit Europe Bank N.V.
Demir-Halk Bank (Nederland) N.V.
The Economy Bank N.V.
Friesland Bank N.V.
GarantiBank International N.V.
Hof Hoorneman Bankiers N.V.
ING Bank N.V.
KAS BANK N.V.
Kempen & Co N.V.
Lombard Odier & Cie (Nederland) N.V.
Mizuho Corporate Bank Nederland N.V.
Bank Nederlandse Gemeenten N.V.
Nederlandse Waterschapsbank N.V.
NIBC Bank N.V.
SNS Bank N.V.
Société Générale Bank Nederland N.V.
Staalbankiers N.V.
TD Bank N.V.
Triodos Bank N.V.
Yapi Kredi Bank Nederland N.V.

APPENDIX IV: RESEARCH DESIGN

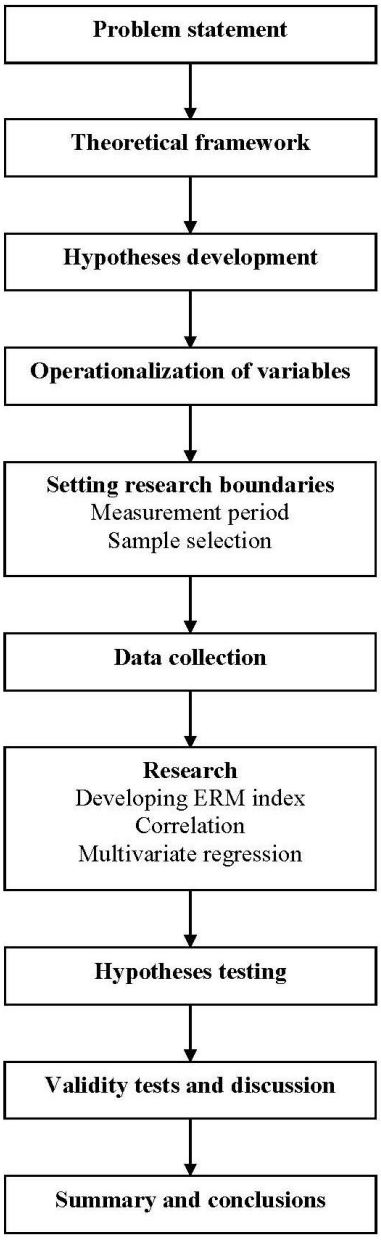

Figure A.2: Research design

APPENDIX V: INITIAL PRINCIPAL COMPONENT ANALYSIS

Descriptive statistics

	Mean	Std. Dev	N
CROBOARD	,22	,40	106
RISKCOMMITTEE	,18	,33	106
BOARDSIZE	1,67	,45	106
BOARDINDEP	,40	,34	106
FINBACK	,77	,22	106
RISKMEETING	,62	1,25	106
RISKDIRECTORS	,59	1,23	106
RISKINDEP	,11	,25	106
CROREP	,30	,45	106
CROCEO	,12	,31	106

Table A.2: Descriptive statistics for ERM indicators, SPSS

Rotated component matrix

	Component		
	1	**2**	**3**
CROBOARD	,295	**,833**	,168
RISKCOMMITTEE	**,953**	,200	-,014
BOARDSIZE	,107	**,498**	,251
BOARDINDEP	,299	,053	**,711**
FINBACK	,167	-,146	**-,776**
RISKMEETING	**,907**	,218	,036
RISKDIRECTORS	**,874**	**,311**	-,005
RISKINDEP	**,899**	,013	,166
CROREP	,158	**,791**	,148
CROCEO	,069	**,808**	-,175

Table A.3: Rotated component matrix initial PCA, SPSS

APPENDIX VI: SCREE PLOT

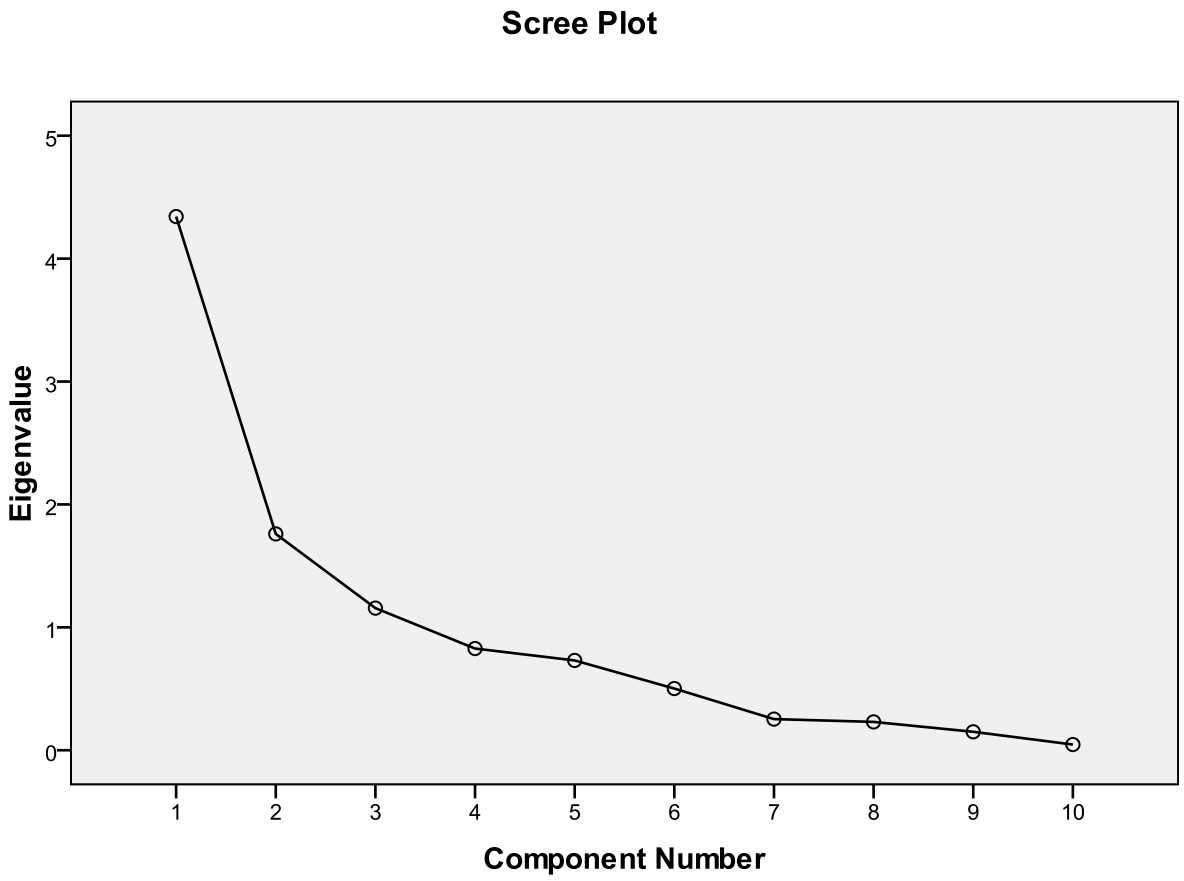

Figure A.3: Scree plot, SPSS

APPENDIX VII: HISTOGRAM BOARDINDEP

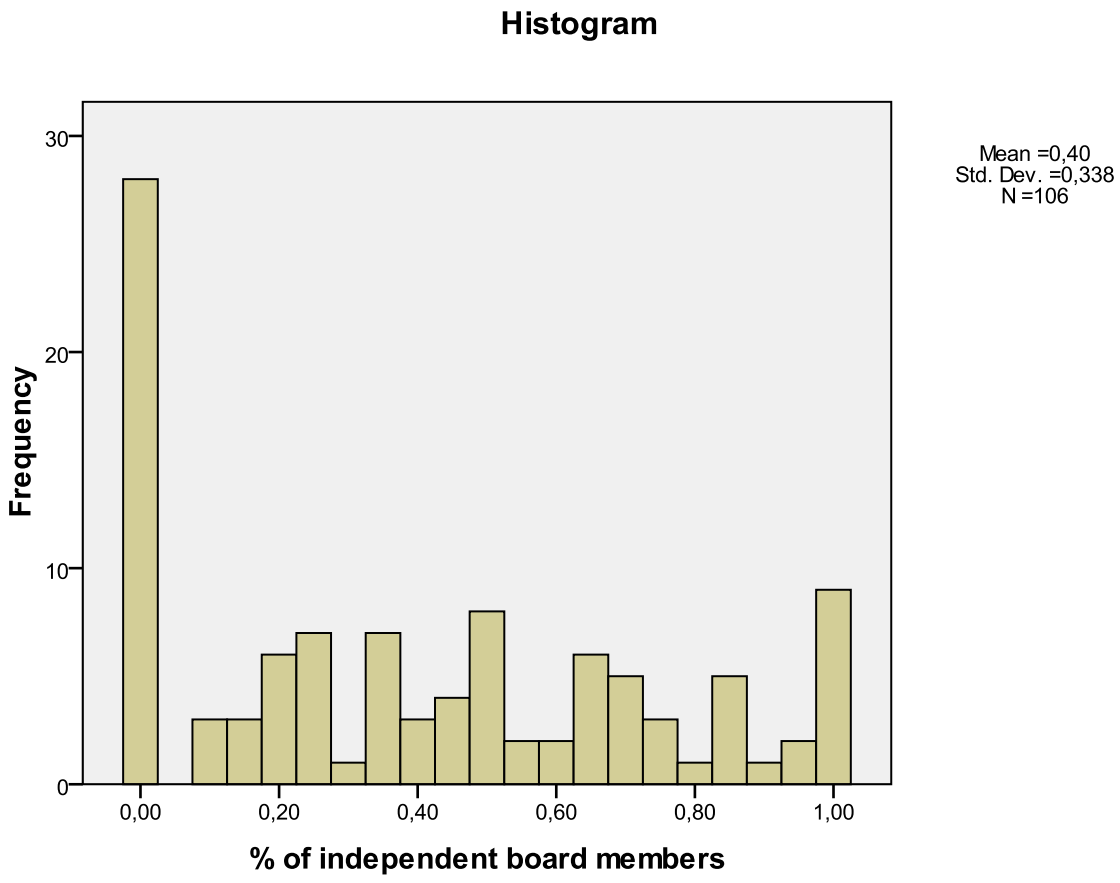

Figure A.4: Histogram BOARDINDEP, SPSS

Correlation matrix before the crisis, n = 34

	ROA	ROA_2	ROE	RC	BOARD	RC^2	$BOARD^2$	EFF	LEV	DIV	TIER1	CRED
ROA	1											
ROA_2	.973 **	1										
ROE	.755 **	.737 **	1									
RC	-.055	-.077	-.194	1								
BOARD	-.073	-.071	-.087	.325	1							
RC^2	-.069	-.085	-.187	.987 **	.337	1						
$BOARD^2$	-.153	-.139	-.196	.120	.846 **	.133	1					
EFF	.171	.208	.006	-.122	-.130	-.120	-.112	1				
LEV	-.486 **	-.441 **	-.081	-.287	.048	-.211	.137	-.328	1			
DIV	.341 *	.377 *	.294	-.229	-.187	-.225	-.284	.503 **	-.150	1		
TIER1	.045	-.025	-.156	.498 **	.072	.465 **	-.009	.078	-.679 **	-.109	1	
CRED	-.062	-.060	.428 *	-.119	.008	-.115	-.145	-.010	.150	.198	-.045	1

**. Correlation is significant at the 0.01 level (2-tailed).
Total observations in sample: 36. Measurement period is 2005-2006.
Performance is measured by return on assets (ROA, ROA_2) and return on equity (ROE). ERMRC is indicated as RC, ERMBOARD is indicated as BOARD. Efficiency, leverage, diversification, tier-1 capital ratio and credit quality are mentioned as EFF, LEV, DIV, TIER1 and CRED.

Table A.4: Correlation matrix before the financial crisis, SPSS

Correlation matrix during the crisis, n = 67

	ROA	ROA_2	ROE	RC	BOARD	RC^2	$BOARD^2$	EFF	LEV	DIV	TIER1	CRED
ROA	1											
ROA_2	.792 **	1										
ROE	.353 **	.567 **	1									
RC	-.106	-.075	-.121	1								
BOARD	-.092	.009	.017	.315 **	1							
RC^2	-.104	-.095	-.131	.976 **	-3.02 *	1						
$BOARD^2$	-.106	-.068	-.095	.294 *	.828 **	.3003 *	1					
EFF	.175	.080	-.091	-.105	-.088	-.110	-.082	1				
LEV	-.666 **	-.596 **	-.029	.103	.060	.111	.003	-.231	1			
DIV	-.100	-.079	-.299 *	-.056	.185	-.066	.063	.109	.006	1		
TIER1	.228	.194	-.100	-.086	-.164	-.094	-.063	.001	-.632 **	-.109	1	
CRED	-.056	-.023	.090	-.105	.127	-.090	-.030	.011	.130	.067	-.090	1

**. Correlation is significant at the 0.01 level (2-tailed).
Total observations in sample: 36. Measurement period is 2007-2008.
Performance is measured by return on assets (ROA, ROA_2) and return on equity (ROE). ERMRC is indicated as RC, ERMBOARD is indicated as BOARD. Efficiency, leverage, diversification, tier-1 capital ratio and credit quality are mentioned as EFF, LEV, DIV, TIER1 and CRED.

Table A.5: Correlation matrix during the financial crisis, SPSS

Correlation matrix after the crisis, n = 62

	ROA	ROA_2	ROE	RC	BOARD	RC^2	$BOARD^2$	EFF	LEV	DIV	TIER1	CRED
ROA	1											
ROA_2	.929 **	1										
ROE	.603 **	.845 **	1									
RC	-.051	-.022	.086	1								
BOARD	-.025	.012	.092	.392 **	1							
RC^2	-.046	-.018	.080	.980 **	.371 **	1						
$BOARD^2$	-.038	-.003	.050	.213	.848 **	.196	1					
EFF	.263 *	.086	-.199	-.203	-.179	-.208	-.081	1				
LEV	-.395 **	-.359 **	-.097	.263 *	.194	.239	.067	-.295 *	1			
DIV	.066	-.035	-.190	-.308 *	-.115	-.349 **	-.027	.623 **	-.097	1		
TIER1	.088	.109	.033	.080	-.249 *	.107	-.181	-.037	-.566 **	-.266 *	1	
CRED	-.066	-.045	.018	-.056	.172	-.049	.155	.041	.093	.218	-.226	1

**. Correlation is significant at the 0.01 level (2-tailed).
Total observations in sample: 36. Measurement period is 2009-2010.
Performance is measured by return on assets (ROA, ROA_2) and return on equity (ROE). ERMRC is indicated as RC, ERMBOARD is indicated as BOARD. Efficiency, leverage, diversification, tier-1 capital ratio and credit quality are mentioned as EFF, LEV, DIV, TIER1 and CRED.

Table A.6: Correlation matrix after the financial crisis, SPSS

APPENDIX IV: NORMAL P-P PLOTS

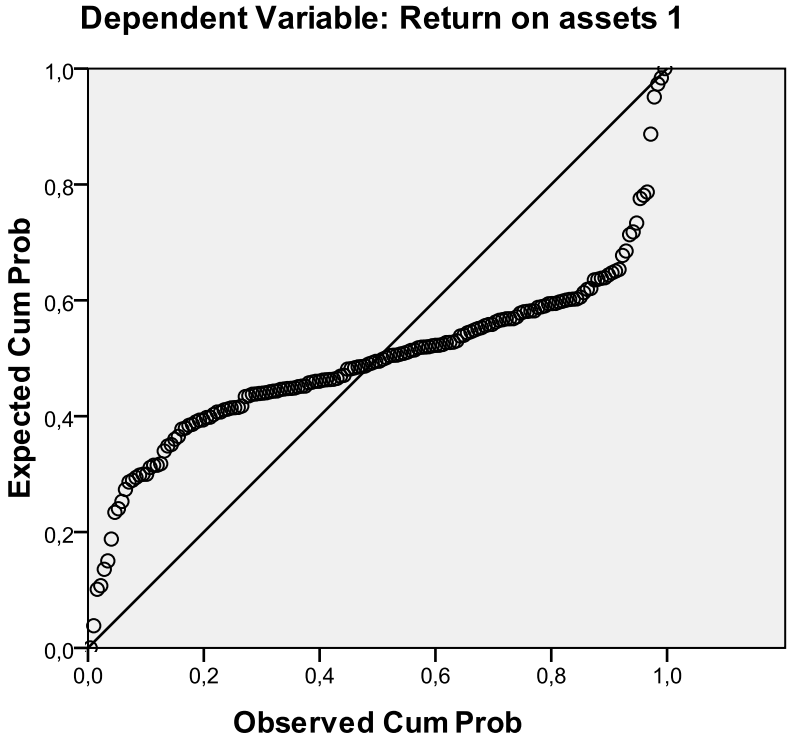

Figure A.5: Normal P-P plot ROA1, SPSS

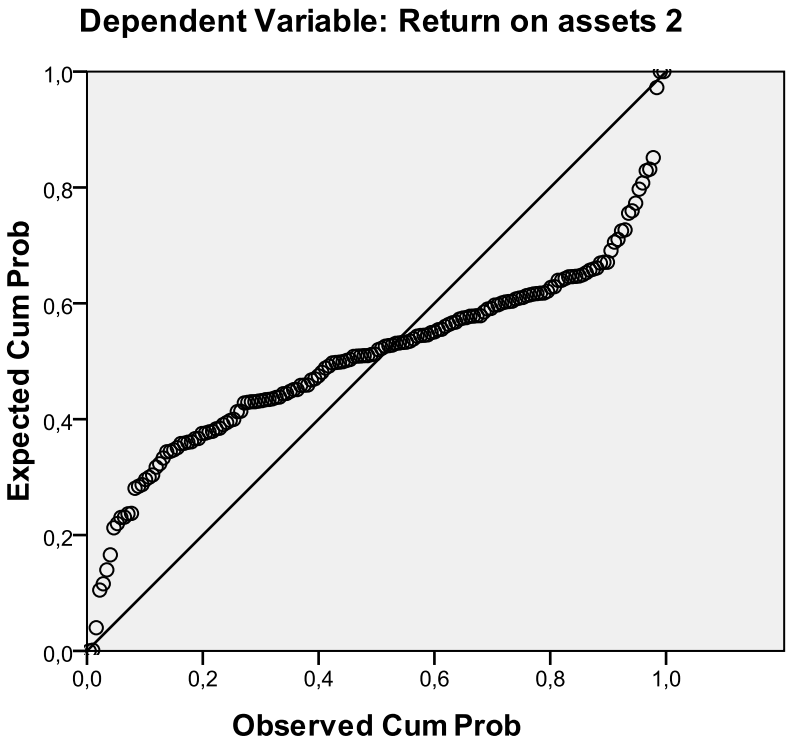

Figure A.6: Normal P-P plot ROA_2, SPSS

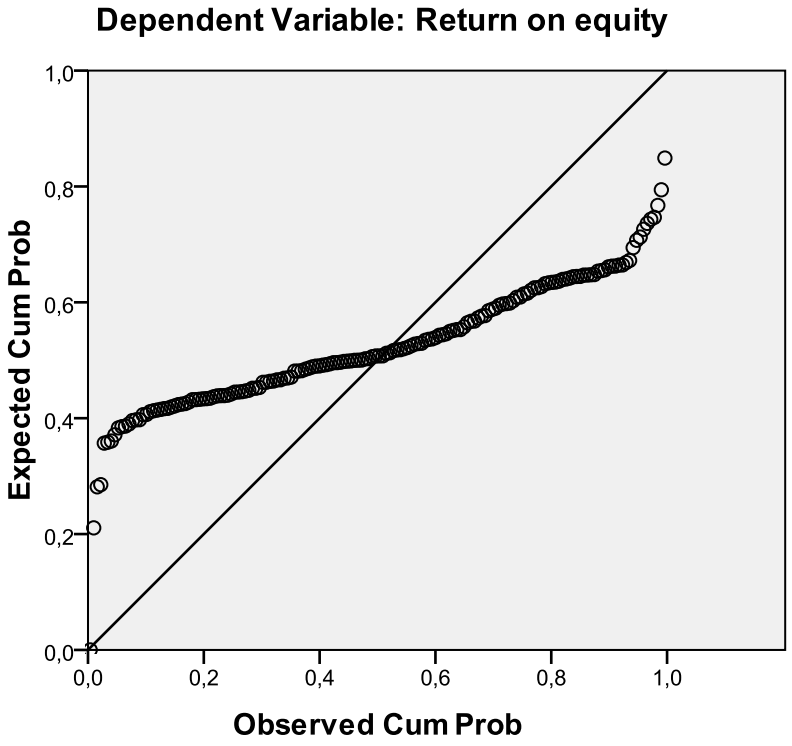

Figure A.7: Normal P-P plot ROE, SPSS

APPENDIX V: NORMAL P-P PLOTS SAMPLE EXCLUDING OUTLIERS

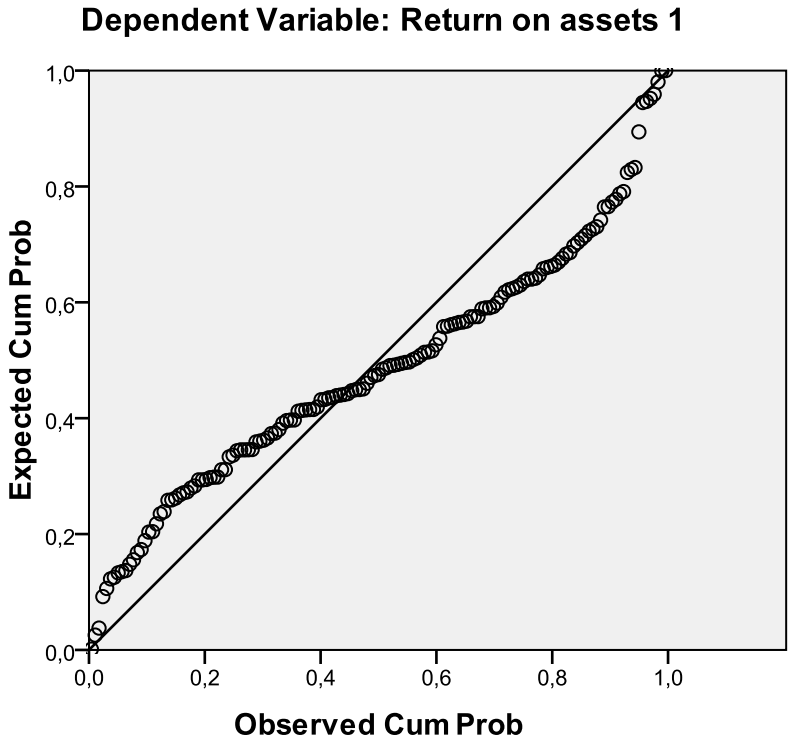

Figure A.8: Normal P-P plot ROA_1 excl. outliers, SPSS

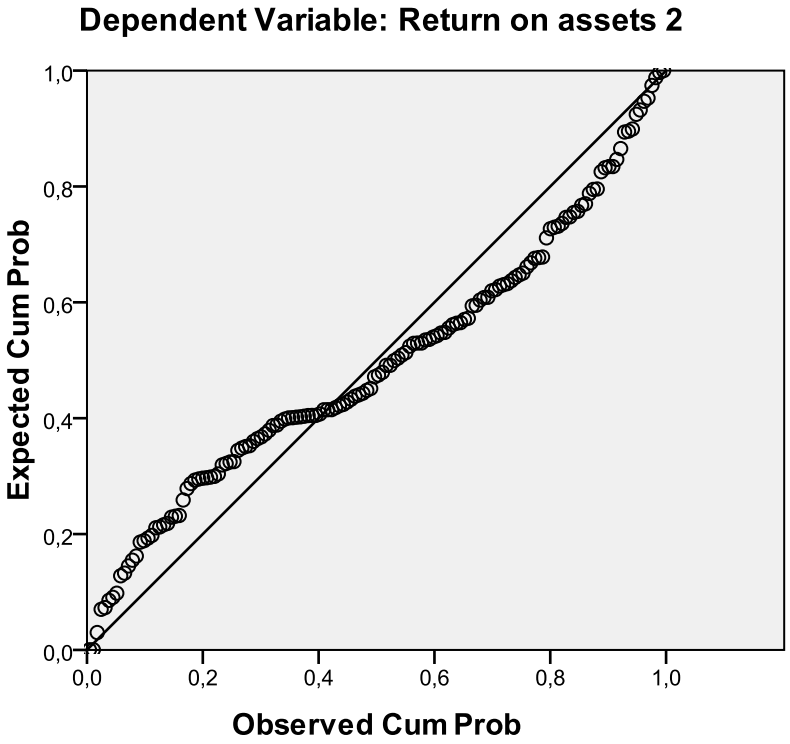

Figure A.9: Normal P-P plot ROA_2 excl. outliers, SPSS

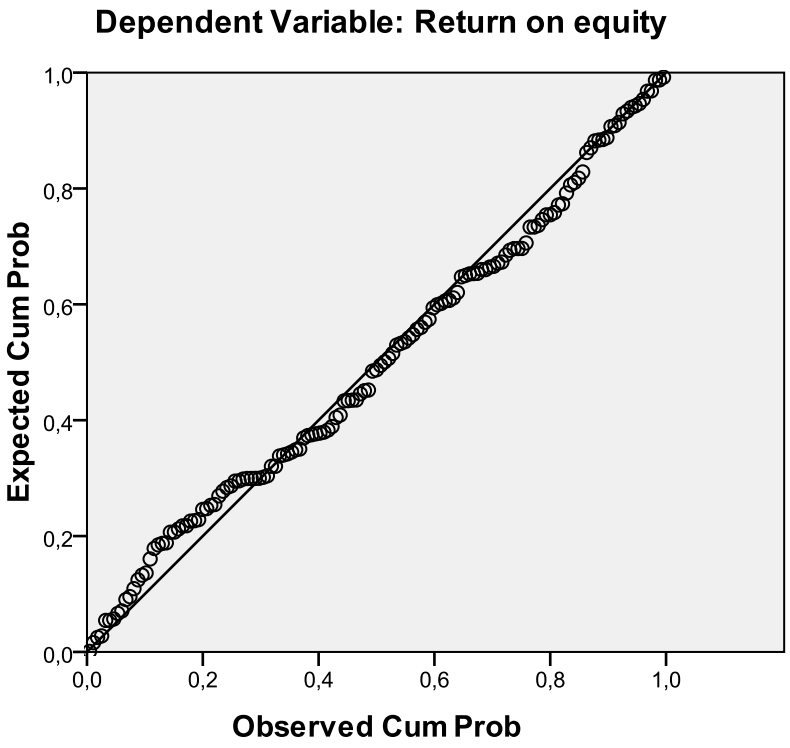

Figure A.10: Normal P-P plot ROE excl. outliers, SPSS