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Essays on Enterprise Risk Management: the Case of European Insurance Industry

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Declaration and Copyright statements

I, Dinh-Tri VO, declare that no portion of the work referred to in the thesis has been submitted in support of an application for another degree or qualification of this or any other university or other institute of learning.

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Glossary/Acronym

BLI	Business line/diversification
BTY	Business type
CAPM	Capital Asset Pricing Model
COSO	Committee of Sponsoring Organizations of the Treadway Commission
CR	Combined ratio
CRO	Chief Risk Officer
EPS	Earnings per share normalised
ERM	Enterprise risk management
FA	Firm age
FERMA	Federation of European Risk Management Associations
FS	Firm size
IAIS	International Association of Insurance Supervisors
INTL	Geographic diversification
LTIg	Long term investments
LVRG	Leverage
NAIC	National Association of Insurance Commissioners
ORSA	Own Risk and Solvency Assessment
PrE	Productivity of employee
RIMS	The Risk Management Society
ROA	Return on Asset
ROE	Return on Equity
RoR	Return on Revenue
SR	Solvency ratio
TobinQ	Tobin's Q

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Chapter 1

General Introduction

Contents

1.1 Research approach

"It seems to me that those sciences which are not born of experience ... and which do not end in known experience are vain and full of error" - (Leonardo da Vinci)

"People who have spent their lives observing nature are best qualified to make hypotheses as to the principles that bring great numbers of facts together" - (Aristotle)

According to Ryan et al. (2002), research is fundamentally about the discovery, interpretation and communication of new knowledge. However, the agreement about the source of knowledge itself is still inconclusive. Basically, there are two distinct sources: rational belief and perceptual belief.

Like most others within the social sciences, research in the financial disciplines is highly diverse in methodology. In fact, scholars in these disciplines have various backgrounds. Furthermore, they sometimes make implicit but different methodological assumptions about the nature of reality, the role of theory and the significance of empirical experimentation. Research in this field is considered a process of building precise and economical theories validated by well-designed tests using large and, as far as possible, unbiased samples. Therefore, replicability and critical evaluation of the method and results are the authentication of this type of research.

The dominant methodology of the financial disciplines, viewed by Ryan et al. (2002), is empiricist in nature and accepts the distinction between theoretical and empirical domains of discovery. Additionally, it lies in the nature of assumptions and in the linkage between observation and theoretical terms. As a consequence, observational data can take on radically different interpretations from different theoretical standpoints of researchers.

The very influential positivist essay 'The methodology of positive economics' (Friedman, 1953) has had a significant impact on the thinking of the early schol-

ars in the theory of finance. Since then, positivism has had a philosophical effect on the development of finance and accounting.

Kaplan (1986) asserts that research papers in management necessary either informed by data or tested on data and not *a priori* reasoning. He advocates that empirical studies can be used to test the validity and limits of theories. In addition, empirical studies cannot only test predictions on the existence of certain practices, but also to confirm 'how' and 'why' these practices have, or have not, been implemented. Hence, empirical studies provide a rich, but virtually untapped, research method for the study of management (including financial management).

Johnson and Duberley (2000) also argue that management research has tended towards empiricism because empiricism is concerned with empirical generalizations or causal connections through the observation of empirical association. Moreover, the attempt to develop generalizable causal propositions supported by data and logic involves the development of sophisticated, replicable data collection techniques and careful attention to sampling would give insight or have predictive powers.

Although mainstream economics and finance is said to be based on empiricist methodology Schinckus (2015), the calls for re-thinking academic finance research is on the rise. Recently, Lagoarde-Segot (2015) claims that academic finance research belongs almost exclusively to the positivist functionalist paradigm, and academic finance indeed rooted in objectivist ontology. Nonetheless, there is a gap between what financial economists (positivist rhetoric) claim to do and what they actually do: that is the impossibility to make a clear distinction between the facts and values. Indeed, it dues to two important assumptions in finance research: the preservation of Gaussian framework and central importance of shareholders (Schinckus, 2015).

Although it is possible to observe the empirical world in a neutral manner through the accumulation of objective sense-data (positivism view), any research method chosen will have inherent flaws, and the choice of that method will limit the conclusions that can be drawn (Scandura and Williams, 2000).

From precedent reviews, especially those of Kaplan (1986) and Johnson and Du-

berley (2000), I choose the empirical method for my research. However, I also support the arguments of Lagoarde-Segot (2015) on a diversification in finance research which bases on the myriad of social, behavioral, historical and institutional processes for conducting a relevant research.

1.2 Motivation

The risk management discipline has a long history. It still and always fascinates public as people aware that "***one thing is certain: nothing is certain***". There were evidence that simple risk-pooling and risk-sharing were used by the Asipu of ancient Babylonia about 3200 BC. The development of probability theory in the 17th century as well as the emergence of mathematical of statistics established a revolution in the risk management field. In addition, achievements in management science and computer science strongly promote risk management practices. However, owing to the fact that risks are more and more complex, risk management theories and practices are necessary to be studied continuously.

During the past years, there has been an impressive change in the role of risk management in corporations. Nowadays, corporate risk management practices include not only insurance but also hedging activities for different types of risk such as: operational risk, reputational risk, and strategic risk. In many companies, the chief risk officer (CRO) is responsible for the risk management function. This position has to report risk measures to the board of directors within the company's resources and risk appetite. According to Murex, a leading firm in providing software solutions for big financial institutions: "*after the subprime credit crisis in 2008, liquidity crisis in 2009, sovereign debt crisis in 2011, and therefore new reguations, there is a strong, constant evolution demand of Enterprise Risk Management (ERM) from clients*"[1].

The recent global financial crisis 2008-2009 has provoked rethinking risk management in the financial industry, focusing not only on banks but also (re)insurers. From the regulatory responses, new regulations such as Dodd-Frank Act, Basel III, Solvency II, etc., and the agreement in principle of some types of financial transactions under

[1] https://www.murex.com/solutions/business-functions/enterprise-risk-management

U.S. Generally Accepted Accounting Principles (GAAP) and International Financial Reporting Standards (IFRS) were instituted. Furthermore, the pressures from rating agencies (Moody's, Standards & Poor's) and risk management standards (COSO, ISO 31000) force risk managers to adopt a system-wide view.

Despite of its interests, ERM discipline is still on the rise and there is no homogeneous definition of ERM. One can find different definitions of ERM, such as:

- *"ERM is a systematic and integrated approach to the management of the total risks that a company faces"* - (Dickinson, 2001)
- *"ERM is defined as an approach under which all risks viewed together within a coordinated and strategic framework"* - (Nocco and Stulz, 2006)
- *"ERM is the way of measuring, understanding and controlling risks facing the firm and also viewed as a management tool that can identify profitable opportunities to enhance shareholder wealth"* - (Altuntas et al., 2011)
- *"ERM could be defined as the strategic enterprise process of identifying, assessing and responding to the collective risks and opportunities that may affect the enterprise's ability to attain its strategic goal, optimize its stakeholders' value and improve its overall stewardship and management"* - (Rochette, 2009)
- *"Integrated risk management in the financial sense is concerned with combining treatment of the various sources of financial risk, recognizing inter-dependencies between both sources risk and management responses"* - (Doherty, 2000)
- *"ERM is a process, effected by an entity's board of directors, management and other personnel, applied in strategy setting and across enterprise, designed to identify potential events that may affect the entity, and manage risks to be within its risk appetite, to provide reasonable assurance regarding the achievement of entity objectives"* - (COSO, 2004)[2]

[2]The Committee of Sponsoring Organizations of the Treadway Commission

- *"ERM process is defined as systematic process, embedded in a company's system of internal control (spanning all business activity), to satisfy policies effected by its board of directors, aimed at fulfilling Its business objectives and safeguarding both the shareholder's investment and the company's assets. The purpose of this process is to manage and effectively control risk appropriately (without stifling entrepreneurial endeavor) within the company's overall risk appetite. The process reflects the nature of risk, which does not respect artificial departmental boundaries and manages the inter-dependencies between the risks. Additionally, the process is accomplished through regular reviews, which are modified when necessary to reflect the continually evolving business environment"* - (Chapman, 2011)

- *Enterprise risk management consists of active and intrusive processes that (1) are capable of challenging existing assumptions about the world within and outside the organization; (2) communicate risk information with the use of distinct tools (such as risk maps, stress tests, and scenarios); (3) collectively address gaps in the control of risks that other control functions (such as internal audits and other boundary controls) leave unaddressed; and, in doing so, (4) complement - but do not displace - existing management control practices.* - (Mikes and Kaplan, 2015)

So, what is ERM? Currently, there are numerous definitions of ERM but among them, the definitions of Standard&Poor's (2005) and Nocco and Stulz (2006) are foremost to reflect the concept of ERM. According to Nocco and Stulz (2006), ERM is defined as "*an approach under which all risks are viewed together within a coordinated and strategic framework*". Similarly, ERM in the insurance industry, from the point view of S&P, indicates "*risk-management processes that are carried across the entire enterprise and that form a basis for informing and directing the firm's fundamental decision making*". More precisely, ERM (1) allows a more prospective view of an insurer's risk profile and capital needs, (2) is a highly tailored analytic process that recognizes each insurer's unique structure, products, mix of business, potential earn-

ings streams, cash flows, and investment strategy, and (3) is a process that recognizes the benefits and risks of a diversified base of products, investments, and geographic spread of risk that can quantify the benefits of uncorrelated or partially correlated risks.

There are several reasons explaining why ERM is on the way of its evolution. First, there would be inefficiency if managing each risk class in a separate silo due to lack of coordination between various risk management departments. Firms could exploit natural hedges by integrating decision making across all risk classes. Particularly, firms with plenty of investment opportunities are more likely to have advantages in selecting investments based on a more accurate risk-adjusted rate. Moreover, there are possible interdependencies between risks across departments that might not be awared in the traditional risk management model. Second, assessing the financial strength and risk profile of complex firms e.g. financial institutions are difficult for outsiders. Through ERM, these firms might better inform outsiders of their risk profile and convey a signal of their engagement to risk management. As enhancing risk management disclosure, ERM is believed to reduce the expected cost of regulatory scrutiny and external capital (Meulbroek, 2002). Third, ERM is said to help evaluating firm's performance better when operating performance will be viewed in the light of risk choices and risk tolerances. For instance, between two firms that have the same levels of risk and the same performance, the firm with ERM will be higher appriciated because its decisions based on risk awareness.

In the context of the insurance industry, ERM plays a more important role as insurance business has considerable contributions to the economy. Outreville (2013) in his profound review figures out that the insurance-growth nexus is not only "demand-following" but also "supply-leading" (Ward and Zurbruegg, 2000), implying the causality links between insurance and economic development (Lee, 2011). In fact, insurance not only enhances a wide range of economic transactions through risk transfer and indemnification but also promotes financial intermediation. The positive externalities from insurance coverage including increased purchases, profits, and employment both within and alongside the insurance sector. Furthermore, insurance encourages inno-

vation within an economy by offering to insure new risks e.g. testing new products. In addition, insurance has possibility to reduce risk in the economy by modifying individual's behavior via bonus-malus incentives as the case of automobile insurance.

Regarding the benefits from insurance as a financial intermediary, the development of the insurance market has significant contributions for the accumulation of efficient capital within an economy. The huge idle-capital also enhances the liquidity in the financial markets when stakeholders want to realize early moneytary of their asset holdings. Furthermore, insurance companies as institutional investors in corporations not only help capital allocation but also further empower their investments through increased level of monitoring. Last but not least, the impact of insurance on economy even was mentioned in the first conference of UNCTAD in 1964 "*a sound national insurance and reinsurance market is an essential characteristic of economic growth*"[3].

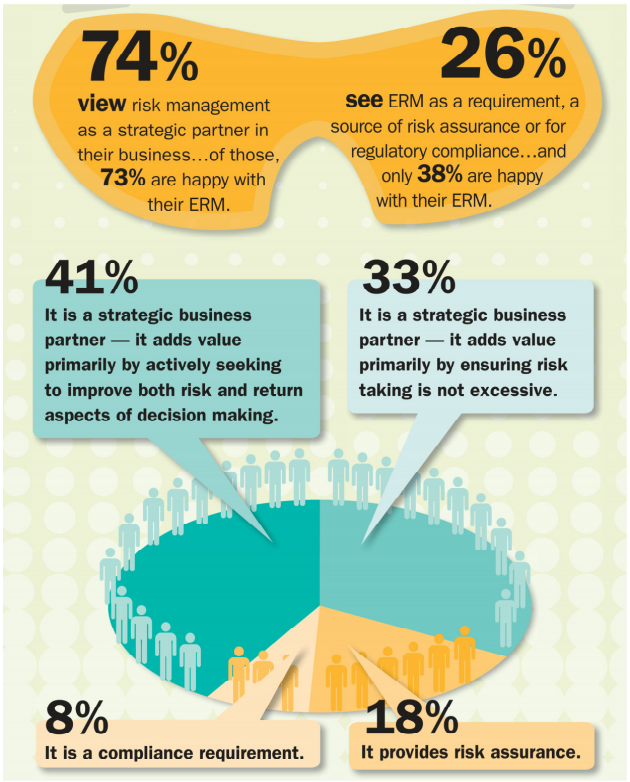
Reports on ERM from consulting firms or professional risk institutions are more and more frequent and regular. This proves that ERM is not only a concern, but interests more public and there is a call for more evidence of ERM adoption. A report of Tower Watson in 2015 which surveyed almost 400 insurance executives worldwide shows in Figure 1.1 that: (1) insurers are mostly satisfied with ERM when they engage risk management as a strategic partner - in the last 10 years, there has been a decided shift, particularly by larger insurers[4], to using ERM as a way to manage risk more effectively in order to improve business results, (2) insurers are looking beyond regulatory imperatives to address their true business needs, (3) Risk appetite and tolerances are viewed as highly important aspects of insurers' end-state ERM vision, and (4) insurers have identified key risk performance metrics and reporting systems as high priorities. Despite the fact that most of these reports rely on surveys, they have become truly additional sources for academic studies. In fact, they provide not only the current status of ERM implementation but also an important evidence affirming that ERM exists, besides the prominent proxy i.e. CRO position.

[3]Proceeding of the United Nations Conference on Trade and Development, first act and report, p.55, Vol. I, annex A.IV.23

[4]company with annual revenue in excess of US$10 billion.

Although research on risk management is numerous, study on enterprise risk management, particularly in the insurance industry, is sparse. The absence of clear empirical evidence on the value of ERM programs continues to limit the growth of these programs. The two main aspects that interest much researchers are the determinants and the economic value of ERM. Regarding the first aspect, variables such as firm size, leverage, volatility, diversification, and ownership are frequently examined with some difference in results due to selected samples and methodologies. On the subject of the second aspect, most of studies advocate the positive relationship between ERM and firm value (Gordon et al., 2009; Hoyt and Liebenberg, 2011; Eckles et al., 2014) but some studies exhibit equivocal or doubtful results (McShane et al., 2011; Pagach and Warr, 2010). However there is no common conclusion.

Figure 1.1: ERM evaluation



Source: Eighth Biennial Global Insurance Enterprise Risk Management Survey - Tower Watson 2015

Studies on this subject, employ both qualitative and quantitative approaches. While surveys and interviews are used in identifying determinants and the maturity of ERM, empirical studies with publicly data are used to examine the impact of ERM adoption on firm performance as well as firm characteristics. Another new trend is field studying. This approach is supported by the contingency theory with the argument that obtained results would be more robust and coherent when researchers can follow the sample over the years. According toGatzert and Martin (2015), empirical studies are often restricted to a single country and/or certain industry sector due to the challenge of data collection. In addition, they document that only seven studies deal with ERM determinants and eight studies consider the value of ERM. Meanwhile, Mikes and Kaplan (2013) promote the contingency theory in managing risk which favors studies within the industry or even within organizations.

Besides the development trend of ERM in both research and practice, current limited empirical studies on ERM in the insurance industry motivate my thesis. In fact, one knows that insurance firms are important financial institutions of all economies. The efficiency of risk management of insurance firms not only affects major stakeholders, but may also cause systemic risk as influential investors. Therefore, more empirical evidence of ERM would complement the literature and practice of risk management in the insurance industry. My study conducted with the EU insurance market data aims to avoid differences that might arise from regulatory and differences across industries. Moreover, obtained results would be used to compare them with previous studies, which mostly exploit the US insurance market data.

1.3 Note on the sample choice

All empirical chapters of this thesis exploit the same database from the EU insurance market. It is knowledgeable that Europe is the cradle of the insurance industry and it presents currently 35,53% of the world market share. Moreover, Europe has a special characteristic that it possesses both common law and civil law system. This peculiar shapes EU a complex and re-united market. Consequently, the obtained results will complement the current literature.

Most of previous studies on ERM focus primarily on the US market and few researchers examine within the insurance market (except for a study of Altuntas et al. (2011) on the German insurance market). In fact, the majority of authors prefer to conduct their study with cross-industry and opulent data of the US market. The sample includes 23/28 countries in the EU. However, a major market such as France presents only 5 firms because most of the insurance companies in France are mutual company. Accessing data for non-stock companies is resources consuming and also a challenge for researchers.

It is important to note that for identifying ERM adoption, current literature and practice based on the proxy of the CRO position or ratings from consulting firms. It is therefore necessary to develop an ERM index database, as what has been done for CSR. This thesis conducts a comprehensive search within the annual reports with keywords used by previous studies. Furthermore, ratings of S&P and Tower Watson are used to compile a list of insurers that implement ERM. Although S&P classifies the maturity of ERM into 4 levels, I choose the ERM as a binary variable due to limitation of observations.

With regards to the legal environment, regulations to some extent affect the decision to implement the ERM system. The insurance market is a market that compliance is one of the critical issues. As a consequence, the decision to implement ERM could provoke endogeneity and/or sample-selection bias issues. For the selected period 2007-2013, I believe that since S&P started to rate ERM of insurance firms in 2005, it takes about 3 years for insurers to put an initiative on the way. Moreover, the financial crisis 2007-2008, the introduction of new regulations in 2009 and discussions on Solvency II during the start of this period should be good signals of implementing ERM for the reason of compliance.

1.4 Thesis structure

This thesis consists of three empirical essays, discussed in Chapters 2, 3, and 4. In Chapter 2, I examine the determinants of ERM adoption through studying EU insurance firms. Chapter 3 investigates the effect of ERM on the performance of

insurance firms via the Tobin's Q, EPS and ROA. Finally, Chapter 4 focuses on the financial distress of these firms via Solvency ratio.

At the context of multidimensional ERM, they all look to better investigate the effects of the implementation of ERM. The three chapters aim to answer three main questions which have not had conclusive answers, particularly in the insurance sector: (1) What are the determinants of ERM adoption in the insurance industry among popularly studied characteristics? (2) Does the ERM adoption affect firm performance? (3) Does the ERM adoption has an impact on the financial vulnerability of firms? From a broaden view, these questions shed lights on the effects of ERM on firm performance.

Gatzert and Martin (2015) recently synthesized in their study that there are two main streams of ERM that attract scholars: the determinants of ERM adoption and the value created by ERM. Studies on ERM, therefore either focus on firm characteristics, or both firm characteristics and firm performance. Under this approach, the main research question of Chapter 2 is related to the identification of firms that implement ERM. Other two research questions deal with the hypothesis of ERM adoption and firm performance, through some indicators: firm value, ROA, EPS and solvability of the insurance firm. In short, all of three main questions examine the empirical evidence of ERM implementation. Therefore, they can be linked together under the ERM discipline.

In Chapter 2, I examine what are the determinants of ERM adoption in the insurance industry. I find that ERM adopting firms in general are more leveraged, bigger and focus more on their core business. Furthermore, adopting firms have higher employee's productivity, firm value and invest more in the long-term. The overall findings of Chapters 2 confirm findings of related previous studies (Hoyt and Liebenberg, 2011; Pagach and Warr, 2011; Beasley et al., 2005). Additionally, it complements some new facets of firms relating ERM adoption.

Chapter 3 examines whether ERM adoption affects firm performance via indicators such as TobinQ, ROA and EPS. I find that ERM adoption is positively associated

with TobinQ and ROA while it is negatively correlated with EPS. The finding related to TobinQ and ROA is consistent with studies of Hoyt and Liebenberg (2011) and McShane et al. (2011), suggesting that the ERM implementation has a positive impact on firm performance. In Chapter 3, I also investigate what are the relations between firm performance and firm characteristics in the presence of ERM. I find that leverage is negatively correlated with firm performance. Similarly, the diversification indicates a negative correlation with firm performance. Furthermore, I find that impacts of firm size on performance is heterogeneous across estimations.

In Chapter 4, I study the relation between ERM adoption and financial distress via solvability. I find that without controlling macro factor (IPP), ERM adoption is a significant factor of insurance firm solvency. In addition, insurance firms with higher leverage, older, bigger, higher market value and business diversified tend to have higher insolvency.

1.5 Contributions of the thesis

Research on ERM in the insurance industry is not only limited in the number of studies with regard to research in financial markets but also focused mostly on the US market. Although European has a perspective of a single market, the practices of each market within EU reflect firm's risk management strategies differently. Moreover, investigating the value of ERM adoption with a comprehensive approach sheds more lights to the understanding of how ERM impact firm performance.

This study matters for several reasons. First, ERM is the subject that interests more and more insurance sector under the pressures of stakeholders such as regulators (Solvency II is enacted in January 2016), shareholders, and rating agencies. Second, to my knowledge this is the first study focus on the EU market, which accounts for 35,53% world market share (SwissRe, 2015b). European and single industry perspective, allowing new insights into the current literature on ERM. Therefore, this study contributes to our understanding about the empirical evidence of ERM implementation in the EU, especially on firm value and firm solvency. Third, this study contributes to the literature on the determinants of ERM adoption in the insurance

industry. Finally, the study suggests some implications for firm executives, researchers and even policymakers.

The three empirical essays presented in Chapter 2, 3 and 4 make several contributions to the literature. Chapter 2 contributes to the literature on the determinants of ERM adoption, particularly in the insurance industry. Furthermore, it provides additional evidence for ERM implementation in the European Union, as the first study to my knowledge. Using the Probit model, the findings suggest that insurance firms are more likely to adopt ERM when they are more leveraged, bigger, and focus more on their core-business. Additionally, adopting ERM firms have higher employee productivity, firm value and invest more in the long-term.

Chapter 3 provides more insides into the value of ERM by investigating the impact of ERM on firm' s performance: TobinQ, ROA and EPS. Furthermore, in Chapter 3, I employ different estimation techniques that deal with both endogeneity and sample-selection issues such as Heckman 2-step, treatment effects and Hausman-Taylor. Results show that ERM adoption has a significant impact on TobinQ, ROA and EPS. In fact, the correlation between ERM and TobinQ/ROA is positive while the correlation between ERM and EPS is negative.

Chapter 4 is the first study to examine the impact of ERM on insurer's solvability, providing insights into the question of how can risk managers justify the value of ERM. The empirical results of Chapter 4 suggest that ERM adoption has a positive impact on insurance firm solvency. These findings enhance our knowledge about the relationship between ERM adoption and firm performance, with some additional financial facets.

Overall, my thesis not only contributes to the literature on ERM and firm performance, but also offers insights into the implementation of ERM in the insurance industry. Similarly with Hoyt and Liebenberg (2011), I find that firm size, leverage, and TobinQ are positively correlated with ERM adoption. Furthermore, I also find that adopting ERM firms are more core-business oriented, located in developed markets, and invest more in the long-term.

Chapter 2

Determinants of ERM adoption in the insurance industry

Contents

Abstract

This chapter seeks to address how to identify the determinants of ERM adoption in the insurance industry. Using the sample of 101 European Union insurers during the period from 2007 to 2013, my findings suggest that insurers tend to implement ERM when they are more leveraged, bigger and concentrate on their core-business. ERM is appreciated where firms have a higher performance and located in developed markets. Despite the fact that the difference between ERM and non-ERM firms is clear, some determinants such as firm age, core-business is life insurance or non-life insurance, internationally operation are not statistically significant. I argue that examined indicators are good references to identify ERM adoption, even firms do not disclose their practice.

2.1 Introduction

Traditionally, risk management is a fundamental activity of insurance companies and it has been performed in separate silos for each major risk (Standard&Poor's, 2005). However, there has been a revolution in the risk management discipline. Much more scrutiny of risk management is now required by rating agencies, regulators, shareholders and other external stakeholders. Not only because insurers play an important role in the financial markets but also because the complexity of the different risks increasing over time. At the International Insurance Society Roundtable on Risk management after crisis organized in 2009, Geoffrey Bell[1] (Bell et al., 2009) stated that *"Models have been very important, and they will continue to be very important. In fact, they are essential to keeping economies going. But models are not economic reality, of course, and you have to be very careful in how you use them; you have to recognize their limitations. We went far too far with the idea that a model can tell you how much capital you need, with little or no need for judgment - p.31"*. This implies that managing risks with advanced models is not sufficient and sometimes could be dangerous, though modeling is one of the core pillars of financial firms. There is a need of managing risks with a global vision that is risk management should be embedded in firm strategies and perceived at all firm levels.

During the recent financial crisis, the insurance sector's write-downs are comparatively small (Lehmann and Hofmann, 2010). Insurers and re-insurers remained solvent, except the special case of AIG. According to Schich (2010), the 2007-2008 crisis may primarily be a banking crisis, and the solvency of the insurance sector as a whole does not appear to be threatened. In many cases, they are profitable throughout the crisis while providing risk transfer products to both corporations and individuals (Doherty and Lamm-Tennant, 2009). However, Khosrowshahi[2] (Bell et al., 2009) emphasized that *"the crisis has revealed a vulnerable spot in the risk management program of many insurance companies such as the asset management function and its*

[1]President of Geoffrey Bell & Company, an international adviser that specializes in international reserve and asset-liability management programs, and in capital market transactions and economic, financial, and country risk analysis

[2]Bijan Khosrowshahi, President and CEO of Fairfax International

tendency to be run as a profit center independently of the core insurance business - p.39". This idea implies that an effective risk management program should be run in a holistic manner. In fact, the current pressure from NAIC ORSA in the U.S, Solvency II in the European Union, and requirements from IAIS are forcing insurers to adopt a new risk management system, which is popularly called Enterprise risk management (ERM).

Since the mid-1990s, ERM has emerged as a concept and as a management function within corporations (Dickinson, 2001). Then, it has interested more practitioners and researchers. For instance, professionals use COSO, AS/NZ4360, FERMA or ISO 31000 as their guidelines for risk management standards in different industries. In practice, ERM also gets much attention in response to the need in the implementation of ERM. As a result, a number of frameworks have been developed, such as COSO or ISO 31000. This new paradigm of risk management even considered as a criteria of ranking in the insurance industry, as the case of S&P, A.M. Best and Moody's.

Researchers also have interest in ERM, especially regarding two aspects: the determinants and the value of ERM implementation (Gatzert and Martin, 2015). In the literature, ERM is widely discussed, spreading from ERM framework, the degree of implementation to the determinants and the benefits of ERM (Pagach and Warr, 2011). The approaches to answer these research questions are various. For instance, several authors study the implementation of ERM based on surveys, questionnaires, or interviews (Kleffner et al., 2003; Beasley et al., 2008; Altuntas et al., 2011). Other quantitative studies examine the characteristics of firms that significantly influence the implementation of an ERM system and the benefits of ERM by using multivariate methods (Gatzert and Martin, 2015).

Nevertheless, identifying firms that implement ERM and its maturity persists as a difficulty. In fact, it is challenged to identify firms that engage in ERM though the existence of CRO or senior risk management positions or even an ERM announcement. In October 2005, Standard & Poor's Ratings Service introduced a separate, major category of evaluating the Enterprise risk management practices of insurance

companies. As insurers are influenced by ratings services (such as S&P, Moody's and A.M. Best), ERM ratings are considered as a high credible evidence of ERM adoption (McShane et al., 2011). The 2015 insurance CRO survey of Ernst & Young shows that the ERM framework has been the second concern of CROs just after capital modeling, stress testing in the near future.

With a restricted number of studies on ERM, empirical evidence on the value of ERM is not clear and somehow differs. As a result, firm executives are uncomfortable making a deeper commitment to ERM (Hoyt and Liebenberg, 2011). This may cause two-way effects on ERM study when identifying ERM adoption still challenge. Empirical evidence could also be cross-sectional studies, field-based studies of organization in the same industry or even within the same organization (Mikes and Kaplan, 2013). Of course, each method has its (in) conveniences depend on the availability of data sample. Cross-sectional studies can give a general understanding of the subject, however field-studies give a deeper understanding when managing risk in reality could not be *"one size fits all"*[3].

In this study, I examine characteristics that are hypothesized to be the main determinants of ERM implementation for a final sample of 101 publicly traded European Union insurers from 2007 to 2013. It is important to identify firms that adopt ERM to evaluate the impact of ERM. Moreover, figuring out the common characteristics of ERM adopting firms helps stakeholders understand more about risk management activities of firms. In fact, outsiders have difficulties in assessing the financial strength and risk profile of complex firms such as insurers. Through ERM, these insurance firms might better inform outsiders of their risk profile and convey a signal of their committement to risk management. For a comprehensive identification of ERM, I follow previous studies with keywords search in the annual reports of these insurers: chief risk officer, enterprise risk management, risk committee, integrated risk management (Hoyt and Liebenberg, 2011; Pagach and Warr, 2011). More importantly, I link with ERM ratings of Standard & Poor's in 2008, 2010, 2011 and 2013 to complement

[3]the frequency of risk identification and assessment processes must match the velocity of risk evolution

with their annual reports.

This study is motivated by the fact that ERM is the subject that interests more and more insurance sector under the pressures of stakeholders such as regulators (Solvency II is applied in January 2016), shareholders, and rating agencies. Second, to my knowledge this is the first study focusing on the European Union market which accounts for 35,53% world market share (SwissRe, 2015b). European and single industry perspective allowing new insights into the current literature on ERM. Therefore, this study contributes to our understanding about empirical evidence of ERM implementation in the European Union, especially on identification of ERM adoption. Finally, the study provides additional evidence on ERM, giving more information for both firm executives, researchers and even policymakers.

Methodologically, I follow the approaches of Liebenberg and Hoyt (2003), Pagach and Warr (2011), and Eckles et al. (2014) who use multivariate binary choice model to answer their research questions. Take the size of the sample into account, both logit or probit model would have not much difference. However, I will compare two methods. I believe that ERM maturity will change at certain thresholds, so the results of the Probit model can be used for other research questions. In this study, I propose a comprehensive approach to identify insurance firms that implement ERM, especially take some proper characteristics and financial indicators of insurers which were ignored in previous studies into account, such as combined-ratio, solvency ratio, productivity of employees, etc.

Using a sample of 101 European insurers from 2007 to 2013, I find that adopting-ERM insurers are more leveraged, bigger and more specialized in their core-business. Regarding characteristics from the view of performance, these firms also have higher performance in terms of ROA, PrE, EPS, and Tobin's Q. In addition, adopting-ERM firms are located more in developed markets.

I conjecture that besides the compliance, insurance firms adopt ERM because of their own interests. The examined variables in this study represent important determinants. Explications for this argumentation are based on the conveyed information

on these variables: risk management strategy and operations are evaluated within the context performance and firm characteristics.

The rest of this chapter is structured as follows. First, I discuss related studies and develop the main hypotheses. Second, I present the research design and discuss econometric issues. Next, I describe the data selection process and summary statistics. Third, I report the empirical results and discussions.

2.2 Literature review and hypothesis development

2.2.1 The evolution of ERM

The history of risk analysis and risk management can be traced as far back as the practices of the Asipu of ancient Babylonia in the Tigris-Euphrates valley about 3200 B.C. and the emergence of probability theory in the 17th century (Covello and Mumpower, 1985). Then, with the rise of capitalism, scientific management (Taylorism and Fayolism) and mathematical theory of probability and statistic, there is a common agreement that risk management, like other fields of business management, is both an art and a science (Gahin, 1967).

Simkins and Ramirez (2008) review the history of risk management with examples of evidences in India around 2000 B.C., in ancient Greek and Roman Empire in the 1100s, or in Japan in 1600s. Modern risk management using futures trading began in the Midwestern United States in the early 1800s in the area of the grain trade. In the 1950s, advancements in the mathematics for quantifying financial risks were developed, with Markowitz's mean-variance theory and then the CAPM model of Sharpe and Lintner. In 1973, Fisher Black and Myron Scholes published their famous paper for option pricing. Collectively, these studies provided a method to quantify the risk that revolutionized the field of finance and economics. According to Simkins and Ramirez (2008), ERM is *"a natural evolution of the process of risk management, and represents a more advanced and sophisticated approach to managing risk"*. Furthermore, under ERM *"all risk areas function as parts of an integrated, strategic, and enterprise-wide system. While risk management is coordinated with senior-level over-*

sight, employees at all levels of the organization using ERM are encouraged to view risk management as an integral and ongoing part of their jobs".

Verbano and Venturini (2011) introduce a brief history the risk management. According to them, Bernoulli is the first person who has researched on risk in 1738 by measuring risk with the geometric mean and minimizing risk by spreading it across a set of independent events. Then, they figured out that Fayol (1931) considered risk management as one of the six main functions of the management of the firm. Between 1955 and 1960, adopting risk management to reduce insurance cost emerge in the USA (Mehr and Hedges, 1963) and only pure risk was taken into account. During the 1980s, insurance premiums increase significantly led to the need of alternative techniques. Insurance now becomes one of the risk transfer tools. The evolution of the economic-financial context of firms force risk management toward managing the volatility of business and financial results as well as to a focus on optimizing firm performance. This evolutionary change led to the modern definition of risk management according to which *the aim of risk management is to create value for a firm through a proactive and integrated approach.* Furthermore, they propose a comprehensive risk management framework with different paths depend on types of risks and the field of application. For example, they are classified as strategic risk management, financial risk management, enterprise risk management, insurance risk management, project risk management, engineering risk management, supply chain risk management, disaster risk management, and clinical risk management.

Risk management is considered as a formal part of the decision-making process within companies in the late of the 1940s and early 1950s. At that time, managers only considered whether to transfer or to retain insurable risks with alternatives. In the 1970s, with the development of financial derivative products, managers began to look more closely at how they managed various financial risks (Dickinson, 2001; Jorion, 2010). However, managing risks during this period seems to only stand on the view that risk management as a means of ensuring loss avoidance, not as an integrated part of value-creation process such as the concept of economic capital.

The mid-70s and the early 1980s also saw a blossoming of risk management in the Europe. In 1982, Crockford (1982) suggested that risk management is a linking function, coordinating diverse disciplines and skills to address both constant and variable risks. Later on, there was recognition arose from more general management thinking: a more holistic approach to risk management is feasible (Kloman, 1992). Similarly, Miller (1992) proposed an integrated risk management framework with its major strength of recognition of trade-offs between exposures to various uncertainties. However, integrated/enterprise-wide risk management is not a new idea when J.Long (1960) advocated an enterprise-wide approach to risk management. His advanced idea, as sometimes, had to wait to be recognized (Corbett, 2004). Since then, risk management has expanded rapidly on a global basis and well beyond its traditional insurance boundaries. Risk analysis and risk assessment have become far more sophisticated, using new tools of mathematics and decision theory, especially in financial theory.

Scholars start to discuss more about the concept of integrated risk management (also called holistic, enterprise-wide risk management) in 2000s. This concept defined by Deloach and Temple (2000) as a structured and disciplined approach that aligns strategy, processes, people, technology and knowledge with the purpose of evaluating and managing threats and opportunities that the enterprise faces as it creates value. Furthermore, current widely discussed and advocated ISO 31000 standards has a similarity with their new set of definitions such as:

- Risk is *"the effect of uncertainty on objectives"*
- Risk management is *"coordinated activities to direct and control and organization with regard to risk"*
- Risk management framework as a *"set of components that provide the foundations and organizational arrangements for designing, implementing, monitoring, reviewing and continuously improving risk management processes throughout the organization"*.

- Risk management process is a *"systematic application of management policies, procedures and practices to the tasks of communication, consultation, establishing the context, identifying, analyzing, evaluating, treating, monitoring and reviewing risk".*

There is another fruitful review of Hunter and Smith (2002) which explains why firms choose to manage risks as well as the development of risk management in the field of financial risk management. They showed that the area of risk management applied at the level of the individual, the corporation, and the economy as a whole. Particularly in corporate risk management, they suggested that risk management at the managerial level must be aggregated or netted at the aggregated level in financial and banking markets. Through the review, they exhibited the picture of risk management chronically with the studies of Modigliani and Miller (1958), Markowitz (1952), Tobin (1958), Arrow (1963), Sharpe (1964), Litner (1965), Black and Scholes (1973), Merton (1973), Ross (1978), Harrison (1979), Doherty and Tinic (1981), Smith and Stulz (1985), and Froot et al. (1993). They also group studies on risk management into five areas as follows: leverage and rationales for corporate risk management; mode value at risk (VaR), stability of risk measures across models and time; trade, credit and systemic risk; and insurance and related issues.

Bromiley et al. (2014) provided a comprehensive review on ERM. The authors synthesized the definitions of ERM and other synonyms such as corporate risk management, multidisciplinary risk management, total risk management, holistic risk management, coordinated risk management, integrated risk management. According to the authors, there is an emerging consensus about the core elements of ERM. First, managing risk as a portfolio is more efficient than in silos. Second, ERM address both quantifiable risks and non-quantifiable risks or traditional and strategic risks. Third, ERM should not just look at downside risk but also upside risks, which means that firms could seek competitive advantage from it. Interestingly, they distinguished between the enterprise risk management study from the point view of management scholars and accounting-finance scholars. For example, they argue that accounting-

finance scholars often define optimal conditions, and then offer tools consistent with those conditions. Meanwhile, management scholars emphasized understanding how firm behave, and sometimes the association of such behaviors with performance. Beside this, they raise two thought-provoking issues. First, Enterprise risk management could be understated its value when Enterprise risk management pays off primarily in exceptional times when using continuing accounting performance. Second, how do we treat when organizations which have objectives beyond accounting performance. In fact, there is a trend of corporate social responsibility in big groups and investment responsibility is one the key pillars.

Apart from the trend that advocating Enterprise risk management as an evolving discipline, Mikes and Kaplan (2015) further suspect the frameworks as well as the maturity of risk management models. Their proposed contingency theory in managing risk indeed very thoughtful, critical and convinced. The fact is that each organization has its own facets that influence the impact of an initiative, as the case of Enterprise risk management adoption. Moreover, human decision always considered as an important factor in the organization' s activities, which differs from one to the others. Apparently, it must have a framework with core principles while keeps studying various risk management practices, toward a universal form of Enterprise risk management.

2.2.2 Determinants of ERM adoption

Studies on determinants of ERM adoption (Kleffner et al., 2003; Beasley et al., 2005; Paape and Speklè, 2012) use mainly qualitative focus with surveys and/or interviews and empirical studies with public data. In the first stream, studies try to find out the level of ERM implementation, the drivers of ERM adoption and several aspects of risk management practices.Kleffner et al. (2003) survey risk managers in Canada who are members of RIMS. With 118 responses from 336 sent surveys, their results suggest that risk management compliance has effects on ERM adoption and top managers play an important role in implementing ERM. Furthermore, ERM is a trend as the awareness of risk management is increased, with the perception of the

company-wide risk management.

Beasley et al. (2005) used survey with the members of IIA's Global Audit Information Network (GAIN) with the final sample of 123 organizations. Their findings suggested that the board and senior management leadership on ERM is critical to extensive ERM implementation. Firm characteristics such as size, industry, auditor type and country of domicile help to explain the extent of ERM deployment. They also argue that the presence of a CRO is positively associated with ERM system, which is statistically significant.

Altuntas et al. (2011) not only used surveys with 86 questions on 21 aspects of ERM but also telephone interviews and empirical data from insurance companies operate in Germany. With data of 113 insurers have at least 40 million euros in gross written premiums during 1999-2008, they find that the adoption of ERM dues to career concerns, especially CEOs. In addition, negative changes in the past firm performance increase a firm's probability to adopt ERM.

Paape and Speklè (2012) used questionnaires for 825 organizations located in the Netherlands which have more than 30 employees and annual revenues over 10 million euros. They proposed 5 stages of ERM implementation and examined several aspects related to ERM such as regulation influence, internal influence, ownership, auditor, and firm/industry characteristics. Their results argue that having CRO and publicly traded firms have more mature ERM systems. In addition, larger organizations and firms in the financial sectors tend to have more sophisticated ERM systems. Similarly with some previous studies, they found no evidence of an effect of institutional ownership as well as auditor-related influences.

These above studies which combine both surveys and empirical data have advantages of further understanding the status of ERM in each organization. However, there is a risk in designing questionnaires if all respondents do not have the same perception of ERM, especially the concept of ERM. Data from cross-sectional or single industry each has its own advantages and disadvantages. Cross-sectional studies give more generality of evaluation, but single industry studies give more pertinence.

In the second stream, researchers aim to find statistical significant evidence regarding the determinants of ERM by using multivariate methods. Most of the studies (McShane et al., 2011; Pagach and Warr, 2011; Hoyt and Liebenberg, 2011) have underlying data from U.S. firms for different time periods. The existence of the position CRO or similar and ERM related keywords is used as the proxy for ERM implementing evidence (Gatzert and Martin, 2015). Another technique to identify ERM is based on ERM ratings and surveys of rating agencies and consulting firms. McShane et al. (2011) and Baxter et al. (2013) using ERM ratings of S&P in 2006-2008 to examine several aspects of banks and insurers and ERM adoption. According to Baxter et al., firms with superior ERM system are more complex, have greater financial resources and better corporate governance. Although McShane et al. (2011) focus on the relation between firm value and the maturity of ERM, they found that there is a positive relationship between ERM rating and firm size, but no straightforward pattern for the relationship of ERM rating and other variables such as leverage, complexity, cash-flow volatility as well as growth opportunity.

Among determinants of ERM adoption, the majority of researchers interest in firm size, financial leverage, volatility, opacity, growth opportunity, diversification, and ownership. According to empirical studies, the impact of firm size on ERM is identified as a positive determinant (Hoyt and Liebenberg, 2008, 2011; Pagach and Warr, 2011). Therefore, larger firms tend to require a more efficient and holistic risk management system as a result of the increasing scope and complexity of risks. Diversification has the same argumentation, however findings cannot confirm this assumption in general. In fact, diversification in different contexts has different results. For instance, industry diversification has positive significant but international diversification has mixed results (Beasley et al., 2005; Hoyt and Liebenberg, 2011).

This also happens when looking at the financial leverage, the results are equivocal. While Liebenberg and Hoyt (2003) find this aspect to be significantly positively related to ERM, Hoyt and Liebenberg (2008, 2011) show a negative relationship. The positive coefficients support the assumption that more leveraged firms need more efficient risk management system to mitigate potential losses due to greater risk of financial

distress. Adversely, lower leveraged firms may have more favor in ERM as they expect to take more financial risk in the future, or leverage is not the most important factor of an ERM engagement.

Regarding volatility and institutional ownership, there is always a positive relationship with ERM adoption. One can argue that as firms with more volatility, an ERM system can help to smooth these variances. With the presence of institutional shareholders, firms supposed under the pressure to engage in an efficient and holistic corporate risk management. In contrast, in general, no significant evidence is found concerning the impact of opacity and growth opportunity.

2.2.3 Hypothesis development

As mentioned earlier, this study examines whether ERM adoption in the insurance industry exhibits some common characteristics of insurers. The main research question of my study is *"which firm characteristics are associated with the implementation of ERM?"*.

Among firm characteristics, some characteristic interest much more scholars than others, such as leverage, size, opacity, earnings/cash flow volatility, growth opportunity, diversification and institutional ownership.

Most of previous studies on ERM determinants take firm leverage into account. However, findings are dissimilar. For instance, Hoyt and Liebenberg (2003,2011) showed contradictory results. Study on the CRO appointment of 26 US firms in which 15 are financial firms, Hoyt and Liebenberg (2003) found that firms with CRO appointment are more leveraged. Nevertheless, studying on ERM adopting firms in the US insurance industry, Hoyt and Liebenberg (2011) argue that insurance firm with the presence of ERM are less leveraged. Pagach and Warr (2007) advocate that firms appear to implement ERM when they are more leveraged.

I assume that insurers engaging in ERM may have higher financial leverage as they are more advanced in capital management and they tend to look forward upside risks. Furthermore, insurers with ERM tend to secure their long-term liabilities with

long-term investments. So, I will test the first hypothesis, stated in its alternative form is:

H1a: adopting ERM insurers are more leveraged than non-ERM firms.

H1b: adopting ERM insurers hold more long-term investments.

Regarding firm size, most results show that firm size positively related to ERM. Beasley et al. (2005, 2008), Gordon et al. (2009), Hoyt and Liebenberg (2008, 2011), and Pagach and Warr (2011) argue that the impact of firm size on ERM is a positive determinant. Thus, the argumentation is that larger firms appear to deploy a more efficient risk management system as the result of increasing scope and complexity of risk. However, in case of insurance industry, insurers are experts in their core business of risk management, so firm size does not matter with the implementation of ERM. There are numerous studies on firm age and its impact (Coad et al., 2013), but in the case of the insurance industry, insurance core business depends a little on the number of years operation.

The hypothesis, expressed in its null form, that I test is:

H2: there is no difference in terms of size and age in adopting ERM between insurers.

Volatility is one of the variables that researchers choose when they study on ERM adoption. However, findings on this variable are not in common. For example, studies in the insurance industry (Hoyt and Liebenberg, 2011; Acharyya and Mutenga, 2013) show that firms are less volatile. However, Pagach and Warr (2010, 2011) with their study on cross-industry advocate that firms engaging in ERM have more volatility. In this study, as focus only on insurance industry which is rather stable, some characteristics such as volatility, opacity and institutional ownership are not priority in research question.

With a different approach to discover other facets, I take geographic diversification, firm type, productivity, and efficiency into consideration. These reasonable characteristics could give more insights into current literature on ERM in the insurance

industry and in generality.

In fact, studies on the above variables are sparse. For instance, some studies assert that there is a significant relation between firm age and firm growth/business cycle (Choi, 2010; Coad et al., 2013; Huynh and Petrunia, 2010; Ouimet and Zarutskie, 2014; Huang and Eling, 2013; Cooley and Quadrini, 2001). Diversification appears in many studies on risk management. Productivity, efficiency could be considered as other proxies for firm performance, which is a major concern of scholars in the field of management research. The long-term investment variable is interested in case of insurance firms because investment is one of the core business of insurers, and long-term investment integrated in their strategies, together with managing risks.

Therefore, the third and the last hypothesis is stated in its alternative form:

H3: adopting ERM insurers are more complex than those who don't.

H4: adopting ERM insurers have higher operational performance than those who don't.

2.3 Research design

2.3.1 Identification ERM adoption

Currently, the empirical literature on ERM is confronted with the challenge of whether or not an ERM system has been implemented and to what level. There is a general acceptance that the CRO is the best signal until now for ERM adoption. Other sources of ERM adoption are ERM ratings from rating agencies, surveys of consulting firms and researcher's own ERM index. As ERM ratings from agencies are not publicly accessible and somehow unclear, it is necessary to have an ERM index which is more accessible and quantifiable like CSR index.

Following previous studies of Liebenberg and Hoyt (2003); Hoyt and Liebenberg (2011), Pagach and Warr (2011), McShane et al. (2011), Johnston and Soileau (2013), I scanned the keywords related to ERM or equivalent from the annual reports of selected insurers for the period 2007-2013. Additionally, I referred to the ERM ratings

of S&P in 2008, 2010, 2011 and 2013 and the survey of Tower and Watson in 2010 to identify which firm has been implemented ERM system. In the final sample, I have 412/707 firm-year observations with the presence of the ERM, which accounts for 58,27% of the total sample.

2.3.2 Model specification and variables discussion

To discover the characteristics of insurers that associated with ERM adoption, the random Probit/Logit model is employed with the assumption that differences across firms have an influence on ERM adoption.

$$ERM_{it}|X_{it} = \alpha + \beta_j f(X_{it}) + \upsilon_{it} + \epsilon_{it} \tag{2.1}$$

The equation 2.1 can be rewritten in a detailed form as follows:

$$\begin{aligned} ERM_{it} = \alpha + \beta_1 LVRG_{it} + \beta_2 LTIg_{it} + \beta_3 FA_{it} + \beta_4 FS_{it} + \beta_5 INTL_{it} \\ + \beta_6 BTY_{it} + \beta_7 PrE_{it} + \beta_8 CR_{it} + \beta_9 SR_{it} + \beta_{10} EPS_{it} \\ + \beta_{11} ROA_{it} + \beta_{12} TobinQ_{it} + \beta_{13} IPP_{it} + \upsilon_{it} + \epsilon_{it} \end{aligned} \tag{2.2}$$

Where ERM=1 if there is evidence of the presence of ERM in the annual reports or ratings, and ERM=0 otherwise. Table 2.1 summarizes the discussion of variables.

2.3.3 Data and sample selection

This study focuses on the European Union insurance industry to complement the current empirical studies on ERM. In fact, most of previous empirical studies based on US market or cross-sectional industry. Moreover, European is the cradle of the insurance industry and presents currently 36 percent of the market share worldwide.

I choose publicly traded insurers for the availability of data and disclosure information. First, I search a list of quoted insurers in the Europe from **Bloomberg**, **Stockopedia** and **Morningstar**. The maximum and minimum number of these lists are 154 and 107. Then, I link this result to the Factiva and ratings of S&P as well

as the survey of Tower Watson. I got a list of 101 insurers due to the availability of data. Indispensable data are from Eastern Europe firms. Finally, based on the final list, I search and download the annual reports of these insurers from their websites.

The period 2007-2013 is suitable for the study because the Europe starts later than the US in ERM and ratings agencies apply ERM to insurers started in 2005. Usually, it takes 2 or 3 years to put an initiative on the way. Moreover, the financial crisis 2007-2008, new regulations in 2009 and discussions on Solvency II during the start of this period could be good signals of implementing ERM.

The data are consolidated at group level. For non-euro currency countries, and data in US dollar, all are converted to euros with exchange rates at equivalent time period. The stock prices are extracted from Bloomberg, Yahoo finance and Google

Table 2.1: Variables discussion

Variable	Definition	Expected sign
LVRG	is firm leverage, measured as the ratio of liabilities to book value of equity.	+
LTIg	is long-term investment, measured as the ratio of long-term investment to asset.	+
FS	is firm size, measured as natural logarithm of number of employees.	+
FA	is firm age, measured as years of operation.	+
INTL	is geographic diversification, if firm operates domestically, it takes on a value of 0, and 1 otherwise.	+
BTY	is business-type, if firm is a broker or insurance related services supplier, it takes on a value of 0, and 1 otherwise.	+
BLI	is business-line, if firm is mono-line, it takes a value of 0, and 1 otherwise.	+
PrE	is productivity of employee, measured as natural logarithm of the ratio of revenue to total employees.	+
CR	is combined-ratio, measured as the ratio of losses and expenses to earned premiums.	-
SR	is solvency ratio, measured as the ratio of book value of equity to the maximum value between 18 percent earned premiums and 26 percent losses-benefits-adjusted.	+
EPS	is earning per share, after diluted	+
ROA	is return on asset	+
TobinQ	is proxy for firm value, measured as the ratio of market value of equity and book value of liabilities to book value of asset	+
IPP	is insurance purchasing power, measured as the natural logarithm of premiums per capita.	+

finance.

The ERM variable is compiled from scanned keywords in annual reports, ratings of S&P and the survey of Tower and Watson. Although there is a different level of ERM maturity, this research simplifies ERM as a binary variable due to limited available data and the complexity of multi-level probit/logit model.

The macro variable used to control is insurance purchasing power (IPP), which is extracted from World insurance annual report Sigma of SwissRe.

The majority of variables such as LVRG, the number of shareholders, EPS, ROA, Losses/Revenues etc. are extracted from **Morningstar**, **Stockopedia** and **Factiva**. When there are unusual figures, I use a double check within these sources and choose the ones which are more reliable.

In general, the research sample consists of 101 firms from 23 countries in the Europe for the period 2007-2013. Examined variables are extracted and computed from public sources.

2.4 Empirical analysis

2.4.1 Data and properties

This section presents descriptive statistics for the variables examined in the empirical analysis of this chapter.

Table 2.2 shows summary statistics of determinants of ERM adoption in the insurance industry in the Europe. The statistics show that nearly 60 percent of the sample associated with ERM system. In fact, among 707 firm-year observations, we have 421 firm-year observations with the presence of ERM. According to this table, on average, insurers in the Europe possess a positive evaluation when the market value is higher book value around 28 percent. ROA of insurance firms in the Europe is about 1.8 percent during the research period. This ratio is consistent with the average ratio worldwide in 2014, though European market has been a matured market.

Regarding operational ratios, especially combined ratio, European insurers show

an under-performance when losses and expenses on average higher than earned premiums about 53 percent. According to this statistic, it is evident that nowadays insurers have other important businesses besides their traditional insurance businesses. When looking at the solvency ratio based on Solvency I requirements, European insurance firms on average have better solvability. The mean value of the solvency ratio of the sample is about 4 times of required level.

From the view of the characteristics of the firm, results present the ratio of liabilities to asset on average is about 10 times. This ratio is rather high. However, it

Table 2.2: Full sample firms

Variable	Obs	Mean	Std. Dev.	Min	Max
ERM	707	0.583	0.493	0.000	1.000
PrE	654	13.244	1.250	6.766	16.496
TobinQ	665	1.287	2.396	0.250	51.966
ROA	675	0.017	0.073	-1.002	0.409
CR	669	1.530	4.422	0.022	85.000
EPS	670	2.244	39.041	-954.917	99.870
SR	667	4.254	18.751	-186.264	276.667
LVRG	673	10.974	15.210	-71.600	186.562
FS	668	7.406	2.158	0.693	12.102
FA	707	65.683	65.957	0.000	246.000
LTIg	636	0.563	0.255	0.000	1.074
BLI	676	0.577	0.494	0.000	1.000
INTL	676	0.652	0.477	0.000	1.000
BTY	676	0.879	0.327	0.000	1.000
IPP	707	7.585	0.989	4.256	8.729

Notes : this table reports descriptive statistics for selected variables in the study, with full sample. ERM is a binary variable. LVRG is firm leverage, LTIg is long-term investment, FS is firm size, FA is firm age, INTL is geographic diversification, BTY is business-type, BLI is business-line, PrE is productivity of employee, CR is combined-ratio, SR is solvency ratio, EPS is earning per share, after diluted, ROA is return on asset, TobinQ is proxy for firm value, IPP is insurance purchasing power. The appendix provides a detailed explanation of the variables.

should be known that insurance firms are regulated with strong capital and a major part of their liabilities is their policy liabilities. Insurance firms in the Europe have a mean value of age is about 65.6 years. This statistic confirms that the Europe is the cradle of the insurance market. Insurers in the Europe also have a high ratio of long-term investment. Their portfolio of long-term investment represents 57.6 percent of their total assets on average.

Statistics results exhibit that 57.6 percent of insurance firms in the study are mixed-line; 87.8 percent are core-insurance business. This confirms that the sample is suitable for the study when some firms are classed in the insurance industry, but in fact they are insurance brokers or insurance related business.

Regard to geographic diversification, 65.2 percent of the sample operate outside their home country. In fact, the European Union has a similar strongly converging regulatory and competitive setting. Hence, it encourages insurers to operate internationally.

For a further investigation, this study compares two groups of firms located in developed and developing markets.

Table 2.3 describes characteristics of firms located in the North-West Europe. In this sub-sample, insurance firms are located in developed markets with high insurance purchasing power and old aged insurers. In the sub-sample, 69.5 percent of these insurance firms associated with ERM system. Insurers located in the North-West Europe are valued 35.02 percent higher their book value on average, while their ROA is about 2.29 percent. However, their combined-ratio shows a high losses/expenses over earned premiums. The average ratio is 1.70, which is higher the ratio of full-sample is 1.53.

The solvency ratio of this sub-sample is about 5.89 which shows a strong solvability. Firms in this group have the average age of 70.44 and the ratio of long-term investments over the asset is about 58.76 percent. Results from the statistics suggest that these firms are mostly core-insurance business with 85.47 percent of the group. A majority of this group operates abroad when 76.84 percent of these firms conduct

their businesses outside their home country.

Table 2.4 describes firms which are located in the South-Eastern Europe. The results of this table demonstrate that rarely these firms adopt the ERM system. Only 32.7 percent of this group associated with ERM system. On average, firms in this group are evaluated about 13.7 percent higher their book value.

In relation to operational ratios, consist with a developing market, they have an ROA of 3.03 percent. Their average combined-ratio is 1.12 reflects a good core-

Table 2.3: North-West Europe firms

Variable	Obs	Mean	Std. Dev.	Min	Max
ERM	490	0.696	0.460	0.000	1.000
PrE	456	13.470	1.184	6.766	16.496
TobinQ	467	1.350	2.840	0.250	51.966
ROA	475	0.023	0.070	-1.002	0.320
CR	469	1.704	5.236	0.022	85.000
EPS	471	0.907	45.263	-954.917	43.721
SR	467	5.890	19.013	-6.784	276.667
LVRG	473	12.654	16.726	1.010	186.562
FS	468	7.644	2.142	0.693	12.102
FA	490	70.443	68.939	0.000	246.000
LTIg	436	0.588	0.253	0.000	1.040
BLI	475	0.537	0.499	0.000	1.000
INTL	475	0.768	0.422	0.000	1.000
BTY	475	0.855	0.353	0.000	1.000
IPP	490	8.086	0.372	6.538	8.729

Notes : this table reports descriptive statistics for selected variables in the study. The selected sample consists of firms located in North-West Europe. ERM is a binary variable. LVRG is firm leverage, LTIg is long-term investment, FS is firm size, FA is firm age, INTL is geographic diversification, BTY is business-type, BLI is business-line, PrE is productivity of employee, CR is combined-ratio, SR is solvency ratio, EPS is earning per share, after diluted, ROA is return on asset, TobinQ is proxy for firm value, IPP is insurance purchasing power. The appendix provides a detailed explanation of the variables.

business performance. However, their solvency ratio shows the problem when their own capital, in general, is less than required by only 43.33 percent.

Insurers in this group are younger with the average age of 54.9. They tend to do business in their registered country and focus on core-insurance business. Statistics show that 93.5 percent of this group are core-insurance firms and 37.8 percent operate

Table 2.4: South-Eastern Europe firms

Variable	Obs	Mean	Std. Dev.	Min	Max
ERM	217	0.327	0.470	0.000	1.000
PrE	198	12.723	1.246	10.371	15.639
TobinQ	198	1.138	0.487	0.662	4.150
ROA	200	0.003	0.079	-0.576	0.409
CR	200	1.125	0.967	0.053	11.264
EPS	199	5.409	16.508	-29.500	99.870
SR	200	0.434	17.585	-186.264	32.349
LVRG	200	7.000	9.749	-71.600	61.460
FS	200	6.849	2.098	3.401	11.355
FA	217	54.935	57.380	0.000	210.000
LTIg	200	0.508	0.251	0.016	1.074
BLI	201	0.672	0.471	0.000	1.000
INTL	201	0.378	0.486	0.000	1.000
BTY	201	0.935	0.247	0.000	1.000
IPP	217	6.455	1.016	4.256	8.342

Notes : this table reports descriptive statistics for selected variables in the study. The selected sample consists of firms located in South-Eastern Europe. ERM is a binary variable. LVRG is firm leverage, LTIg is long-term investment, FS is firm size, FA is firm age, INTL is geographic diversification, BTY is business-type, BLI is business-line, PrE is productivity of employee, CR is combined-ratio, SR is solvency ratio, EPS is earning per share, after diluted, ROA is return on asset, TobinQ is proxy for firm value, IPP is insurance purchasing power. The appendix provides a detailed explanation of the variables.

internationally.

In details, I use t-test to find out the differences between two groups of firms. Table 2.5 shows the statistical results as follows

Insurance firms in the North-West Europe have a higher mean value of ERM. The mean difference is 0.369 and significant at 1 percent level. Other variables such as productivity per employee, ROA, solvency ratio, Leverage, firm size, firm age, long-term investments, and international diversification also have higher mean value and significant at 1 percent level. These results support the view that the problem of 2-speed Europe also found in the insurance market.

Regarding to Tobin's Q and combined-ratio, there is differences between the two groups but the statistics are insignificant. In fact, the mean value of Tobin's Q and CR are higher in the group of North-West firms. However, it is possible that emerging markets in the South-Eastern Europe have outlier effects on the summarized results.

This table also illustrates that firms in the South-Eastern Europe are more core-insurance business and conduct both life and non-life businesses. The statistical results of these mean differences are significant at 1 percent level. It is acknowledged that major insurance firms are located in developed markets such as Germany, Switzerland, the United Kingdom, Norway and France. These giant firms tend to specialize in either life or non-life business. Moreover, there is a concentration of big reinsurance firms, insurance brokers and insurance service firms in the North-West Europe.

Among countries in the study, I choose the United Kingdom and Cyprus as particular cases. I expect that these two markets with their distinctness will give further information about ERM and other determinants.

The United Kingdom has the most listed firms in the sample and its market traditionally does not reflect popular characteristics of European firms. Table 2.6 shows that within the United Kingdom market, ERM adopting firms and non-ERM firms are nearly equal. Insurance firms in the United Kingdom have a high ROA

and Solvency ratio. On average, insurers in the United Kingdom are valued about 70 percent higher than their book value. They have a strong solvency ratio as the United Kingdom have advances in regulation and computed data of this study based on the requirements of Solvency I.

Firms in the United Kingdom are more international and specialized in core-insurance business. In fact, nearly 77 percent of the United Kingdom sample has

Table 2.5: Compare t-test North-West vs. South-Eastern firms

Variables	G1(0)	Mean1	G2(1)	Mean2	MeanDiff
ERM	217	0.327	490	0.696	-0.369***
PrE	198	12.723	456	13.470	-0.748***
TobinQ	198	1.138	467	1.350	-0.213
ROA	200	0.003	475	0.023	-0.020***
CR	200	1.125	469	1.704	-0.579
EPS	199	5.409	471	0.907	4.502
SR	200	0.434	467	5.890	-5.457***
LVRG	200	7.000	473	12.654	-5.654***
FS	200	6.849	468	7.644	-0.795***
FA	217	54.935	490	70.443	-15.507***
LTIg	200	0.508	436	0.588	-0.079***
BLI	201	0.672	475	0.537	0.135***
INTL	201	0.378	475	0.768	-0.390***
BTY	201	0.935	475	0.855	0.081***

*Notes : this table reports t-test results between firms located in North-West vs. South-Eastern Europe. G1(0) means South-Eastern firms and G2(1) means North-West firms. The selected sample is full sample. ERM is a binary variable. LVRG is firm leverage, LTIg is long-term investment, FS is firm size, FA is firm age, INTL is geographic diversification, BTY is business-type, BLI is business-line, PrE is productivity of employee, CR is combined-ratio, SR is solvency ratio, EPS is earning per share, after diluted, ROA is return on asset, TobinQ is proxy for firm value, IPP is insurance purchasing power. The appendix provides a detailed explanation of the variables. ***,**,* indicate significance at 1%, 5% and 10% levels, respectively.*

international businesses. Furthermore, about 74 percent of the United Kingdom firms are core-insurance business. This also means that broker and insurance-related services though well-known in the United Kingdom, only account for about 25 percent. In addition, the United Kingdom firms have a higher mean of firm age. The average age of the United Kingdom firm is 40.65. The oldest the United Kingdom firm is 173 years old. The ratio of liabilities to assets is about 10 times, mostly reflect the policy liabilities. Results from this table also show that long-term investments of the United Kingdom firms account for nearly 60 percent of firm total assets. Surprisingly,

Table 2.6: The United Kingdom firms

Variable	Obs	Mean	Std. Dev.	Min	Max
ERM	224	0.513	0.501	0.000	1.000
PrE	194	13.176	1.417	6.766	16.264
TobinQ	209	1.699	4.202	0.250	51.966
ROA	213	0.033	0.053	-0.241	0.320
CR	207	2.354	7.738	0.022	85.000
EPS	210	-4.262	66.192	-954.917	43.721
SR	206	9.291	28.174	-6.784	276.667
LVRG	212	9.836	11.182	1.010	50.040
FS	206	6.846	2.233	0.693	10.948
FA	224	40.656	56.372	0.000	173.000
LTIg	185	0.583	0.232	0.000	1.040
BLI	213	0.197	0.399	0.000	1.000
INTL	213	0.765	0.425	0.000	1.000
BTY	213	0.742	0.439	0.000	1.000
IPP	224	8.244	0.173	8.066	8.491

Notes : this table reports descriptive statistics for selected variables in the study. The selected sample consists of firms located in UK. ERM is a binary variable. LVRG is firm leverage, LTIg is long-term investment, FS is firm size, FA is firm age, INTL is geographic diversification, BTY is business-type, BLI is business-line, PrE is productivity of employee, CR is combined-ratio, SR is solvency ratio, EPS is earning per share, after diluted, ROA is return on asset, TobinQ is proxy for firm value, IPP is insurance purchasing power. The appendix provides a detailed explanation of the variables.

the mean value of EPS in the United Kingdom market is negative. Whether this is the result of the crisis or the business cycle, or dividend policy, the need for more information is necessary.

Cyprus is a special case when there is no evidence of ERM in this country. Firms registered in Cyprus are known for fiscal reasons. That is why their performance rather low in terms of ROA, even negative. Table 2.7 shows that firms registered in Cyprus are locally and core-insurance business. There are no firms registered in Cyprus operate internationally and 100 percent of Cyprus firms are not insurance brokers or insurance-related service firms.

The TobinQ mean value is almost equal 1, implying that market value reflects exactly the book value of firms in Cyprus. Additionally, combined-ration is about 0.93 suggests that the insurance business is controlled towards balancing. Regarding leverage, the ratio of 3.16 indicates that non-life insurers play an important role in the Cyprus market. Furthermore, the average firm age is 30.8 with the oldest is 57 implies that firms in this market is rather young. Insurance firms in Cyprus are also found majority in mono-line insurance. Indeed, nearly 36 percent of Cyprus firms are mixed-line insurance firms.

One of the most important part of this study is to examine the determinants of ERM adoption. It aims to find out the differences, if any, between ERM-adopting firm and non-ERM firms. Table 2.8 shows the major differences between firms adopting ERM and non-ERM firms. The differences in mean value of most examined variables are statistically significant. ERM-adopting firms have higher employee-productivity with the mean difference is 1.61 and significant at 1 percent level. With regard to ROA and EPS, non-ERM firms have lower mean value but the differences are insignificant. The ROA between two groups slightly differ with the mean difference is 0.008.

Particularly, Tobin's Q in the non-ERM group has a mean value higher than the ERM group. This gap is significant at 5 percent level. One explanation for this is that non-ERM firms located in emerging markets. These markets with potential growth on both insurance and stock markets may increase the optimism of investors.

Similarly, combined-ratio and solvency ratio of non-ERM firms are higher than ERM firms. While the difference in the combined-ratio is not significant, the difference in solvency ratio is significant at 10 percent level. A possible explanation lies

Table 2.7: Cyprus firms

Variable	Obs	Mean	Std. Dev.	Min	Max
ERM	42	0.000	0.000	0.000	0.000
PrE	38	12.317	0.590	11.270	13.461
TobinQ	39	0.994	0.163	0.779	1.500
ROA	39	-0.004	0.076	-0.271	0.120
CR	39	0.937	0.189	0.663	1.664
EPS	39	0.371	2.149	-1.710	13.200
SR	39	3.922	2.741	-0.204	9.630
LVRG	39	3.163	12.829	-71.600	22.208
FS	39	4.496	0.327	3.738	4.942
FA	42	30.833	13.215	13.000	57.000
LTIg	39	0.382	0.241	0.035	0.852
BLI	39	0.359	0.486	0.000	1.000
INTL	39	0.000	0.000	0.000	0.000
BTY	39	1.000	0.000	1.000	1.000
IPP	42	6.799	0.132	6.570	7.010

Notes : this table reports descriptive statistics for selected variables in the study. The selected sample consists of firms located in Cyprus. ERM is a binary variable. LVRG is firm leverage, LTIg is long-term investment, FS is firm size, FA is firm age, INTL is geographic diversification, BTY is business-type, BLI is business-line, PrE is productivity of employee, CR is combined-ratio, SR is solvency ratio, EPS is earning per share, after diluted, ROA is return on asset, TobinQ is proxy for firm value, IPP is insurance purchasing power. The appendix provides a detailed explanation of the variables.

on the fact that non-ERM could be less efficient in policy management and capital management.

With respect to variables related to firm characteristics, there is a clear difference between two groups. ERM firms are found to have a longer history than non-ERM about 45 years on average. Results also indicate that ERM firms are more leveraged with significance at 1 percent level. In addition, they are bigger in terms of assets. Furthermore, ERM-firms invest more in long-term asset than non-ERM firms. It is apparent that ERM-firms are more diversified. For instance, they are more complex when operating internationally, in core-insurance and mixed-line insurance. All of the

Table 2.8: ERM firms vs. non-ERM firms

Variables	G1(0)	Mean1	G2(1)	Mean2	MeanDiff
PrE	260	12.274	394	13.884	-1.611***
TobinQ	262	1.564	403	1.107	0.457**
ROA	272	0.013	403	0.020	-0.008
CR	267	1.731	402	1.397	0.334
EPS	267	0.173	403	3.616	-3.443
SR	266	5.914	401	3.153	2.760*
LVRG	269	4.483	404	15.296	-10.814***
FS	265	6.166	403	8.222	-2.056***
FA	295	38.969	412	84.811	-45.841***
LTIg	232	0.461	404	0.621	-0.160***
BLI	273	0.476	403	0.645	-0.169***
INTL	273	0.418	403	0.811	-0.394***
BTY	273	0.703	403	0.998	-0.294***

*Notes : this table reports t-test results between firms with and without ERM. G1(0) means non-ERM presence and G2(1) means ERM presence. The selected sample is full sample. ERM is a binary variable. LVRG is firm leverage, LTIg is long-term investment, FS is firm size, FA is firm age, INTL is geographic diversification, BTY is business-type, BLI is business-line, PrE is productivity of employee, CR is combined-ratio, SR is solvency ratio, EPS is earning per share, after diluted, ROA is return on asset, TobinQ is proxy for firm value, IPP is insurance purchasing power. The appendix provides a detailed explanation of the variables.***,**,* indicate significance at 1%, 5% and 10% levels, respectively.*

preceding examined variables have mean differences that are significant at 1 percent level.

In regard to the differences between firms which run mono-line business and mixed-line business, Table 2.9 shows that on average, mixed-line firms tend to employ more ERM system. The mean value of the difference is 0.167 and significantly at 1 percent. In addition, mono-line firms have higher productivity with significance level at 10 percent.

Table 2.9: Mono-line firms vs. mixed-line firms

Variables	G1(0)	Mean1	G2(1)	Mean2	MeanDiff
ERM	286	0.500	390	0.667	-0.167***
PrE	267	13.131	387	13.322	-0.192*
TobinQ	282	1.577	383	1.074	0.503***
ROA	285	0.020	389	0.015	0.005
CR	280	2.070	389	1.142	0.928***
EPS	283	0.337	386	3.648	-3.311
SR	278	6.170	389	2.885	3.285**
LVRG	283	11.276	389	10.780	0.495
FS	279	6.337	389	8.173	-1.836***
FA	286	33.556	390	91.823	-58.267***
LTIg	260	0.536	375	0.580	-0.044**
INTL	286	0.615	390	0.679	-0.064*
BTY	286	0.836	390	0.910	-0.075***

*Notes : this table reports t-test results between firms run mono business-line or mixed business-line. G1(0) means mono line firms and G2(1) means mixed firms. The selected sample is full sample. ERM is a binary variable. LVRG is firm leverage, LTIg is long-term investment, FS is firm size, FA is firm age, INTL is geographic diversification, BTY is business-type, BLI is business-line, PrE is productivity of employee, CR is combined-ratio, SR is solvency ratio, EPS is earning per share, after diluted, ROA is return on asset, TobinQ is proxy for firm value, IPP is insurance purchasing power. The appendix provides a detailed explanation of the variables. ***,**,* indicate significance at 1%, 5% and 10% levels, respectively.*

Firms with mono-line business also found that they have higher Tobin's Q, combined-

ratio, ROA, solvency ratio, and leverage. However, only the differences in Tobin's Q, combined-ratio and solvency ratio are significant at 1 percent level and 5 percent level respectively. ROA of mono-line firms are higher than mixed-line firms but statistic is insignificant. This implies that there is no clear evidence on ROA between two investigated groups.

Results from this table suggest that mixed-line firms have higher EPS, higher productivity of employees, more diversified, bigger and older. Among these results, only the differences in mean value of EPS are insignificant. For instance, mixed-line insurers have an average age of 91 while mono-line insurers have an average age of 33. In addition, mixed-line insurance firms have more international businesses and focus more on core-insurance business.

Firms with core-insurance business differ from related-insurance business are shown in Table 2.10. Core-insurance business firms have a higher ERM presence which is significant at 1 percent. Results shown in this table indicate that the core-insurance firms have higher productivity per emplpyee that broker/insurance related firms, with significance level at 1 percent. In addition, core-insurance firms also have higher EPS and ROA. However, only statistic of EPS is significant at 1 percent level.

Meanwhile, the results show that related-insurance business firms have higher Tobin's Q, combined-ratio as well as solvency ratio. The mean difference of TobinQ, combined ratio and solvency ratio are all significant at 1 percent level.

To the extent of other firm characteristics, core-insurance firms show evidence that they are more leveraged, bigger as well as older. Furthermore, they invest more in long-term assets and more likely in mixed-line business than non core insurance firms. Although evidence shows that core-insurance firm are more likely to operate internationally, there is no exact conclusion when the result is insignificant.

Concerning geographic diversification, statistics shown in Table 2.11 exhibit the differences between firms that operate locally and firms that operate internationally.

This table indicates that firms operate outside their home country appear to adopt

more ERM. Statistics show that the mean difference between two groups is significant at 1 percent level. Furthermore, international firms are likely to have higher productivity, EPS and combined-ratio. Nonetheless, the result of EPS is insignificant within the sample. In contrast, local firms have lower Tobin's Q, lower ROA as well as solvency ratio. Except for TobinQ is statistically significant at 1 percent level, ROA and Solvency ratio is insignificant. While TobinQ of locally operate firms are higher than internally operate firms and even significant, it should be noticed that

Table 2.10: Core-insurance vs. related insurance firms

Variables	G1(0)	Mean1	G2(1)	Mean2	MeanDiff
ERM	82	0.012	594	0.677	-0.665***
PrE	71	11.693	583	13.433	-1.739***
TobinQ	82	2.614	583	1.100	1.513***
ROA	82	0.015	592	0.017	-0.002
CR	78	3.461	591	1.276	2.186***
EPS	79	-12.753	590	4.256	-17.008***
SR	78	10.833	589	3.383	7.450***
LVRG	80	3.058	592	12.060	-9.002***
FS	75	5.619	593	7.632	-2.013***
FA	82	28.524	594	72.507	-43.982***
LTIg	54	0.348	581	0.582	-0.234***
INTL	82	0.573	594	0.663	-0.090
BLI	82	0.427	594	0.598	-0.171***

*Notes : this table reports t-test results between firms with core insurance business or broker/insurance related business. G1(0) means broker/related and G2(1) means core insurance business firms. The selected sample is full sample. ERM is a binary variable. LVRG is firm leverage, LTIg is long-term investment, FS is firm size, FA is firm age, INTL is geographic diversification, BTY is business-type, BLI is business-line, PrE is productivity of employee, CR is combined-ratio, SR is solvency ratio, EPS is earning per share, after diluted, ROA is return on asset, TobinQ is proxy for firm value, IPP is insurance purchasing power. The appendix provides a detailed explanation of the variables. ***,**,* indicate significance at 1%, 5% and 10% levels, respectively.*

small firms usually have more opportunities for growth. Locally operated firms found to be less leveraged, smaller and younger in comparison with international firms. The mean difference of these examined variables is significant at 5 percent level and 1 percent level respectively. In addition, locally operated firms tend to focus on mono-line businesses. The statistical result of this examination is significant at 10 percent level.

Furthermore, evidence also shows that international firms invest more in the long-term. This could be a general strategy to deal with their risk profiles. It is important

Table 2.11: Local vs. international firms

Variables	G1(0)	Mean1	G2(1)	Mean2	MeanDiff
ERM	235	0.323	441	0.741	-0.418***
PrE	222	12.635	432	13.557	-0.922***
TobinQ	226	1.644	439	1.103	0.541***
ROA	234	0.018	440	0.017	0.002
CR	230	1.022	439	1.797	-0.776**
EPS	230	0.345	439	3.244	-2.898
SR	229	4.412	438	4.172	0.240
LVRG	231	9.315	441	11.865	-2.550**
FS	227	6.235	441	8.009	-1.773***
FA	235	49.149	441	76.776	-27.627***
LTIg	209	0.478	426	0.603	-0.125***
BTY	235	0.851	441	0.893	-0.042
BLI	235	0.532	441	0.601	-0.069*

*Notes: this table reports t-test results between firms operate domestically or internationally. G1(0) means only domestic firms and G2(1) means international firms. The selected sample is full sample. ERM is a binary variable. LVRG is firm leverage, LTIg is long-term investment, FS is firm size, FA is firm age, INTL is geographic diversification, BTY is business-type, BLI is business-line, PrE is productivity of employee, CR is combined-ratio, SR is solvency ratio, EPS is earning per share, after diluted, ROA is return on asset, TobinQ is proxy for firm value, IPP is insurance purchasing power. The appendix provides a detailed explanation of the variables. ***,**,* indicate significance at 1%, 5% and 10% levels, respectively.*

to note that Europe market is considered a single market. As a consequence, only small firms operate locally. This also explains why international firms are larger and older.

2.4.2 Multiple linear regression (multivariate analysis)

Despite the fact that the univariate analysis shows preliminary supporting evidence to justify the above hypotheses, it fails to control for the interrelation between observed variables and other forecast and firm characteristics. Therefore, I use a multivariate analysis to conduct more appropriate tests of hypotheses.

Before estimating the model 2.1, I verify the multi-collinearity issue by calculating the variance inflation factor (VIF). A commonly given rule of thumb is that VIFs of 10 or higher (or equivalently, tolerances of .10 or less) may be reason for concern[4].

Table 2.12 reports the results for VIF values. According to reported results, VIF values are small and acceptable for all observed variables. The mean VIF is 1.63 shows that multi-collinearity is not an issue of the proposed model. Furthermore, the Pearson correlation test also conducted to check the linear correlation between variables.

Table 2.13 presents the Pearson correlations. In general, the magnitudes of correlations between independent variables are rather small. Except for the relation between business-line and firm and business-line and firm size. Although there is a stronger relation in comparison with other variables, these coefficients are still less than 0.5. Obtained results show that most of variables have a positive correlation with ERM, except for Tobin's Q, combined-ratio, EPS and solvency ratio. However, variables such as ROA, combined-ratio, EPS and solvency ratio are insignificant at 5 percent level. ERM is significantly positively correlated with PrE, LVRG, FS, FA as well as firm diversification while significantly negatively correlated with Tobin's Q.

There is a negative correlation between Tobin's Q and firm diversification as well as combined-ratio and solvency ratio. Although the magnitudes of theses correlations

[4]Paul Allison states that he gets concerned when the VIF is over 2.5 and the tolerance is under .40

are relatively low, most of them are significant at 5 percent, implying that firm value may not associated in the same direction with other determinants. Productivity of employee in the sample indicate a positive correlation with variables except for

Table 2.12: Multi-collinearity test

Variable	VIF	SQRT-VIF	Tolerance	R-Squared
ERM	2.36	1.54	0.4243	0.5757
PrE	2.43	1.56	0.4112	0.5888
TobinQ	1.34	1.16	0.7459	0.2541
ROA	1.35	1.16	0.7418	0.2582
CR	1.15	1.07	0.8703	0.1297
EPS	1.16	1.08	0.8621	0.1379
SR	1.33	1.15	0.7500	0.2500
LVRG	1.38	1.17	0.7248	0.2752
FS	2.00	1.41	0.5011	0.4989
FA	1.53	1.24	0.6539	0.3461
LTIg	1.29	1.14	0.7747	0.2253
BLI	1.70	1.30	0.5877	0.4123
INTL	1.68	1.30	0.5953	0.4047
BTY	1.73	1.32	0.5767	0.4233
IPP	2.02	1.42	0.4958	0.5042
Mean VIF	**1.63**			

Notes : this table reports multi-collinearity test. The selected sample is full sample. ERM is a binary variable. LVRG is firm leverage, LTIg is long-term investment, FS is firm size, FA is firm age, INTL is geographic diversification, BTY is business-type, BLI is business-line, PrE is productivity of employee, CR is combined-ratio, SR is solvency ratio, EPS is earning per share, after diluted, ROA is return on asset, TobinQ is proxy for firm value, IPP is insurance purchasing power. The appendix provides a detailed explanation of the variables.

TobinQ, combined-ratio, solvency ratio and EPS. Most of positive correlations are significant at 5 percent level except for ROA and BLI. ROA, meanwhile, has a negative correlation with most of the variables except for solvency ratio, EPS, and BTY. Among these correlations, only the correlations with SR and LVRG are significant at 5 percent level.

Firm characteristics such as firm age, firm size and diversification are found to have positive correlations with other characteristics but not the performance indicators. For instance, firm size and firm age both have significantly positive correlations with PrE, TobinQ, and ERM. Results show negative insignificant correlations between firm size, firm age with ROA and combined ratio. Firm diversification such as business line, business type and geographic variousness show a positive correlation with ERM with significance at 5 percent level. Similar results also displayed for firm characteristics like firm size, firm age, leverage and long-term investment. However, solvency ratio is reported to have a negative correlation with most variables, except for ROA and combined ratio. Although not all correlations are significant, these findings could suggest further explications for the discussion section.

To examine the determinants associated with ERM adoption, I apply both the Logit and the Probit model to model 2.1 for estimating the likelihood that insurance firm adopt the ERM system. As ERM adoption is a binary variable, one cannot use the linear probability model because the predicted probabilities will not limited between 0 and 1 and dependent variable is not normally distributed. Therefore, I employ the Logit and the Probit model. Both of the two models are estimated by Maximum likelihood method. While Probit model assumes ϵ_i a normal distribution, Logit model assumes that ϵ_i has a logistic distribution. The interpretation of coefficients is not straight as in linear model: an increase in x makes the outcome of 1 more or less likely and the interpretation is rather based on the sign of the coefficient but not the magnitude. Usually, the marginal effects are computed to reflect the change in the probability of $y = 1$ given a 1 unit change in an independent variable x. Results illustrated in Table 2.14 reports the Probit estimation results for model 2.2.

Table 2.13: Pearson correlation

	ERM	PrE	TobinQ	ROA	CR	EPS	SR	LVRG	FS	FA	LTIg	BLI	INTL	BTY	IPP
ERM	1.000														
PrE	**0.631**	1.000													
TobinQ	**-0.093**	**-0.216**	1.000												
ROA	0.051	0.017	0.029	1.000											
CR	-0.037	-0.028	-0.024	-0.042	1.000										
EPS	0.043	-0.058	0.029	0.065	-0.003	1.000									
SR	-0.072	-0.023	**-0.116**	**0.236**	**0.220**	-0.005	1.000								
LVRG	**0.349**	**0.356**	-0.059	**-0.105**	0.051	0.011	-0.043	1.000							
FS	**0.466**	**0.200**	**-0.205**	-0.009	-0.014	**0.148**	-0.057	**0.247**	1.000						
FA	**0.343**	**0.250**	**-0.079**	-0.073	-0.058	0.073	**-0.086**	**0.266**	**0.406**	1.000					
LTIg	**0.302**	**0.305**	-0.035	-0.047	-0.009	**0.086**	-0.051	**0.078**	**0.261**	**0.252**	1.000				
BLI	**0.168**	0.075	**-0.104**	-0.035	**-0.104**	0.042	**-0.086**	-0.016	**0.420**	**0.435**	**0.086**	1.000			
INTL	**0.406**	**0.349**	**-0.107**	-0.010	**0.083**	0.035	-0.006	**0.080**	**0.389**	**0.199**	**0.232**	0.067	1.000		
BTY	**0.442**	**0.433**	**-0.208**	0.011	**-0.159**	**0.141**	**-0.128**	**0.192**	**0.295**	**0.217**	**0.257**	**0.113**	0.062	1.000	
IPP	**0.422**	**0.432**	0.018	**0.101**	0.059	**-0.086**	**0.135**	**0.163**	**0.212**	**0.170**	**0.273**	**-0.107**	**0.424**	**-0.090**	1.000

Notes : this table reports Pearson correlation between selected variables. ERM is a binary variable. LVRG is firm leverage, LTIg is long-term investment, FS is firm size, FA is firm age, INTL is geographic diversification, BTY is business-type, BLI is business-line, PrE is productivity of employee, CR is combined-ratio, SR is solvency ratio, EPS is earning per share, after diluted, ROA is return on asset, TobinQ is proxy for firm value, IPP is insurance purchasing power. The appendix provides a detailed explanation of the variables. Numbers in bold are significantly different from zero at 5 percent.

The results show that the coefficients on PrE, TobinQ, LVRG, FS, LTIg, BTY, and IPP are significant and positive, suggesting that productivity of employee, firm value, leverage, firm size, firm-type and insurance purchasing power are significant determinants of ERM adoption. The signs of these coefficients imply that insurance

Table 2.14: Probit model

ERM	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
PrE	**.6176119**	**.3308875**	**1.87**	**0.062**	**-.0309157**	**1.266139**
TobinQ	**1.196316**	**.4943625**	**2.42**	**0.016**	**.227383**	**2.165248**
ROA	6.836162	5.346617	1.28	0.201	-3.643015	17.31534
CR	-.0992025	.0841241	-1.18	0.238	-.2640826	.0656777
EPS	-.0072075	.0275498	-0.26	0.794	-.0612041	.0467891
SR	-.0018408	.0412024	-0.04	0.964	-.082596	.0789144
LVRG	**.1080436**	**.062176**	**1.74**	**0.082**	**-.013819**	**.2299063**
FS	**.6365982**	**.3316448**	**1.92**	**0.055**	**-.0134136**	**1.28661**
FA	.0142762	.0090217	1.58	0.114	-.003406	.0319585
LTIg	**3.688984**	**1.43452**	**2.57**	**0.010**	**.8773762**	**6.500592**
BLI	1.192921	1.303966	0.91	0.360	-1.362805	3.748647
INTL	2.751075	1.840675	1.49	0.135	-.8565812	6.358731
BTY	**9.2173**	**3.087584**	**2.99**	**0.003**	**3.165746**	**15.26885**
IPP	**2.481552**	**.8016602**	**3.10**	**0.002**	**.9103267**	**4.052777**
_cons	-46.15448	7.262287	-6.36	0.000	-60.3883	-31.92066
/lnsig2u	3.148303	.3661016			2.430757	3.865849
sigma_u	4.826645	.8835212			3.37157	6.909688
rho	.9588418	.0144479			.9191428	.9794846

Likelihood-ratio test of rho=0: chibar2(01) = 154.70 Prob >= chibar2 = 0.000

Notes : this table reports Probit model. The selected sample is full sample. ERM is a binary variable. LVRG is firm leverage, LTIg is long-term investment, FS is firm size, FA is firm age, INTL is geographic diversification, BTY is business-type, BLI is business-line, PrE is productivity of employee, CR is combined-ratio, SR is solvency ratio, EPS is earning per share, after diluted, ROA is return on asset, TobinQ is proxy for firm value, IPP is insurance purchasing power. The appendix provides a detailed explanation of the variables. Bold numbers indicate statistical significance.

firms with higher productivity of employees, higher firm value, more leveraged, bigger, more focused on core-insurance business and in developed markets more likely to engage in ERM. The coefficients on ROA, FA, BLI, INTL are positive but not significant, implying that adopting ERM firm and non-ERM firm are not significantly different. Nevertheless, these results suggest that an increasing of these determinants could have a positive impact on increasing the probability to implement ERM.

As with the Probit model, the effects of a given predictor are dependent both on the values of the other predictors and the starting value of the given predictors. Hence, results can only indicate that the probability of firm to adopt ERM increase when there is an increasing in determinants with positive coefficients. The empirical findings which are insignificant suggest that the null hypothesis is not rejected, as the case of firm age. In contrast, the coefficients on CR, SR, EPS are negative but insignificant. These results express indirectly that the higher these indicators are, the less likely firms engage in ERM. However, take into consideration that these coefficients are insignificant, there is no evidence supporting the argument that firms are more likely to adopt ERM when they have higher CR, SR and EPS.

An alternative approach is using the Logit model. The logistic regression coefficients indicate the amount of change expected in the log odds when there is a one unit change in the predictor variable with all of the other variables in the model held constant. Table 2.15 reports the coefficients on PrE, TobinQ, LVRG, FS, FA, LTIg, INTL, BTY, and IPP are significant and positive, implying that these variables are significant determinants of ERM adoption.

For further details, an increase one unit of each preceding determinant holding others constant will increase the log odds of ERM adoption. This demonstrates that firms more tend to adopt ERM (predicted value towards the value of 1) when they are more productive, more leveraged, bigger, older, diversified and higher valued in the market. The significance of these coefficients is at least at 10 percent level support for the arguments that they are favorable determinants of ERM adoption. There are two determinants that have a positive impact on ERM adoption but their statistics are

insignificant: ROA and BLI. These results suggest that there is no evidence advocating that firms with higher ROA or more focus on mixed-line business will have more possibility to implement ERM. However, intuitively, these determinants should be considerable.

Table 2.15: Logit model

ERM	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
PrE	**1.386586**	**.8124745**	**1.71**	**0.088**	**-.2058346**	**2.979007**
TobinQ	**2.194227**	**.9331832**	**2.35**	**0.019**	**.3652216**	**4.023232**
ROA	12.27792	10.7867	1.14	0.255	-8.863624	33.41947
CR	-.1777391	.1376264	-1.29	0.197	-.4474819	.0920038
EPS	-.0102789	.0480044	-0.21	0.830	-.1043657	.083808
SR	-.0065112	.1066919	-0.06	0.951	-.2156236	.2026011
LVRG	**.1842729**	**.1083877**	**1.70**	**0.089**	**-.028163**	**.3967089**
FS	**1.175108**	**.5539491**	**2.12**	**0.034**	**.0893882**	**2.260829**
FA	**.0263839**	**.014593**	**1.81**	**0.071**	**-.0022178**	**.0549856**
LTIg	**6.105954**	**2.602147**	**2.35**	**0.019**	**1.00584**	**11.20607**
BLI	2.152517	2.234308	0.96	0.335	-2.226645	6.531679
INTL	**5.071115**	**2.499298**	**2.03**	**0.042**	**.1725803**	**9.969649**
BTY	**15.87715**	**5.788923**	**2.74**	**0.006**	**4.531075**	**27.22323**
IPP	**4.309814**	**1.352433**	**3.19**	**0.001**	**1.659095**	**6.960533**
_cons	-84.9672	14.26621	-5.96	0.000	-112.9285	-57.00594
/lnsig2u	4.289029	.3666315			3.570445	5.007614
sigma_u	8.537897	1.565131			5.960906	12.22896
rho	.9568177	.0151483			.9152582	.9784747

Likelihood-ratio test of rho=0: chibar2(01) = 158.26 Prob >= chibar2 = 0.000

Notes : this table reports Logit model. The selected sample is full sample. ERM is a binary variable. LVRG is firm leverage, LTIg is long-term investment, FS is firm size, FA is firm age, INTL is geographic diversification, BTY is business-type, BLI is business-line, PrE is productivity of employee, CR is combined-ratio, SR is solvency ratio, EPS is earning per share, after diluted, ROA is return on asset, TobinQ is proxy for firm value, IPP is insurance purchasing power. The appendix provides a detailed explanation of the variables. Bold numbers indicate statistical significance.

From a contrastable view, CR, EPS and SR have negative effects on ERM adoption. Obtained statistics indicate that an increasing in these determinants would decrease the possibility of firms to adopt ERM. However, these results have are not persuadable as their coefficients are insignificant.

Table 2.16 reports the correlation matrix of the parameter estimated of the previous Logit model (variance–covariance matrix of the estimators - VCE). In general, the magnitudes of correlations between estimated coefficients are far from 1.0. This implies that coordinated changes in the parameter values could produce the same simulated values and, therefore, the model are likely fitted.

The results suggest that evidence of correlations between estimated parameters is mixed. There are both positive and negative relationship between variables concerning three groups: performance, risk management practices and firm characteristics. For instance, the coefficient of TobinQ is positive correlated with coefficients of CR, EPS, SR and LVRG but not with PrE and ROA. Similarly, this coefficient is positive correlated with coefficients of LVRG, BLI, BTY but not with FA, FS and INTL. Furthermore, the coefficients of FS are found negatively correlated with the ones of TobinQ, EPS, LVRG, FA, BLI, BTY, INTL and IPP. Its coefficients are only positively correlated with PrE, ROA, SR, and LTIg.

There is a slight difference between the two models: the significance of FA and INTL. Although the signs of the coefficients are positively the same, FA is insignificant in the Probit model but significant in the Logit model at 10 percent level. The INTL variable is significant at 5 percent level in the Logit model but not in the Probit model. This could be explained by the reason that coding INTL into 0 and 1 may not reflect the different levels of complexity of geographic operation. The differences between two models shown in Table 2.17. In general, results from both probit and logit model suggest that PrE, TobinQ, LVG, FS, LTIg, BTY, IPP are favorable determinants of ERM adoption. For example, results show that BTY, IPP are significant at 1 percent level[5]. Other variables such as Tobin, FS, LTIg, INTL are significant at 5 percent

[5]***,**,* indicate significance at 1%, 5% and 10% levels, respectively

Table 2.16: Post-estimation Logit model

e(V)	ERM PrE	TobinQ	ROA	CR	EPS	SR	LVRG	FS	FA	LTIg	BLI	INTL	BTY	IPP	_cons	lnsig2u _cons
ERM																
PrE	1.000															
TobinQ	-0.054	1.000														
ROA	-0.106	-0.104	1.000													
CR	-0.019	0.024	0.027	1.000												
EPS	0.061	0.047	-0.416	-0.087	1.000											
SR	0.071	0.061	-0.075	-0.089	-0.018	1.000										
LVRG	-0.173	0.004	0.113	-0.280	0.052	0.111	1.000									
FS	0.361	-0.031	0.162	-0.132	-0.074	0.123	-0.068	1.000								
FA	0.033	-0.040	0.019	0.091	-0.142	-0.031	-0.045	-0.157	1.000							
LTIg	0.107	-0.063	0.036	-0.155	-0.043	-0.006	0.142	0.072	-0.037	1.000						
BLI	-0.146	0.055	0.032	0.014	0.115	-0.012	0.130	-0.180	-0.338	0.063	1.000					
INTL	-0.182	-0.063	-0.106	-0.079	0.069	-0.105	0.143	-0.321	0.147	0.073	0.332	1.000				
BTY	-0.374	0.134	0.115	-0.009	-0.014	-0.052	-0.016	-0.051	-0.195	-0.081	0.329	0.175	1.000			
IPP	-0.328	0.162	0.105	0.025	0.071	-0.063	-0.019	-0.102	-0.182	-0.094	0.240	-0.325	0.278	1.000		
_cons	-0.469	-0.176	-0.093	0.060	-0.083	-0.047	0.056	-0.431	0.180	-0.121	-0.256	0.252	-0.315	-0.519	1.000	
lnsig2u																
_cons	-0.179	0.002	0.142	-0.117	-0.041	-0.081	0.114	0.091	0.128	0.241	0.152	0.303	0.317	0.097	-0.154	1.000

Notes: this table reports postestimation, VCE of previous Logit model.

level. Additionally, Pre, LVRG, FA are significant at 10 percent level.

From both models, the signs of coefficients on ROA and BLI are positive while the coefficients on SR, CR and EPS are negative. However, these all coefficients are all statistically insignificant, suggesting that there is no evidence that these determinants

Table 2.17: Probit vs. Logit

VARIABLES	**Probit Model**	**Logit Model**
PrE	0.618*	1.387*
	(0.331)	(0.812)
TobinQ	1.196**	2.194**
	(0.494)	(0.933)
ROA	6.836	12.28
	(5.347)	(10.79)
CR	-0.0992	-0.178
	(0.0841)	(0.138)
EPS	-0.00721	-0.0103
	(0.0275)	(0.0480)
SR	-0.00184	-0.00651
	(0.0412)	(0.107)
LVRG	0.108*	0.184*
	(0.0622)	(0.108)
FS	0.637*	1.175**
	(0.332)	(0.554)
FA	0.0143	0.0264*
	(0.00902)	(0.0146)
LTIg	3.689**	6.106**
	(1.435)	(2.602)
BLI	1.193	2.153
	(1.304)	(2.234)
INTL	2.751	5.071**
	(1.841)	(2.499)
BTY	9.217***	15.88***
	(3.088)	(5.789)
IPP	2.482***	4.310***
	(0.802)	(1.352)
Constant	-46.15***	-84.97***
	(7.262)	(14.27)
/lnsig2u	3.148***	4.289***
	(0.366)	(0.367)
Observations	606	606
Number of ID	95	95

have an conclusive impact on the ERM adoption or these impacts are rather small.

2.4.3 Discussion of empirical results

This section discusses the results obtained from the preceding descriptive analysis and multivariate analysis.

With the sample of 101 publicly traded insurance firms in the European Union for the period 2007-2013, preliminary results illustrate empirical evidence of adopting ERM in the insurance industry and plot major characteristics of the European Union insurance market.

First, the presence of ERM found in nearly 60 percent of the sample. This finding is not far from the current ERM status reported recently by Ernst&Young (2015). Moreover, this ratio is higher in comparison with the study of Eckles et al. (2014) and Eastman and Xu (2015), as well the study of Hoyt and Liebenberg (2011) where the ratio of ERM presence is 69/354, 43/371, and 117/275 respectively. This evidence indicates that ERM is more and more adopted in the insurance industry, whether this phenomenon is affected by compliance, requirements of shareholders or just incentives of top managers.

Second, insurance firms in European Union have an average Tobin's Q of 1.28 which means that in general, their market value is higher their book value about 30 percent. It is important to note that the insurance industry is rather stable, even during the recent financial crisis. The examined period, mostly in the rebound stage after the crisis so reactions of investors over the stocks of the insurance market is understandable. In fact, this finding is consistent with the arguments of Doherty and Lamm-Tennant (2009), Lehmann and Hofmann (2010), Schich (2010), and Liedtke and Schanz (2010).

Third, regarding key-insurance indicators, the average combined ratio indicates an inefficient performance when losses and expenses higher than earned premiums about 53 percent. Meanwhile, solvency ratio presents a good solvability, which is 4 times higher than required level. For further details, natural disasters is one of the

most concern of the insurance industry. According SwissRe (2015a), 10-year average insured losses (exclude liability and life) is about US 60 billion. The European Union and the US (where European Union firms conduct their businesses as usual) account for 50-70 percent of this amount. For example, catastrophes in 2013 (Germany, Czech Republic et al.), in 2011-2012 (US), and in 2007 (France, the United Kingdom et al.) are among the 40 most costly insurance losses (1970-2014). Additionally, the Solvency II directive (2009/138/EC) forces European Union insurance firms to hold an amount of capital to reduce the risk of insolvency.

Fourth, the European Union insurance firms have a long history, high leverage, and rather diversified. Actually, the average age of the European Union insurance firm is 65,68 where the oldest firm is 246 years old. It is well known that the European Union is the cradle of the insurance industry. High leverage (debt-to-equity ratio) is normal in the financial sector. However, besides big firms with strong capital, the nature of insurance business with advanced premiums and sum insured lead to a high average leverage ratio of the selected sample. Another explanation of this pattern could be affected by non-core insurance business. In regard to diversification, European Union insurance firms are mostly internationally, core-insurance business and balanced business lines. These findings reflect the reality of this market where geographic barriers do not exist and insurance related services play a supporting role. This finding complements the argument of Allen and Song (2005) that financial institutions in EMU countries became more active in initiating integration between EMU and non-EMU partners. Furthermore, there is a balance between mono-line and mixed-line firms. In fact, it is still debatable whether omnibus is better than specialization.

In addition, the analysis between sub-samples provides further details of ERM-adopting in the European Union insurance market. For example, there is a clear difference between firms located in North-West and firms located in the South-Eastern Europe. For instance, firms in North-West have mean value of ERM 0.696 while firms in South-Eastern have only 0.327. Furthermore, other examined variables such as the productivity of employee, ROA, solvency ratio, firm age, firm size and diversification

all have a higher mean value which is statistically significant. These findings support the discussions about two-speed Europe by Beachill and Pugh (1998) and Martin (1995).

Moreover, the differences also found in the sub-samples concerning ERM firms and non-ERM firms. ERM firms are found to have higher productivity of employees, ROA, more leveraged, bigger, older, more diversified. Surprisingly, the preliminary pattern shows that ERM firms have lower Tobin's Q mean value, which is significant at 5 percent level. It is important to know that the findings on ERM and firm value are prominently positive in the insurance industry (McShane et al., 2011; Eckles et al., 2014; Eastman and Xu, 2015; Hoyt and Liebenberg, 2011; Grace et al., 2015). However, these findings are only descriptive results and need more further analysis.

Regarding other sub-samples, the findings of this study also indicate that there is a difference between firms with core-insurance business vs. related-insurance business; between firms run mono-line business vs. mixed-line business; and between firms operate locally vs. internationally. In fact, theories suggest that diversification is associated with both benefits and costs. Some studies have found a discount, others have found a premium (Villalonga, 2004; Liebenberg and Sommer, 2008; Graham et al., 2002; Elango et al., 2008; Denis et al., 2002; Lin et al., 2012).

Results from multivariate analysis shed further lights on the topic of ERM adoption determinants.

Results from Logit/Probit models indicate that insurance firms in the European Union with more productivity, more leveraged, bigger, older and more diversified as well as higher valued in the market more likely to implement ERM. From the risk management perspective, there are both downside and upside view (Bromiley et al., 2014; Hillson, 2002). In the one hand, if top risk managers believe that their firms are threatened by different risk sources, then they have reason to implement ERM. On the other hand, top risk managers also prefer ERM when they want to protect their performance from a threshold and even want to seek added value from risks.

In fact, performance of insurance firms not only affects investors but also their

clients. As a consequence, firms with higher performance would seek higher business target or at least current growth. ERM, then is a suitable management tool to assure these objectives. Moreover, firms with higher performance have more resources to support ERM initiatives. Ching and Colombo (2014) state that investments in most areas of risk management is increasing. Resources are needed for *"improving data quality and reporting, strengthening risk assessment processes, management training in risk management, analytic and quantification, risk framework or model development, setting risk committee roles and responsibilities"*.

As the complexity of firms increases with business scope and accumulated operations, insurance firms have to deal with these challenges. Risk management is obviously a vital management tool but with the new business context, ERM is not only "fashionable" but also considered as a cost-revenue efficiency investment (Grace et al., 2015).

2.5 Conclusion

This chapter examines the determinants of ERM adoption in the insurance industry during the period from 2007 to 2013 for a sample of 101 insurance firms in European Union. I find that insurance firms more likely to adopt ERM when they are more leveraged, bigger, and focus more in their core-business. I also find that adopting ERM firms have higher productivity, firm value and invest more in long-term. Adopting firms are mostly located in developed markets.

These findings suggest that ERM-adopting firms in general have a more competitive profile than others. The coefficients on these characteristics are significant confirming that they are the important and favorable determinants of ERM adoption. In comparison with previous studies, I find that these results are consistent with the findings of Liebenberg and Hoyt (2003) and Hoyt and Liebenberg (2011) in the context of US market. Meanwhile, this study does not take the volatility variables as previous studies into account. This is not only because the interest of research but also because previous results are almost homogeneous (positively correlated with ERM).

Similarly, the institutional ownership variable is found to have a positive correlation with ERM in all previous empirical studies. Furthermore, nearly 100 percent of insurance firm has institutional ownership. That is why there is no interest to take into account this variable between adopting ERM and non-adopting ERM insurance firms.

Although the empirical results generally support my hypotheses, some results remain unexplained. The hypothesis that adopting firms have higher operational performance is justified with some variables but not with others. For instance, ROA is found to have a positive coefficient with ERM but not statistically significant. Meanwhile, combined ratio, solvency ratio and EPS are found to be in a negative relation with ERM, but similarly are not significant. These results may be due to heterogeneous policies applied to the accounting standards. With accounting tactics and internal models, book value of certain indicators could be justified to balance firm's strategies. Nevertheless, such a pattern may also have implications beyond the explanatory ability of the argument I provide to explain the difference between adopting and non-adopting ERM firms.

There are several limitations in this study that have implications for future research. First, although there are firms that implement ERM before 2007, the sample does not include this period due to the unavailability of data. Moreover, generalization of my results is limited and the findings may be different for insurers in countries other than the European Union. Therefore, future studies should enlarge the sample to capture more statistic proprieties.

Second, I suggest that more complex firms would adopt ERM but the indications for risk management strategies e.g., reinsurance activities or hedging portfolio are not included in the model specification. Including these indicators can contribute to our knowledge about ERM and risk management strategy in the insurance industry.

Third, as ERM maturity is classified with different levels, the model specification should use multi-level logistic regression. However, as the limits of sample and data availability, further research should take issue in consideration.

Finally, a combination with qualitative method, i.e. surveys will give more robust results. One of the explanations may be that with questionnaires, researchers can access other aspects of ERM, especially perception assessments.

Accompanying with the identification of firms that implement ERM, evaluating the impact of ERM on firm performance is an essential issue. The two following chapters investigate this relationship from the financial performance perspective: firm value and financial vulnerability.

Chapter 3

ERM and financial performance: Tobin's Q, ROA and EPS

Contents

Abstract

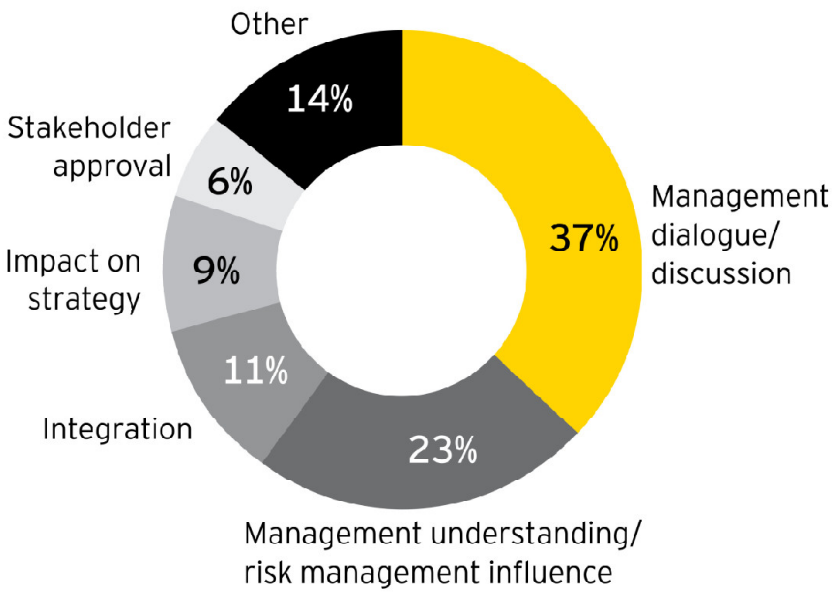
I study whether ERM adoption has impacts on the firm' s performance in terms of firm value (TobinQ), ROA and EPS. I conjecture that there is a positive correlation between ERM adoption and firm performance. The empirical results suggest that ERM adoption significantly influences TobinQ and ROA, with ERM premiums at least about 40%. Moreover, ERM adoption in general is negatively correlated with EPS. Additionally, leverage is found to be negatively correlated with examining firm performance variables. This also happens to diversification indicators when coefficients of these variables are negative.

Using four different estimations for correcting endogeneity and sample selection bias: Treatment effects, Heckman two-step, Hausman-Taylor and treatment effects included inverse Mills ratio, I show that the impact of ERM adoption on firm performance, especially TobinQ and ROA is identical. I argue that firm with ERM adoption would enhance its performance, such as firm value and ROA. The findings, therefore, support my hypothesis that ERM implementation would favor firms.

3.1 Introduction

It is widely agreed that risk management creates value, both academically (Nocco and Stulz, 2006; Simkins and Ramirez, 2008; Santomero and Babbel, 1997; Meulbroek, 2002; Rochette, 2009; Bromiley et al., 2014; Hoyt and Liebenberg, 2011; Eckles et al., 2014) and practically. According to Ernst&Young (2015), nearly a third of CROs reported that integration of the risk function into the business is their success in 2014. When management understanding of risk and risk processes, they can deliver value to the business. For example, one CRO states in the report that *"The measure of value is whether there is anything that surprised management. If they get surprised, then that is a failure of the risk department"*.

Figure 3.1: How risk function creates value



Source: EY's fifth annual survey of chief risk officers (CROs) in the insurance industry - interviews with CROs and other senior risk executives from 20 North American insurance companies - page 9.

Moreover, Satell (2016) argues recently in the Harvard Business Review that most organizations today fall into the same trap: *"they look at isolated metrics, but fail to see the whole system. They optimize each part of the business separately, and fail to*

consider how they interact. When we see an operation as a set of isolated metrics to optimize, we can lose our sense of context and decrease overall performance"[1]. The glolal vision, therefore, is also applicable in the field of risk management.

Although a number of studies argue that ERM really matter in firm value, there is ongoing debate about consistent benefits from ERM (Bromiley et al., 2014). In fact, the returns of investments on ERM can be valued in different ways, both financially and non-financially. Investing in ERM with a sustainable development perspective to protect from collapse in the future with tail risks can be seen with positive social impacts. The positive externalities of ERM could also be viewed in the insurance-growth nexus. The stability of insurance firms would ensure the functionality of financial markets and therefore the whole economy.

From the financial perspective, empirical studies on the value of ERM are identified mostly deal with the impact of ERM on shareholder value (Tobin's Q). Other examined indicators are excess stock market returns, cost and revenue efficiency, stock price and cash flow volatility. However, few studies focus on the insurance market, and data almost exploited from the US market. The prominent study of Hoyt and Liebenberg (2011) uses maximum-likelihood treatment effects model that jointly estimates the decision to engage in ERM and the effect of that decision on Tobin's Q in a two-equation system. This approach solves the endogeneity of ERM choice (self-select). Nonetheless, they ignore the problem of sample selection bias when there could be the case that ERM status has not only an intercept effect, but also a slope effect i.e. the parameters differ according to ERM status as well. In other words, selected sample could be observed only for a restricted, nonrandom sample.

In this chapter, I study the impact of ERM on firm value (Tobin's Q) of insurance firms listed in the European Union. Moreover, I also investigate its effect in other performance indicators such as ROA and EPS to check the robustness of the results. Previous studies on ERM in the insurance industry showed that ERM affects positively firm performance in the context of different views. For instance, there is a

[1]https://hbr.org/2016/01/optimizing-each-partof-a-firm-doesnt-optimize-the-whole-firm

significant positive relationship between ERM and firm value (Hoyt and Liebenberg, 2011; McShane et al., 2011). Furthermore, there is also a significant positive impact of ERM on cost and revenue efficiency depending on ERM activity (Grace et al., 2015).

To complement the previous study, in addition to endogeneity treatment effect model, I deploy Heckman's selection correction model with two-step estimations[2]. I conjecture that besides the endogeneity issue, sample selection bias is also another issue one has to solve when dealing with binary variable that has rather than intercept effect, as the case of this study. Overall, ERM has a positive impact on firm value and the presence of ERM affects.

Using the same data set as in the previous chapter, I find that ERM increases firm value about 30%. Furthermore, sample selection bias seems to be an issue. When take this into consideration, Heckman two-step estimation with inverse Mills' ratio indicates that ERM also increases firm value about 30%.

In addition to the endogeneity treatment effects and sample selection bias, another possibility that both types of biases occur. Based on my empirical tests, I suggest that correction for bias is necessary. Moreover, unobservables are negatively correlated with one another. With both sample correction and treatment effect, ERM has a major impact to firm value.

This chapter contributes to the related literature in three aspects. First, it contributes to the literature on ERM adoption and firm performance, especially firm value in the context of the insurance industry. Second, complement to previous studies, it takes into account not only endogeneity but also sample selection issues. Third, we provide new empirical evidence from a new data set, which differs from previous studies with intensively US data.

The rest of this chapter is organized as follows. Section 3.3 discusses related studies and develops my main hypotheses. Section 3.4 presents the research design and discussions on methodology. Section 3.5 reports the empirical results. Section 3.6 presents the conclusions of this chapter.

[2]For more details, see: Main et al. (1993), Millimet (2000), Maddala (1983).

3.2 Litterature review and hypothesis development

3.2.1 ERM in the insurance industry

According to Fraser and Simkins (2009), ERM first appeared and used by James LAM in the mids-1990. Since then, it has emerged as a concept and as a management function within corporations (Dickinson, 2001). As a key pillar of sound management, ERM is and will be a major concern of insurance companies, policyholders, regulators, and rating agencies.

Generally speaking, **ERM** is now the widely recognized term used to describe *"the process by which organizations assess, control, exploit, finance and monitor risks from all sources for the purpose of increasing short- and long-term value for stakeholders"*.

From the view of the insurance industry, Segal (2005) advocates a value-based ERM framework where firms should include upside risk exploitation, rather than just downside risk mitigation. Moreover, all sources of risk must be addressed to reflect the correlation-adjusted enterprise-wide impact of risks, rather than just the impact of risks on a standalone basis. In addition, firms should encourage the measurement of risk using long-term value-based metrics, rather than just current period metrics, ***not a once-and-done event***.

From the actuarial view, Wang and Faber (2006) asserted that one should view ERM as an integrated risk management system and risk managers must assess inter-related impacts on multiple units, integrate responses valuation because firms constantly face choices of what risks to take and what risks to avoid. According to the author, an insurer is a huge risk warehouse. Insurance business faces three major risk categories: Asset risk (credit risk, market risk), Liability risk, and Operational risk (business risk, event risk). Simple auditing by checking boxes will not work; naïve quantification can be misleading. Therefore, insurers need to truly capture the key risks and opportunities.

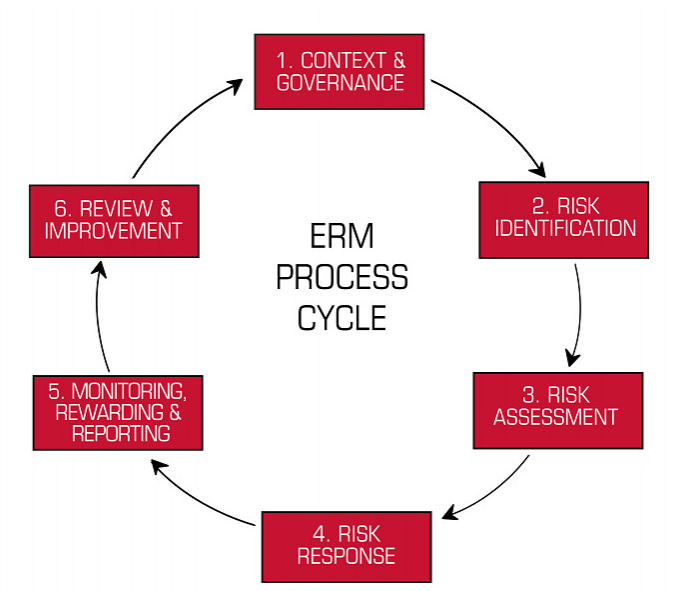
Supporting the same idea that ERM has positive impacts on insurers, Grünbichler and Errath (2007) argue that insurer's reputation, especially the perception of it as

reliable is one of its main assets. ERM helps explain the risks of the business, thereby raising customer value and enhancing confidence by clients and the media. ERM also raises regulators' s confidence and facilitate reviews, and thereby decrease the regulatory burden and capital costs. Additionally, ERM has a positive effect on the financial strength rating, thus impacting the overall cost of capital.

Furthermore, these authors believe that organizations of all types and sizes face a range of risks affecting the achievement of their objectives and influencing all decision-making. ERM supports intelligent and effective decision-making in order to optimize the level of calculated risk taken and to recognize opportunities where taking risks might benefit the organization. However, the results of ERM depend on five pillars: Risk Governance and Culture as the Foundation of ERM, Risk Quantification, Risk Management Operations, Risk Communication and Disclosure, Strategic Risk Management.

In summary, Figure 3.2 and Figure 3.3 illustrate the view of industry on ERM value drivers, risks, and ERM process in the insurance industry.

Figure 3.2: ERM process



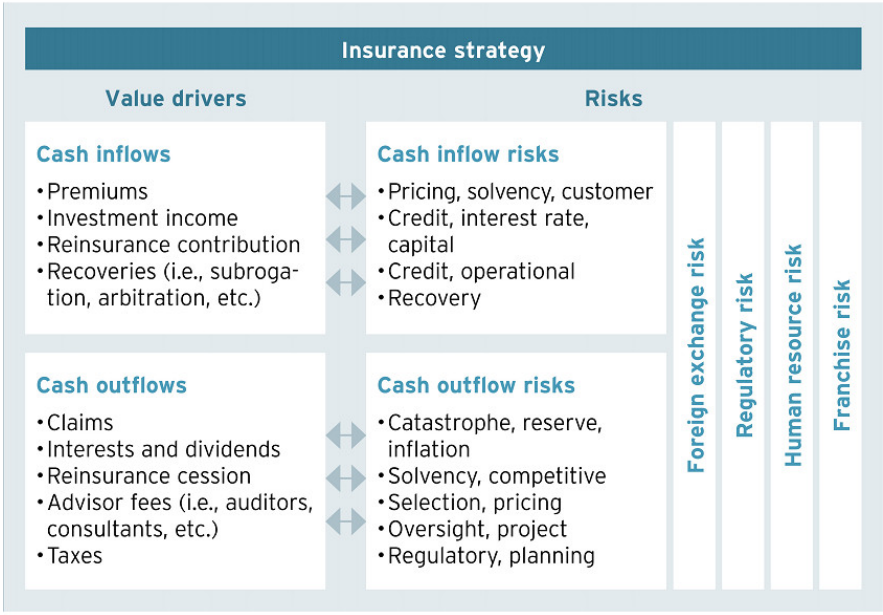
Source: Segal (2005). Value-based ERM. *The Actuary, June/July*

Similarly to the Deming cycle which appiles for ISO standards, including ISO

31000 on Enterprise risk management, ERM process cycle is a continuous improvement model. One important thing to note is the risk appetite of firms. Given that each firm has its risk appetite, there would be firm-specific ERM framework. Furthermore, in risk identification and risk assessment, one must pay attention to upward risks, and not only downside risks.

When integrated risk management embedded in business strategy, not financial and operational risks but all risks must be viewed in a holistic manner, at all firm levels. According to Ernst&Young (2015), insurance firms nowadays have much more doubts in regulation/capital standards risks, cyber risk and interest rates/economy risks. However, as risks are value drivers of firms, managing risks also means to maximize firm value.

Figure 3.3: Insurance value drivers and the risks



Calandro et al. (2008). ERM - an insurance perspective & overview. *Journal of Financial Transformation*, 22:117-122.

From the financial perspective, the benefits of ERM adoption are widely discussed (Kleffner et al., 2003; Nocco and Stulz, 2006; Beasley et al., 2008; Acharyya and Mutenga, 2013; Gordon et al., 2009; Eckles et al., 2014; Hoyt and Liebenberg, 2011;

McShane et al., 2011; Lin et al., 2012). However, examined financial aspects are various to the extent of firm value, cost-revenue efficiency, and volatility. Nonetheless, Beasley et al. (2008) argue that ERM only creates value for nonfinancial firms. In addition, these authors also assert that cost and benefit of ERM adoption are firm-specific. Particularly, for financial firms, there are fewer statistical associations between announcement returns and firm characteristics. In addition, results from the study of Gordon et al. (2009) indicated that the relationship between ERM and firm performance is conditional on the match between ERM implementations. Moreover, Acharyya and Mutenga (2013) argues that insurers' stock market performance depends much on the characteristics of industry event rather than on the performance of ERM.

Considered as a revolutionary version of risk management, ERM inherits the core values of risk management. Stulz (1996) and Nocco and Stulz (2006) assert that ERM creates value by reducing the probability of large negative cash flows (costly lower-tail outcomes) i.e.: financial distress, external financing, and managerial risk aversion. In line with this strand, it is believed that ERM should result in synergies between different risk management activities, increases capital efficiency, decreases earnings volatility, reduce stock-price volatility, external capital costs and marginal cost of risk reduction, and value-maximizing (Cummins et al., 2001; Meulbroek, 2002; Eckles et al., 2014). Furthermore, they support the idea that the goal of risk management should not be to reduce total risk, but to allocate risks to play on a firm's strengths.

ERM is supposed to facilitate the identification of inter-dependencies between risks of the firm. For firms with financially and operationally complex like insurers, ERM better informs outsiders their risk profiles. It is clear that the demonstration of value is a fundamental problem for risk management. However, to prove separately that risk management creates values is difficult as the intangibility of cost and value. In essence, firm performance is recognized through the outcomes of financial management and strategic management, or mixed.

Until now, although a comprehensive tool to evaluate the benefit of ERM does

not exist, there is a fact that more and more insurers adopt ERM (Altuntas et al., 2011). In fact, several frameworks of ERM exist with the common view that risk management should be integrated in all processes and viewed in a holistic manner. Currently, some well-known ERM frameworks can be cited such as the framework of: COSO, ISO 3100, Standard & Poor's, Basell II/Solvency II, Zurich, ERM maturity model (RIMS)[3]. Among a few empirical studies on ERM and firm performance in the insurance industry, there are only seven studies among which only four are published.

According to McShane et al. (2011), the purpose of ERM is to gain a systematic understanding of the inter-dependencies and correlation among risks. Applying concepts of portfolio theory, ERM can increase firm value because the risk of aggregate portfolio should be less than the sum of the individual risks if the risks are not 100 percent correlated, especially if nature hedges exist. Furthermore, management risk in silos creates inefficiencies due to lack of coordination between the various risk management departments and duplication of risk management expenditure. Consequently, the concept of ERM is that a firm should reduce exposure to risk in areas where it has no comparative information advantage and exploit risks in areas where it has an advantage, meaning that total risk can possibly decrease under ERM risk allocation. Using S&P ratings released for 152 insurers and Tobin's Q, their results suggest that firm value increases as firms implement increasingly more sophisticated traditional risk management, but does not increase further as firms achieve ERM (maturity). In other words, once firms achieve the "strong" or "excellent" ERM rating, the correlation between ERM and firm is insignificant.

Hoyt and Liebenberg (2011) use data of 275 US insurers for the period 1995-2005 and Tobin's Q as a proxy for firm value in their research and find that insurers with ERM program are valued approximately 20 percent higher than other insurers statistically and economically significant. With maximum-likelihood treatment effects model that jointly estimates the decision to engage in ERM and the effect of that decision (or treatment) on Tobin's Q in a two-equation system, their results are found to be robust. However, they seem to ignore the problem of sample selection bias

[3]The risk management society

when there could be the case that ERM status has not only an intercept effect but also a slope effect. Furthermore, they find that the average ERM user is larger, less leveraged, less opaque, has less financial slack, and lower return volatility than the average nonuser.

An alternative approach to examine the aspect of ERM add value is studying the impact of ERM adoption on firm's risk taking behavior. Eckles et al. (2014) study a sample of 69 insurers whose data come from CRSP/COMPUSTAT for the period 1990-2008. Having the same consideration with Hoyt and Liebenberg (2011), they believe that endogeneity must be confronted as omitted-variable bias would trigger this issue. However, they implement the Heckman two-step procedure instead of treatment effect. Their results suggest that after adopting ERM, firm' risk (stock return volatility) decreases and accounting performance increases for a given unit of risk. In addition, adopting-ERM firms have a higher reduction in return volatility over time. In general, they argue that with ERM, firms can produce a greater risk reduction per dollar spent. As discussed in previous reviews, this study also ignore the possibility of sample selection bias.

Considering another approach, Grace et al. (2015) exploited data from 532 insurers in the US in 2004 and 2006 and the Tillinghast Towers Perrin ERM survey for the same period to answer their research question: whether ERM adoption impacts the cost and revenue efficiency of firms? Their study aimed to identify a specific way in which ERM contributes to firm value. In details, authors measure frontier efficiency via data envelopment analysis (DEA) method. Furthermore, they implemented the bootstrapping procedure cost and revenue efficiency to correct the upward bias. The results found in this research suggest that the use of simple economic capital models (ECMs) favors insurers. They also found that no added value in the short run to investing in an advanced or sophisticated EMC relative to a simple ECM. Additionally, a dedicated firm-wide risk manager who reports to the board of directors or officials in the C-Suite contributes a higher level of efficiency and returns on assets. Lastly, they find that a firm's confidence that risk in reflected in their business decisions is related to greater performance. This research potentially possesses some caveats.

First, the studied period is rather short for efficiency evaluation. Second, there could be endogeneity and/or sample selection bias issues and one should take into consideration. Third, there is a need to prove a direct contribution of ERM to firm's cost and revenue efficiency.

With regard to three very elaborated studies but not published yet (Lin et al., 2012; Berry-Stölzle and Xu, 2015; Eastman and Xu, 2015), the impact of ERM on insurer's performance is mixed. Using a longitudinal data set of 85 U.S. publicly traded property and casualty (PC) insurers during the period 2000-2007, Lin et al. (2012) find that the market responds negatively to ERM adoption. For example, ERM presents a strong negative correlation with firm value with a discount of 5% (4%) in terms of Tobin's Q(ROA). According to the authors, explanations may be linked to *"ERM's infancy stage and firms adopting ERM have to rely on experiential learning conduct experiments and accumulate knowledge through trials and errors, the process of which can be demanding and time-consuming"*. Moreover, *"given its unclear utility, the market apparently views ERM, at the current state, as too costly to justify its implementation"*.

Considering similarly the impact of ERM on firm's cost, Berry-Stölzle and Xu (2015) investigate whether ERM adoption affects the firm's cost of equity capital. Their study is restricted to the U.S. insurance industry to control for unobservable differences in business models and risk exposures across industries. Regarding methodology, the authors employ a two-equation treatment effects model as well as event study. Their results indicate that ERM adoption is significantly associated with a reduction in firm cost of equity capital and reverse causality is unlikely. Moreover, based on Gordon (1959) growth model, they assert that reduction in cost of capital increases firm value.

Meanwhile, the study of Eastman and Xu (2015) reconciles mixed results of pior studies. Using event study on 43 insurers in the U.S. through various windows, especially the year 2005[4] and 2011[5], their findings suggest that ERM adoption is associated

[4]first announcement of S&P on ERM ratings
[5]Own Risk and Solvency Assessment (ORSA) enacted in November 2011

with a negative market reaction for firms that adopted prior to 2005, but that firms adopting following 2005 experienced a positive market reaction. Furthermore, they find some evidence of positive market reactions surrounding S&P's announcement for ERM firms, but not for non-ERM firms. They also find that regarding ORSA, generally ERM adopters enjoyed positive abnormal returns on key dates leading to the final passage, while non-adopters suffered negative abnormal returns. Overall, their results support the theory that ERM adds value in general.

3.2.2 Hypothesis development

Findings of Hoyt and Liebenberg (2011) and McShane et al. (2011) suggested that there is a positive correlation between ERM adoption and firm value in terms of Tobin's Q. They documented that the market value of firms increases when firms are more likely to adopt ERM or implement more sophisticated traditional risk management. Nonetheless, Lin et al. (2012) found contrary results where there is a strong negative correlation between ERM and Tobin's Q/ROA.

It is important to note that, empirical studies on ERM and firm performance of financial firms are limited. Accordingly, fewer studies are conducted in the insurance industry. Regarding firm performance, current literature advocates numerous indicators, both financial measurements (accounting value and market value) and non-financial measurements. Each indicator has its purpose and targets to one or some group of people. For example, market value, EPS are important for investors while booking values are important for regulators. In the meanwhile, ERM identification/measurement is still simple with well accepted proxy such as CRO or equivalent words, or ratings of agencies. These limitations could be progressed if one can construct an ERM index, as has been done with Corporate social responsibility (CSR).

Accordingly, I am interested to know whether ERM adoption has a positive impact on firm value, especially in the EU market. With inspirations from the work of Hoyt and Liebenberg (2011) and Eckles et al. (2014), I take into consideration of both endogeneity and sample selection bias by using treatment effects model and Heckman two-step procedure. I conjecture that with the presence of ERM, firm value

of adopting firm is higher than non-adopting one. Similarly, accounting performance such as ROA and EPS are also higher with adopted-ERM firms.

Literally, EU insurance firms are highly interconnected with the U.S. market. Since S&P's and A.M. Best's ERM ratings started in 2005 and 2006, EU firms have advantages with benchmarks from U.S. firms. Furthermore, a long preparation for Solvency II, which is in force since January 2016, and the rising awareness of stakeholders encourage much ERM implementation. Importantly, when ERM attracts more attention, ERM receives more investments and more efforts. As a result, the impact of ERM on firm performance would progress positively over time.

Therefore, I test the following hypotheses:

H1: There is a positive association between ERM adoption and firm value.

H2: There is a positive association between ERM adoption and accounting performance.

The hypotheses that take market value and/or book value into account are found in many empirical studies, particularly in the insurance sector with Hoyt and Liebenberg (2011) and Lin et al. (2012). Although each approach reflects its standpoint, the approach with market value is preferable as ERM promotes economic captial model for risk measures.

3.3 Research design and empirical analysis

3.3.1 Research design

To test the hypotheses that ERM adoption has a positive impact on firm value and accounting performance (ROA, EPS), I follow (Hoyt and Liebenberg, 2011; Eckles et al., 2014) and examine the following model

$$TobinQ_{it} = \gamma + \mu ERM_{it} + \theta X_{it} + \eta_{it} \tag{3.1}$$

$$ROA_{it} = \gamma + \mu ERM_{it} + \theta X_{it} + \eta_{it} \tag{3.2}$$

$$EPS_{it} = \gamma + \mu ERM_{it} + \theta X_{it} + \eta_{it} \tag{3.3}$$

where ERM_{it} indicates whether firms adopt ERM in year t and X_{it} is a vector of control variables that are hypothesized to explain variation in firm value. Important variables taken into consideration are those present diversification, core firm characteristics, accounting performance, and core-business performance. Consequently, the Equations 3.1, 3.2, 3.3 can be rewritten in a detailed form as follows

$$\begin{aligned} TobinQ_{it} = \gamma + \theta_1 LVRG_{it} + \theta_2 FA_{it} + \theta_3 FS_{it} + \theta_4 BLI_{it} + \theta_5 INTL_{it} \\ + \theta_6 BTY_{it} + \theta_7 ROA_{it} + \theta_8 EPS_{it} + \theta_9 CR_{it} + \mu ERM_{it} + \eta_{it} \end{aligned} \tag{3.4}$$

$$\begin{aligned} ROA_{it} = \gamma + \theta_1 LVRG_{it} + \theta_2 FA_{it} + \theta_3 FS_{it} + \theta_4 BLI_{it} + \theta_5 INTL_{it} \\ + \theta_6 BTY_{it} + \theta_7 TobinQ_{it} + \theta_8 EPS_{it} + \theta_9 CR_{it} + \mu ERM_{it} + \eta_{it} \end{aligned} \tag{3.5}$$

$$\begin{aligned} EPS_{it} = \gamma + \theta_1 LVRG_{it} + \theta_2 FA_{it} + \theta_3 FS_{it} + \theta_4 BLI_{it} + \theta_5 INTL_{it} \\ + \theta_6 BTY_{it} + \theta_7 ROA_{it} + \theta_8 TobinQ_{it} + \theta_9 CR_{it} + \mu ERM_{it} + \eta_{it} \end{aligned} \tag{3.6}$$

The binary decision to adopt ERM in the year t is modeled as the outcome of an unobserved latent variable ERM^*_{it}. It is assumed that ERM^*_{it} is a linear function of the determinants of ERM adoption.

$$ERM^*_{it} = \alpha + \beta f(X_{it}) + \upsilon_{it} + \epsilon_{it} \tag{3.7}$$

Or

$$\begin{aligned} ERM^*_{it} = \alpha + \beta_1 LVRG_{it} + \beta_2 LTIg_{it} + \beta_3 FA_{it} + \beta_4 FS_{it} + \beta_5 INTL_{it} \\ + \beta_6 BTY_{it} + \beta_7 PrE_{it} + \beta_8 CR_{it} + \beta_9 SR_{it} + \beta_{10} EPS_{it} \\ + \beta_{11} ROA_{it} + \beta_{12} TobinQ_{it} + \beta_{13} IPP_{it} + \upsilon_{it} + \epsilon_{it} \end{aligned} \tag{3.8}$$

The observed ERM adoption in a particular year is expressed as follows:

$$ERM_{it} = \begin{cases} 1 & if\ ERM^* > 0 \\ 0 & if\ ERM^* < 0 \end{cases} \tag{3.9}$$

I estimate each pair of Equations 3.4 and 3.8, 3.5 and 3.8, 3.6 and 3.8 simultaneously using both treatment effects and Heckman two-step procedure. Moreover, I also run Hausman-Taylor estimation to fit this panel-data random-effects model with the assumption that some of the explanatory variables are correlated with the individual-level random effects (but that none of the explanatory variables are correlated with the idiosyncratic error). Furthermore, there is a possibility that not only endogeneity but also sample selection bias exists. Therefore, I employ the last estimation through treatment effects with inverse Mills ratio.

The main idea of simultaneous estimation is to check whether the error term in Equation 3.1/ 3.2/ 3.3 are correlated with the error term in 3.7. If yes, then ordinary least squares (OLS) estimates of the impact of ERM on firm value and ROA/EPS will be biased because the equations are not independent.

Variables discussion is presented in the Table 2.1 in Chapter 2. More justifications of some examined variables are presented subsequently.

Firm size (FS) is measured as the natural logarithm of the number of employees. In fact, there are several ways to denote firm size, i.e. total assets, revenues. However, as insurance firms are regulated and have a strong capital capacity, the number of employees would capture better signals of firm size. Regarding geographic diversification (INTL), I denote a value of 0 if firm operates locally and 1 otherwise. Given that my sample consists of only EU firms, doing business in another country member of the EU still have constraints because of barriers such as language, culture, local taxation and local business environment. As a consequence, I do not distinguish firms operate in another EU country or outside EU.

Regarding the solvency ratio (SR), the calculation draws upon the Directive 2002/83/EC

for Life insurance undertakings and the Directive 2002/13/EC for Non-life insurance undertakings. Although I agree that one must differentiate between the solvency regulations in respect of non-life insurance and those in respect of life insurance, this study simplifies by using premium index and claim index for both all sample. This choice may be explained by the fact that nowadays, insurance groups run both life and non-life businesses and only consolidated reports are accessed publicly. As a result, I calculate the solvency margin[6] as the maximum value between 18 percent of earned premiums and 26 percent of adjusted claims. For a simple and prudent reason, I take the maximum percentage because with certain threshold, the percentage is lower. Then, I compute the solvency ratio (SR) by dividing the firm's book value of equity by its solvency margin.

ERM is denoted as 1 if I find evidence via ERM ratings of S&P and inclusive research with related keywords through the annual reports, Factiva and Websites. Otherwise, ERM is denoted as 0. Although S&P reports different levels of ERM and it is reasonable to conduct a multinominal logit model to extend the conventional Heckman's two-step model, I face difficulty when the number of observations is limited.

The research database is constructed from different sources. For accounting data, I extract from annual reports and financial data service like Morningstar, Stokopedia. Information of firms is extracted from Bloomberg, Factiva. Other sources of data come from Yahoo finance, Google finance, Sigma reports of SwissRe and exchange rates platform i.e. *www.xe.com*. Some variables are computed via MS Excel. Data analysis and estimations are carried out by Stata v.13.

3.3.2 Empirical analysis

As argued by (Hoyt and Liebenberg, 2011; Eckles et al., 2014) when examining the impact of ERM on firm performance, the endogeneity and sample selection bias issues would cause OLS estimates biased. Therefore, I check these possibilities with four different estimations: Treatment effects, Heckman two-step, Hausman-Taylor

[6]required minimum amount of own funds

and Treatment effects including inverse Mills ratio (Heckman two-step).

These estimations will be applied to models 3.4, 3.5, 3.6 and model 3.8. For calculating inverse Mills ratio (IMR), probit model is used for Equation 3.8 and via some Stata commands.

Table 3.1 reports the analysis of the impact of ERM adoption on Tobin's Q via four different estimations. Overall, I find that ERM adoption is significantly positively correlated with TobinQ. This result is consistent with my expectation that ERM has a positive impact on TobinQ as stated in the *H1*.

Results from columns (2), (4), and (5) show that ERM is significantly positively correlated with TobinQ at 1 percent level. Treatment effects estimation indicates an ERM premium of 30% while this rate is even higher in Hausman-Taylor and Treatment effects with IMR. This result is consistent with study of Hoyt and Liebenberg (2011) on the US sample for the period 1995-2005 where ERM premium is about 20%. A high ERM premium is plausible for the studied period (2007-2013) because Eckles et al. (2014) assert that over time, the value of ERM adoption has a progression.

Column (5) shows a significantly positively coefficient on Invmills indicating that OLS will be biased and inconsistent. Therefore, applying Heckman selection is justifiable. Moreover, the coefficient on lambda is significant on both columns (2) and (5) reconfirm my hypotheses that one should take endogeneity into consideration for bias correction.

Column (3) reports a negative lambda suggesting that the error terms in the selection and primary equations are negatively correlated. So (unobserved) factors that make ERM adoption more likely tend to be associated with lower TobinQ. However, the coefficient on lambda is insignificant, implying that statistically, there is no enough evidence to conclude that non-ERM adoption is associated with lower TobinQ.

Other results presented in Table 3.1 also indicate that with bias correction, TobinQ is negatively associated with leverage. Apparently, this result suggests that with higher leverage, a firm would be valued lower on the market. Furthermore, firms with

more diversification in term of business line or business type as well as international operation, have a positive correlation with firm value. Surprisingly, firm size and

Table 3.1: Different estimations with TobinQ as dependent variable

	TE	**Heckman**	**HT**	**TE_IMR**
	Coef./SE	**Coef./SE**	**Coef./SE**	**Coef./SE**
main				
LVRG	-0.005***	-0.003*	-0.001	-0.006***
	(0.00)	(0.00)	(0.00)	(0.00)
FA	0.001	0.001**	0.000	0.001*
	(0.00)	(0.00)	(0.00)	(0.00)
FS	-0.003	0.031*	-0.080*	0.009
	(0.01)	(0.01)	(0.03)	(0.01)
BLI	-0.254***	-0.256***	-0.140	-0.297***
	(0.04)	(0.06)	(0.15)	(0.05)
INTL	-0.170***	-0.160**	-0.029	-0.095
	(0.05)	(0.05)	(0.16)	(0.06)
BTY	-0.452***	-0.220	-0.321	-0.352***
	(0.08)	(0.42)	(0.26)	(0.09)
ROA	0.711*	3.879***	-0.683**	0.690*
	(0.32)	(0.51)	(0.23)	(0.34)
EPS	-0.001	-0.005*	0.001	-0.002
	(0.00)	(0.00)	(0.00)	(0.00)
CR	-0.007	-0.005	0.000	-0.007
	(0.00)	(0.01)	(0.00)	(0.00)
ERM	**0.305*** **		**0.409*** **	**0.650*** **
	(0.08)		(0.07)	(0.12)
PrE			0.012	
			(0.02)	
SR			-0.002*	
			(0.00)	
LTIg			0.005	
			(0.08)	
IPP			-0.069	
			(0.06)	
Invmills				**0.866*** **
				(0.23)
Constant	1.658***	1.313**	2.240***	0.835***
	(0.10)	(0.47)	(0.59)	(0.24)
hazard				
lambda	**-0.168****			**-0.363*** **
	(0.05)			(0.07)
mills				
lambda		**-0.109**		
		(0.08)		

* p<0.05, ** p<0.01, *** p<0.001

Notes : this table reports 4 estimates of TobinQ: Treatment effects, Heckman two-step, Hausman-Taylor and Treatment effects with inverse Mills ratio. Variables are the same in Chapter 2.

firm age in the insurance industry have marginal effects on firm value. One possible explanation for this result is that investors focus much on current and future business performance rather than firm's history and size. Recent evidence in the service industry shows that technology-drivers, especially IoTs make firm size in terms of number of employees becomes an unimportant factor.

Regarding Hausman-Taylor estimation in column (4), unexpectedly, the coefficient on ROA is negatively correlated with TobinQ. This result seems to be biased because as without correction of selection bias. In fact, other estimations all show that there is a positive significantly correlation between TobinQ and ROA. Additionally, solvency ratio is also found to be negatively associated with TobinQ. Although the magnitude of the coefficient is small, the economic significance indicates that a higher solvency ratio could be due to inefficient capital management when capital surplus excesses the real needs. Therefore, investors would prefer firms that better manage capital allocations.

Table 3.2 presents four different estimations on the relation between ERM adoption and firm's EPS. Generally speaking, empirical evidences show incoherent results concerning the impact of ERM on EPS. For instance, treatment effects estimation shows a negative significantly correlation, while Hausman-Taylor estimation shows a negatively insignificant correlation. Meanwhile, result in treatment effects with IMR shows a positive correlation. Despite less informative in terms of statistics, these patterns in another way, economically confirm the EPS policy is heterogeneous among firms. As a consequence, ERM adoption is not a plausible factor in EPS evaluation.

It is widely known that dividend policy is different across firms. A low EPS in a given year does not give much information, that is why investors usually look at the average EPS for 3 or 5 years. Moreover, as EPS is captured partially in firm value when there are dividend announcements, the effect of ERM on EPS becoming minor. Conversely, the coefficients on ROA are positively significantly correlated with EPS. Moreover, the magnitudes of these coefficients indicate a strong relation between these two variables. These findings not only show a statistical significance but also

imply that ROA is an important indicator in evaluating EPS. It is convinced that with higher ROA, firms would pay higher dividends in most cases.

Table 3.2: Different estimations with EPS as dependent variable

	TE	**Heckman**	**HT**	**TE_IMR**
	Coef./SE	**Coef./SE**	**Coef./SE**	**Coef./SE**
main				
LVRG	-0.046	-0.031	-0.011	-0.065
	(0.04)	(0.03)	(0.04)	(0.04)
FA	0.039***	0.029***	0.060	0.049***
	(0.01)	(0.01)	(0.04)	(0.01)
FS	1.026**	0.620	0.361	1.455***
	(0.33)	(0.33)	(1.14)	(0.33)
BLI	-3.546**	-0.941	-4.384	-5.219***
	(1.24)	(1.36)	(5.85)	(1.26)
INTL	-1.504	2.056	-2.368	1.218
	(1.39)	(1.33)	(6.09)	(1.46)
BTY	5.093*	-4.149	-0.561	8.256***
	(2.40)	(10.13)	(10.40)	(2.42)
ROA	40.468***	74.031***	50.193***	38.667***
	(8.74)	(12.70)	(6.35)	(8.51)
TobinQ	-1.020	-2.970*	0.686	-1.788
	(1.16)	(1.21)	(1.20)	(1.14)
CR	0.007	0.120	0.019	-0.016
	(0.11)	(0.20)	(0.08)	(0.11)
ERM	**-7.823*** **		**-1.132**	**5.585**
	(2.14)		(1.95)	(3.41)
PrE			-0.055	
			(0.72)	
SR			-0.029	
			(0.02)	
LTIg			5.736*	
			(2.42)	
IPP			-1.721	
			(1.82)	
Invmills				**32.263*** **
				(6.50)
Constant	-1.865	1.899	11.760	-31.117***
	(3.29)	(11.33)	(19.76)	(6.71)
hazard				
lambda	**4.317****			**-3.224**
	(1.48)			(2.10)
mills				
lambda		**-2.855**		
		(1.87)		

* p<0.05, ** p<0.01, *** p<0.001

Notes : this table reports 4 estimates of EPS: Treatment effects, Heckman two-step, Hausman-Taylor and Treatment effects with inverse Mills ratio. Variables are the same in Chapter 2.

Importantly, the coefficients on lambdas from columns (2), (5) provide evidences confirming the hypothesis that endogeneity and selection bias exist in model specification. However, with contrary values of lambdas (both positive and negative) I cannot give a conclusion on the relation between error terms of the selection and primary equations. Further investigations should be conducted to shed lights on this issue with more observations and/or other advanced techniques.

Other less important results reported in Table 3.2 to some extents, are also informative. For example, the coefficients on leverage are negative in all estimations. In spite the fact that they are insignificant, the same signs indicate a negative correlation between EPS and leverage. These patterns suggest that firms with higher EPS are more likely to have lower leverage ratio.

In another aspect, firm size and firm age are positively correlated with EPS. Nonetheless, the magnitudes of the coefficients on firm size are much bigger than those of firm age. This implies that firm size plays a more important role and firm age has minor effect on EPS. It is important to note that, in the context of growth theory, existing a non-linear relationship between growth (firm size) and performance. In other words, at a certain level of growth (firm size) the performance margins will slow down.

Regarding diversification facet, empirical results on business line is homogeneous with negative signs suggesting that mixed business firms are more likely to have lower EPS. Meanwhile, coefficients on business type and international operations have both positive and negative signs. As a consequence, it is impossible to have inferences from these patterns. Similarly, the coefficients on other performance variables such as TobinQ, combined-ratio are mixed implying that there is no clear evidence on the relation between EPS and these indicators.

Overall, there is a limited interpretation on EPS and ERM adoption. On the one hand, investors interest in EPS but on the other hand, other indicators capture better conveyed information from managerial decisions and/or activities.

Table 3.3 shows the analysis of ERM adoption and ROA through different es-

timations. Identically with results presented in Table 3.1, coefficients on ERM are positively significantly correlated with ROA. ERM adopting firms have premiums about 4% in columns (2), 4.3% in column (5), and 2.4% in column (2). Broadly speaking, firms with ERM adoption benefit a higher ROA. This result is inconsistent with Lin et al. (2012). However, Lin et al. (2012) find that both Tobin's Q and ROA have a negative correlation with ERM adoption, implying that Tobin's Q and ROA have the same signs on ERM. Meanwhile, empirical results of my study indicate a coherent positive relationship between ERM and Tobin's Q. Therefore, I conjecture that ROA is positively correlated with ERM adoption.

Importantly, the coefficients on lambdas in column (2) and (5) are significant, implying that treatment for endogeneity is necessary. Otherwise, OLS will be biased without corrections.

Results shown in Table 3.3 for other variables indicate generally a small magnitude. Despite this fact, the signs of these coefficients are coherent. For instance, leverage is negatively correlated with ROA, suggesting that firms with more leverage indicate a lower ROA. This is consistent with the theory of cost of capital when debts always associated with costs.

Firm size and firm age also represent a negative correlation with ROA. As argued by Coad et al. (2013), firms improve with age, but on the other hand, firm performance deteriorates with age. Moreover, firm size increase means complexity also increase and the cost of risk reduction would increase too.

When examining the diversification factor, results show a negative relation between ROA and business line and international operations. These results indicate that mixed-line firms and firms operate internationally seem likely to have lower ROA. In fact theory suggest that diversification is associated with both costs and benefits. On the one hand, diversification may be performance accelerating but on the other hand, diversification may deteriorate performance as well.

To obtain an alternative view on ERM adopting and firm performance, I conduct an analysis by combining three indicators TobinQ, EPS and ROA within each

estimations.

Table 3.4 presents results of treatment effects over three performance indicators.

Table 3.3: Different estimations with ROA as dependent variable

	TE	**Heckman**	**HT**	**TE_IMR**
	Coef./SE	**Coef./SE**	**Coef./SE**	**Coef./SE**
main				
LVRG	-0.001**	-0.000***	-0.000	-0.001**
	(0.00)	(0.00)	(0.00)	(0.00)
FA	-0.000**	-0.000*	-0.000	-0.000*
	(0.00)	(0.00)	(0.00)	(0.00)
FS	-0.001	-0.005***	-0.002	-0.000
	(0.00)	(0.00)	(0.01)	(0.00)
BLI	-0.010	-0.017**	-0.001	-0.010
	(0.01)	(0.01)	(0.04)	(0.01)
INTL	-0.009	-0.001	0.009	-0.009
	(0.01)	(0.01)	(0.04)	(0.01)
BTY	0.012	-0.039	0.017	0.013
	(0.01)	(0.04)	(0.07)	(0.01)
EPS	0.001***	0.001***	0.002***	0.001***
	(0.00)	(0.00)	(0.00)	(0.00)
TobinQ	0.012*	0.033***	-0.024**	0.012*
	(0.01)	(0.00)	(0.01)	(0.01)
CR	-0.000	-0.001	-0.000	-0.000
	(0.00)	(0.00)	(0.00)	(0.00)
ERM	**0.041*** **		**0.024***	**0.043****
	(0.01)		(0.01)	(0.02)
PrE			0.004	
			(0.00)	
SR			0.001***	
			(0.00)	
LTIg			-0.015	
			(0.01)	
IPP			-0.009	
			(0.01)	
Invmills				**0.004**
				(0.03)
Constant	-0.007	0.090*	0.059	-0.011
	(0.02)	(0.04)	(0.12)	(0.03)
hazard				
lambda	**-0.023****			**-0.024***
	(0.01)			(0.01)
mills				
lambda		**-0.011**		
		(0.01)		

* p<0.05, ** p<0.01, *** p<0.001

Notes : this table reports 4 estimates of ROA: Treatment effects, Heckman two-step, Hausman-Taylor and Treatment effects with inverse Mills ratio. Variables are the same in Chapter 2.

With treatment effects estimation, the coefficients on ERM are statistically significant. All lambdas are significant at 5 percent level, suggesting that treatment for endogeneity is necessary to avoid OLS biases. Moreover, negative signs in estimation of TobinQ and ROA indicate that the error terms in the participation and primary equation of interest are negatively correlated. In other words, unobserved factors that make participation more likely tend to be associated with lower TobinQ/ROA.

Table 3.4: Treatment effects

	TobinQ	**EPS**	**ROA**
	Coef./SE	**Coef./SE**	**Coef./SE**
main			
LVRG	-0.005***	-0.046	-0.001**
	(0.00)	(0.04)	(0.00)
FA	0.001	0.039***	-0.000**
	(0.00)	(0.01)	(0.00)
FS	-0.003	1.026**	-0.001
	(0.01)	(0.33)	(0.00)
BLI	-0.254***	-3.546**	-0.010
	(0.04)	(1.24)	(0.01)
INTL	-0.170***	-1.504	-0.009
	(0.05)	(1.39)	(0.01)
BTY	-0.452***	5.093*	0.012
	(0.08)	(2.40)	(0.01)
ROA	0.711*	40.468***	
	(0.32)	(8.74)	
EPS	-0.001		0.001***
	(0.00)		(0.00)
CR	-0.007	0.007	-0.000
	(0.00)	(0.11)	(0.00)
ERM	**0.305*** **	**-7.823*** **	**0.041*** **
	(0.08)	(2.14)	(0.01)
TobinQ		-1.020	0.012*
		(1.16)	(0.01)
Constant	1.658***	-1.865	-0.007
	(0.10)	(3.29)	(0.02)
hazard			
lambda	**-0.168****	**4.317****	**-0.023****
	(0.05)	(1.48)	(0.01)

* p<0.05, ** p<0.01, *** p<0.001

Notes : this table reports Treatment effects estimation on TobinQ, EPS and ROA. Variables are the same in Chapter 2.

Columns (2) and (4) present a positive correlation between ERM adoption and TobinQ/ROA meanwhile column (3) shows a negative correlation between ERM and EPS. Importantly, all of the coefficients on ERM are significant at 0.1 percent level. These findings support my hypothesis that ERM adoption play an essential role in contributing to firm performance.

Other discussions on firm characteristics and diversification are presented in the previous section with analysis of Table 3.1, Table 3.2, and Table 3.3.

With the Heckman two-step estimation shown in Table 3.5, obtained results present negative lambdas meanwhile the coefficients on lambdas are not significant. This result implies that I cannot reject the hypothesis that there is no problem of sample selection bias. However, there is no enough evidence for reaching to a definitive conclusion.

Furthermore, Heckman two-step provides a consistent sign (negative) of leverage in the relation with three performance indicators. Among which, there is statistical significance in case of TobinQ and ROA. These results indicate that leverage, in general, has a negative relation to firm performance. In other words, with sample selection correction, firms with higher leverage tend to have lower performance. Moreover, they at least partially support my hypothesis that the presence of ERM to some extents contribute to firm performance.

In addition, diversification factors such as business type, business line, and international operations show a negative correlation with performance when ERM exists. In other words, given the assumption of sample selection bias, the more firms diversify, the lower firm perform. However, due to statistical insignificance of lambdas, there is only economical significance with one possible explanation that diversification is associated with both benefits and costs.

Table 3.5 also reports coefficients on combined-ratio, which are negative with TobinQ/ROA and positive with EPS. Although these results are insignificant, they at least show the direction of correlations. Insurance firms with higher combined-ration tend to have lower TobinQ/ROA. This result reflects the true nature of business and

economy within the theory of costs-benefits.

Table 3.6 and Table 3.7 present Hausman-Taylor and treatment effects with sample selection bias (including inverse Mills ratio) respectively.

To the extent of Hausman-Taylor estimation, it is assumed that some of the explanatory variables are correlated with the individual level random effect. Given this assumption, statistical results indicate a positive significant correlation between ERM

Table 3.5: Heckman 2-step

	TobinQ	**EPS**	**ROA**
	Coef./SE	**Coef./SE**	**Coef./SE**
main			
LVRG	-0.003*	-0.031	-0.000***
	(0.00)	(0.03)	(0.00)
FA	0.001**	0.029***	-0.000*
	(0.00)	(0.01)	(0.00)
FS	0.031*	0.620	-0.005***
	(0.01)	(0.33)	(0.00)
BLI	-0.256***	-0.941	-0.017**
	(0.06)	(1.36)	(0.01)
INTL	-0.160**	2.056	-0.001
	(0.05)	(1.33)	(0.01)
BTY	-0.220	-4.149	-0.039
	(0.42)	(10.13)	(0.04)
ROA	3.879***	74.031***	
	(0.51)	(12.70)	
EPS	-0.005*		0.001***
	(0.00)		(0.00)
CR	-0.005	0.120	-0.001
	(0.01)	(0.20)	(0.00)
TobinQ		-2.970*	0.033***
		(1.21)	(0.00)
Constant	1.313**	1.899	0.090*
	(0.47)	(11.33)	(0.04)
mills			
lambda	**-0.109**	**-2.855**	**-0.011**
	(0.08)	(1.87)	(0.01)

* p<0.05, ** p<0.01, *** p<0.001

Notes : this table reports Heckman two-step estimation on TobinQ, EPS and ROA. Variables are the same in Chapter 2.

adoption and TobinQ/ROA. The coefficient on ERM in relation with EPS is negative but insignificant. Nonetheless, most of other coefficients are insignificant. I do not role out other possible explanations but may be strict assumptions are partially violated. I conjecture that there may be a correlation between one explanatory varible and the idiosyncratic error, or may be omitted variables.

Table 3.6: Hausman-Taylor

	TobinQ	**EPS**	**ROA**
	Coef./SE	**Coef./SE**	**Coef./SE**
LVRG	-0.001	-0.011	-0.000
	(0.00)	(0.04)	(0.00)
FA	0.000	0.060	-0.000
	(0.00)	(0.04)	(0.00)
FS	-0.080*	0.361	-0.002
	(0.03)	(1.14)	(0.01)
ROA	-0.683**	50.193***	
	(0.23)	(6.35)	
EPS	0.001		0.002***
	(0.00)		(0.00)
CR	0.000	0.019	-0.000
	(0.00)	(0.08)	(0.00)
PrE	0.012	-0.055	0.004
	(0.02)	(0.72)	(0.00)
SR	-0.002*	-0.029	0.001***
	(0.00)	(0.02)	(0.00)
LTIg	0.005	5.736*	-0.015
	(0.08)	(2.42)	(0.01)
IPP	-0.069	-1.721	-0.009
	(0.06)	(1.82)	(0.01)
ERM	**0.409*** **	**-1.132**	**0.024***
	(0.07)	(1.95)	(0.01)
BLI	-0.140	-4.384	-0.001
	(0.15)	(5.85)	(0.04)
INTL	-0.029	-2.368	0.009
	(0.16)	(6.09)	(0.04)
BTY	-0.321	-0.561	0.017
	(0.26)	(10.40)	(0.07)
TobinQ		0.686	-0.024**
		(1.20)	(0.01)
Constant	2.240***	11.760	0.059
	(0.59)	(19.76)	(0.12)

* p<0.05, ** p<0.01, *** p<0.001

Notes : this table reports Hausman-Taylor estimation on TobinQ, EPS and ROA. Variables are the same in Chapter 2.

The results in Table 3.6 show evidence that leverage is negatively correlated with all three examined performance variables. Despite of small magnitudes and insignificance, these patterns present to some extent a plausible economic relation. Otherwise stated, empirical evidence support the prediction that leverage has a negative correlation with firm performance.

Results on diversification factors such as business line, business type and international operation present a negative relationship with performance indicators. Nonetheless, only the coefficients on business line with TobinQ and ROA are significant at 0.1 percent level and five percent level respectively. These findings complement other estimations of this study toward a conclusion that diversification has a negative impact on firm performance, to some extents.

Similarly with results in Table 3.5, coefficient on combined-ratio has a negative sign with ROA and a positive sign with EPS with very small magnitudes. This complements other findings related to the relationship between combined-ratio and examined performance indicators.

Interestingly, the coefficients on IPP (premium per capita) show a negative correlation with performance indicators. The magnitude is smallest with ROA and biggest with EPS. Although statistics are insignificant, the economic view indicates that insurance firms in more developed market have lower performance with those in developing markets (as discussed in Chapter 1 with European two-speed).

Regarding treatment effects with IRM estimation, there is a slight difference between Table 3.7 and Table 3.5.

The evidence presented in Table 3.7 shows three important things. First, the coefficients on lambdas are negative and significant, suggesting that correction with treatment effects is necessary. Second, included inverse Mills ratio is significant over 2/3 variables, and all have the same sign (positive) implying that correction for sample selection bias is plausible too. Third, similarly with treatment effects presented in Table 3.5, coefficients on ERM are positively significantly correlated with TobinQ and ROA. One thing differs two estimations is that the coefficient on ERM in Table 3.7

is positive. However, this statistic result is not significant while coefficient on ERM in Table 3.5 is negative significant.

Furthermore, combined-ratio is found to be negative correlated with dependent examined variables. This result is consistent with estimation in Table 3.2 and Ta-

Table 3.7: Treatment effects with IMR

	TobinQ	**EPS**	**ROA**
	Coef./SE	**Coef./SE**	**Coef./SE**
main			
LVRG	-0.006***	-0.065	-0.001**
	(0.00)	(0.04)	(0.00)
FA	0.001*	0.049***	-0.000*
	(0.00)	(0.01)	(0.00)
FS	0.009	1.455***	-0.000
	(0.01)	(0.33)	(0.00)
BLI	-0.297***	-5.219***	-0.010
	(0.05)	(1.26)	(0.01)
INTL	-0.095	1.218	-0.009
	(0.06)	(1.46)	(0.01)
BTY	-0.352***	8.256***	0.013
	(0.09)	(2.42)	(0.01)
ROA	0.690*	38.667***	
	(0.34)	(8.51)	
EPS	-0.002		0.001***
	(0.00)		(0.00)
CR	-0.007	-0.016	-0.000
	(0.00)	(0.11)	(0.00)
Invmills	**0.866*** **	**32.263*** **	**0.004**
	(0.23)	(6.50)	(0.03)
ERM	**0.650*** **	**5.585**	**0.043** **
	(0.12)	(3.41)	(0.02)
TobinQ		-1.788	0.012*
		(1.14)	(0.01)
Constant	0.835***	-31.117***	-0.011
	(0.24)	(6.71)	(0.03)
hazard			
lambda	**-0.363*** **	**-3.224**	**-0.024** **
	(0.07)	(2.10)	(0.01)

* p<0.05, ** p<0.01, *** p<0.001

Notes : this table reports Treatment effects with inverse Mills ratio estimation on TobinQ, EPS and ROA. Variables are the same in Chapter 2.

ble 3.5 applied for TobinQ and ROA. Additionally, business line, business type and international operations show similar results with Table 3.5, indicating that there is a negative relationship between diversification and firm performance in terms of TobinQ and ROA.

Overall, with corrections via treatment effects and sample selection bias, obtained empirical results support my hypothesis that ERM is one of the factors that contribute to firm performance, and a correction for endogeneity and sample selection bias is necessary. The work of Hoyt and Liebenberg (2011) mentions the endogeneity but not selection bias. In addition, they find that there would be bias if the issue of endogeneity is not treated.

3.4 Conclusion

This chapter examines the impact of ERM adoption on insurance firm's performance via three financial indicators: TobinQ, EPS and ROA. I find that ERM adoption has a significant impact on TobinQ, ROA and EPS. Indeed, empirical evidence shows a positive correlation between ERM adoption and TobinQ/ROA. Meanwhile, ERM adoption is negatively correlated with EPS. Firstly, my finding relating to ERM and TobinQ is consistent with study of Hoyt and Liebenberg (2011) and McShane et al. (2011), suggesting that ERM implementation enhances insurance firm's value. Secondly, finding on the relation between ERM adoption and ROA indicates a positive correlation. However, this is the first study to investigate this correlation except for the study of Lin et al. (2012) which is still not recognized. Thirdly, pattern relating to ERM adoption and EPS shows, in general, a negative correlation. To my knowledge, this is the first study examines this relation in the insurance industry but intuitively, ERM implementation is costly. Moreover, Altuntas et al. (2011) argue that ERM adoption may link to negative changes in the past firm performance.

An important contribution of my study is that I examine the relation between firm's performance and ERM adoption by using four different estimation techniques. I find that results remain largely similar among estimations. These empirical results support my hypothesis that with the presence of ERM, the performance of insurance

firm is enhanced. Therefore, my study complements evidence that ERM adoption has a positive impact on firm performance. Moreover, the significance of lambdas and the added invers Mills ratio supports my prediction that correction for endogeneity and sample selection bias is necessary and plausible.

Other findings of my study also are informative for inference. Leverage is found to be negative correlated with firm performance, implying that firms with more liabilities would have lower performance. However, besides the theory of cost of capital, I do not rule out other possible explanations given that a major part of an insurer's liabilities is advanced premiums and policy obligations.

Diversification factors such as business line, business type and international operations present a negative correlation with firm performance. This pattern is consistent with the argument that diversification is associated with both costs and benefits. Diversification on the one hand may be a risk mitigation tool but on the other hand, it may accelerate costs and even risks and finally affect firm performance. On the contrary, there is no one-way sign of the coefficients on firm size and firm age. With all estimation, firm age is reported to have a positive relation with TobinQ/EPS but not with ROA. Similarly, firm size' coefficients are heterogeneous across estimations. In details, firm size is positive correlated with EPS but negative correlated with ROA.

Although the empirical results generally support my hypotheses, some results remain unexplained. Lambdas of Heckman two-step estimation on all three examined variables all are negative and not significant. The negative signs have implications that unobserved factors causing participation are more likely to be associated with lower performance. The insignificance of all Heckman's lambdas suggesting that the evidence of sample selection bias is not confirmed. Meanwhile, I cannot reject my prediction that correction for sample selection bias is necessary. Another caveat of my study is that Hausman-Taylor estimation shows some different statistic results in comparison with others estimations which are mostly homogeneous. This may due to the strict assumptions of this estimation and issue of omitted variables.

My study suggests several questions that future studies can examine. First, I

argue that ERM adoption enhances firm performance (TobinQ/ROA). Future studies should test whether results remain similarly when enlarging the data sample, including other major insurance markets such as the US and Japan. Second, it is interesting to know whether the maturity level of ERM has the same effects on firm performance. A proposed approach for this research question is using multi-logit for two-step extended model, which is employed by Wu and Shen (2013). However, this requires a rich ERM index data. Third, researchers should look to understand how insurance firms with (with different level) and without ERM adoption react with important events such as crucial change in regulations, natural disasters by using event study with different windows. Finally, finding an instrumental variable for ERM adoption as well as find out important omitted variables can provide more insights into the answer of what and how ERM adoption affects firm performance.

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Chapter 4

ERM and financial vulnerability

Contents

Abstract

I study the relation between ERM adoption and insurance firm solvency during the period from 2007-2013 for a sample of 101 publicly traded insurers in the EU. I find that ERM adoption has a positive impact on insurance firm solvency. Moreover, geographic diversification (international operation) is positively correlated with solvency. Meanwhile, firm solvency is negatively associated with leverage, firm size, firm age, TobinQ and combined-ratio. In addition, the relation between solvency and long-term investments is inclusive.

I also claim that endogeneity and sample selection bias corrections must be addressed in a study of ERM and related subjects. Further research on ERM and solvency will contribute more to literature when considering the caveats of this chapter.

4.1 Introduction

ERM and insurance firm solvency has attracted several studies in economics, finance and management. Knowledge about ERM and solvency (not solely actuarial issues) is also important for firm managers, claimers, regulators and investors. Carson and Hoyt (2000) argue that financial vulnerability faced by policyholder is the same to that face by bondholder for the counter-party risk. According to the authors, insurance firm solvency is affected by capital and surplus, geographic focus, asset mix and leverage. Chen and Wong (2004) claim that firm size and investment performance are significant factors that have impacts on firm solvency. Furthermore, diversification in business also plays a role in study solvency.

It is said that the insurance sector has a significant contribution to the development of economies (Outreville, 2013). A healthy insurance market would empower the stability of the financial market, the whole economies, especially in the context of financial integration. International regulators also suggest solvency assessment as the core component of the ERM framework as shown in Figure 4.1. Indeed, insurance firm insolvency interests not only regulators, policyholders but also shareholders/investors.

Unlike numerous studies in insurance solvency in the field of mathematical finance, and general ERM, few studies investigate the relation between ERM and insurance solvency from the managerial standpoint. In this chapter, I study the impact of ERM adoption on insurance firm solvency during the period from 2007-2013 for a sample of 101 publicly traded insurers in the EU. Take into consideration of endogeneity and/or sample selection bias issues, I employ different estimation methods: treatment effects, Heckman two-step, Hausman-Taylor and treatment effects included IMR. I also conduct 2 specifications: one only firm-specific factors and one controlling for the macro factor i.e. IPP. The IPP which is measured via premiums per capita can stands for other macro factors directly or indirectly.

My chapter contributes to the literature in several ways. First, this is the first empirical on EU insurance firms regarding ERM and solvency in the view of financial management. Second, a comprehensive approach with different estimation methods

help to figure out coherent results among applied methods. Third, using directly the solvency margin and then solvency ratio complements previous studies on solvency in the context of solvency measurement.

I find that ERM adoption has a positive impact on insurance firm solvency. Moreover, geographic diversification (international operation) is positively correlated with solvency. Meanwhile, firm solvency is negatively associated with leverage, firm size, firm age, TobinQ and combined-ratio. In addition, the relation between solvency and long-term investments is inclusive. The findings in this chapter are consistent with claims that documented in previous studies (Carson and Hoyt, 2000; Chen and Wong, 2004).

The rest of this chapter is organized as follows. Section 4.3 presents a literature review and develops hypotheses. Section 4.4 documents research design. Section 4.5 reports empirical analysis and discussion. Section 4.6 concludes the chapter.

4.2 Prior research and hypothesis development

4.2.1 How does ERM affect solvency?

According to Pentikäinen (1967), solvability of an insurance firm can be viewed from two different points: the management of the company and the supervising authorities. The first view means the continuation of the function and existence of the company must be secured, while the second view indicating the benefits of the claimants and policyholders must be secured. As a result, core aspects relating to insurance solvency: 1) the valuation of liabilities; 2) the evaluation of assets; 3) the level of the premiums of long term policies and 4) reinsurance.

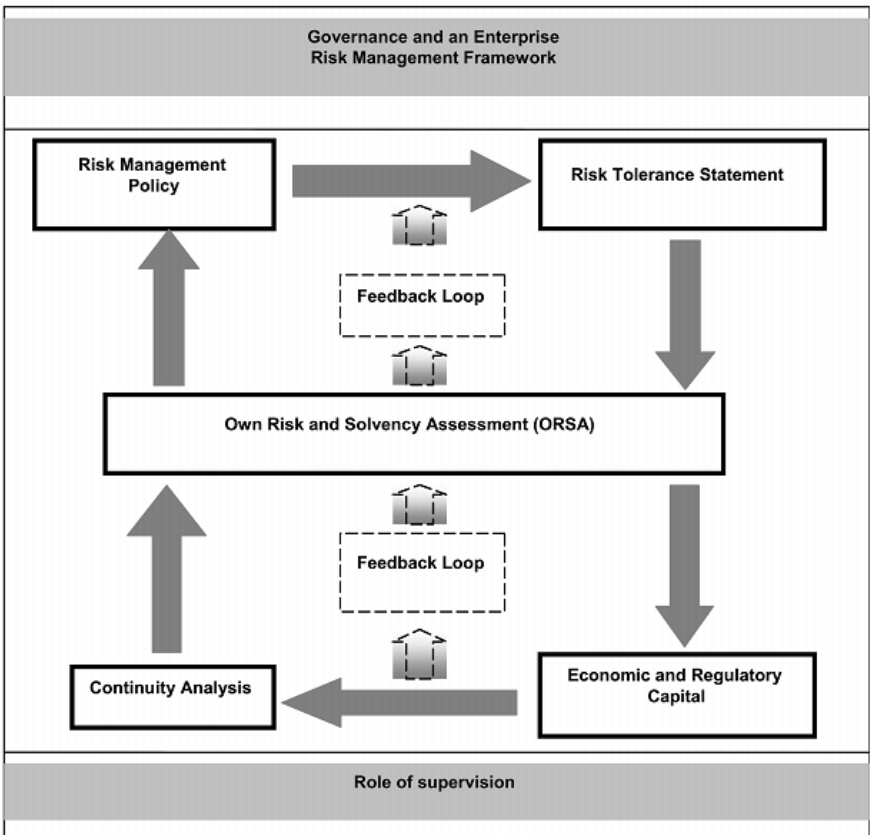
In the line with assessment life insurer's financial health, Pottier (1998) argues that adverse rating changes are important predictors of insolvency. Given that monitoring solvency of insurers is vital, regulators, policyholders and other parties should allocate their resources sufficiently and efficiently. Author suggests that among sources of information such as financial ratios, ratings and rating changes, one could use solely or combine these sources with agreement that financial ration analysis is more costly

than others.

Carson and Hoyt (2000) argue that detection of financially impaired situation, i.e. financial distress is important to several stakeholders. For example, the counter-party risk faced by policyholders or claimers is similar to that faced by bondholders - namely, the risk of default. Furthermore, detecting insurers that are likely to experience financial distress helps insurance regulators decide the extent of regulatory attention to focus on particular firms. Moreover, firm managers are also motivated partly from personal costs that may result in the event of firm bankruptcy.

For a long time, studies on insurance solvability are considered rather actuarial issues than managerial issues. However, as Geoffrey Bell (Bell et al., 2009) stated that *"... . We went far too far with the idea that a model can tell you how much*

Figure 4.1: ERM framework



Source: IAIS guideline 2008b

capital you need, with little or no need for judgment - p.45", solvency is now among other important pillars of management in the insurance industry.

With the revolutionary risk management aka. ERM, solvency assessment is one part of the ERM (Sandström, 2010). This implies that all risks that the organizations face should be part of the solvency assessment, either measured quantitatively or qualitatively. Moreover, the International Association of Insurance Supervisors (IAIS, 2008) recommends that in their ERM framework, Own Risk and Solvency Assessment is at the central.

In comparison with the study on actuarial solvability, study on managerial solvability is sparse and recognized as a small research stream. One possible explanation is that insolvencies of insurers are rather infrequent. In reality, distressed insurers would usually find an arrangement for a merger and/or acquisition solution. Although Purnanandam (2008) argues that one should distinct between financial distress and insolvency, it is important to acknowledge that financial distress is the key trigger of insolvency.

Few studies on the solvency of insurance firms with the managerial view are traced in the literature. Carson and Hoyt (1995, 2000) studied life insurers from the National Association of Insurance Commissioners (NAIC) database for the period 1986-1992. Their findings suggest that surplus measures and leverage measures are strong indicators for measuring financial strength. Furthermore, they find that distressed insurers carried significantly larger investments of their assets in real estates. Meanwhile, they find no evidence for a strong relationship between state minimum capital requirements and insolvency.

Particularly, Carson and Hoyt (2000) showed that significant variables that are likely to be relevant in the early detection of financially distressed life insurers are capital and surplus, geographic focus, asset mix, and leverage. They also remind that holding relatively high proportions of assets in real estate is the explanation for life insurers. Additionally, they emphasize that leverage adds an element of risk that manifest itself in a higher propensity for failure than for less-leveraged insurers. With

inference for EU market, they assert that EU life insurers with high level of geographic concentration were less likely to have trouble.

In a study on insurance companies in Asian economies, Chen and Wong (2004) found that firm size and investment performance are significant factors that affect insurer's financial health. When segregated into life and non-life business, results show that with non-life insurers, financial health is associated with liquidity ratio, surplus growth, combined ratio, and operating margin. Meanwhile, in regard to life insurers, financial health is correlated with change in asset mix and change in product mix.

With more technical view, Jevtić and Regis (2015) calibrated mathematical models with UK life-health insurance data and show that natural hedging can improve the solvency of insurers. Importantly, insurers have to manage the match between asset allocation choices and the composition of the liability portfolio. Indeed, they stress the importance of implementing Liability Driven Investment (LDI) and life insurers should manage simultaneously the interest rate risk and the longevity risk profile. The pattern of Asset-Liability Management (ALM) is consistent with the argument of Malkiel (1991) where the duration match between assets and liabilities. Moreover, Malkiel (1991) also argues that other indicators of health of the insurance industry must include: profitability, risk level of assets, capital cushion, and possible agency problems.

Then, what is the relationship between solvency and ERM?

Yow and Sherris (2008) asserted that matching assets and liabilities is an important part of effective risk management. Evidence from the 1997 crisis and recent crisis showing that after crisis, there is more stress on insurers regarding ALM due to interest rate risk. Furthermore, the presence of high frictional costs creates a trade-off between the costs of holding capital and the benefits of financial strength. Poor management of this type of risk could lead insurers to the financial distress situation, and even insolvency. From the insurer's risk management policy, both capital and pricing strategies are important. In fact, holding too high a level of capital results in higher

taxes and agency costs. Conversely, holding too low a level of capital increases the risk of bankruptcy and reduces the profits from insurance margins when policyholders care about financial strength.

In finance theory, there are arguments and evidence opposing the CAPM and APT-based propositions that risk management activities are worthless. Findings of Cassidy et al. (1990) indicate that investors do value firm specific risk management activities when the reduction of the agency costs of bankruptcy exceed the explicit costs of the risk management activity. Other prominent scholars in finance (Smith and Stulz, 1985; Jin and Jorion, 2006; MacKay and Moeller, 2007) also advocate that risk managing through hedging activities do increase the firm's value, implying a reduction in possibility of insolvency.

More generally, Smithson and Simkins (2005) documented in their brilliant review that academic researches show a positive effect of risk management (hedging) on cash flow volatility. As a consequence, the likelihood that firm will become financially distressed or be forced to abandon valuable investment opportunities is reduced. For firms with intensively use of derivatives to manage foreign exchange rate risk and interest rate risk, which is the case of international insurance groups, recent studies indicate a clear positive correlation between higher share values and hedging. Particularly with the insurance industry, Cummins et al. (2009) found that risk management creates value for non-life insurers in the US, improve efficiency and therefore have a positive impact of insurers' solvency.

However, it is still questionable whether the contribution of risk management is the market's reaction to the risk management activity itself or we are observing some kind of "self-selection" process in which successful firms are more likely to have the capital and other resources needed to run a derivatives program. In addition, whether there is a manipulation in reserves calculation of insurers to avoid violating solvency assessment of regulators (Gaver and Paterson, 2004). Although transparent reporting has been promoted with International Financial Reporting Standards (IFRS 4) and Solvency II, periodical accounting reports still leave a chance for insurers to 'cook'

their numbers in case of necessity.

Finally, it is difficult for any outsiders to assess the strength of financial institutions. If one only relies on crude proxies, there would be misleading in some instances (Malkiel, 1991). Therefore, information concerning the solvency of insurers and their risk management activities must be transparent and examined in a holistic manner too.

4.2.2 Hypothesis development

The ostensible causes of the record insolvent insurers in 1990s were myriad. Santomero and Babbel (1997) conclude that the underlying factor in all of them was the same: inadequate risk management practices. Since Stulz (1984) first suggested why firms manage risks and Doherty (1985) applied this notion for insurers in a financial framework, the rationales for risk management in the insurance industry can be classified in four aspects: managerial self-interest, the nonlinearity of taxes, the cost of financial distress, and the existence of capital market imperfections.

Acknowledged that insurers are in the business of risks, it is evident that they view risk as a central ingredient in the industry's franchise. Santomero and Babbel (1997) report their investigations in an article that insurance firms face six generic types of risk: 1) actuarial risk, 2) systematic risk (interest rate risk), 3) credit risk, 4) liquidity risk, 5) operational risk, and 6) legal risk.

As discussed in Section 4.3.1 that risk management have significant effect on agency costs of bankruptcy, cost of financial distress, and solvency, it is plausible to investigate the relationship between ERM and insurance firm's solvency. Apparently, ERM would have a positive impact on solvability but a more detailed answer needs a more evidence from empirical studies.

Therefore, I hypothesize that

H1: ERM adoption positively affects the solvability of insurance firms.

Moreover, I agree with (Carson and Hoyt, 2000; Chen and Wong, 2004) that leverage, firm size, business diversification, operating margin, and investment are

important indicators of financial strength of insurers. Indeed, insurance firms own two sources of leverage: from insurance contracts and from financial markets and both can be the trigger of insolvency. Bigger firm would have more resources to cope with insolvency, but it has weakness too: agility and severity in big shocks. Business diversification usually considered as a risk mitigation tool, but concentration could be more effective when financial distress occurs.

From the above considerations, I hypothesize that

H2: Solvability is positively correlated with operation margin, firm size long-term investment, while negatively correlated with leverage and business diversification.

4.3 Research design and empirical analysis

4.3.1 Research design

In this study, I use the solvency ratio as a measure of firm solvency. In previous studies, insurer insolvency studies employed matched-pair samples applied multiple discriminant analysis (MDA) (Trieschmann and Pinches, 1973), neural network model (Brockett et al., 1994; Huang et al., 1994), and the Logit model (Carson and Hoyt, 1995; Chen and Wong, 2004).

Chen and Wong (2004) argue that using samples of solvent and insolvent insurers is impossible for markets where no insurers has failed so far. Then they developed a new approach based on the HHM model of (Hollman et al., 1993). The main idea of HHM model is to provide an early warning of insurers in possible financial trouble using ratio-based methodology. An index of stability (I) is measured by the relative changes of balance sheet items. The larger value of I_k, the greater instability is presented in comparison with the sample mean I_{av} . The mathematical expression of the HMM model is given below, which is in weighted natural logarithmic form as follows

$$I_k = \sum_{i=1}^{n} x_i [ln\, x_i / y_i]$$

where I_k is a summary measure of instability of the kth section of financial data series; $i = 1, 2, ..., n$ is the order of appearance of n financial statement items; x_i presents a specific item from specific financial statements; and y_i represents the corresponding (prior period) reference component.

With computation derived from HHM model, Chen and Wong (2004) divide insurers into two groups and coding for 1 if financially stable and 0 otherwise. Then they use the Logit model to test their hypotheses on firm-specific factors.

The caveats of this approach represented at two points. First, comparing I_k with I_{av} to conclude whether a firm is in financial trouble is incoherent when the financial strength of the sample, on average, at tails of regulations. Second, including all of items of balance sheet could dilute the weights of important items directly reflect insolvency. Therefore, obtained information more likely to be incorrect. However, the idea of computing relative change can combine with the Probit model in future insolvency studies. For example, one can calculate the relative change of the solvency ratio based on current guidance of authorities, which defines the floor level of minimum capital requirements (MCR) for each type of business line.

To examine the correlation between ERM adoption and solvency, I use the Probit model as in Chapter 2 and Chapter 3 to identify the possibility of ERM adoption. Then, I employ simultaneous equations (TE, Heckaman, HT, TE with IMR) to deal with the endogeneity and selection bias problems. For a primary analysis, I check the difference of coefficients estimated by OLS between two ERM groups with seemingly unrelated estimation and Chow test. I expect that these obtained results will give me some ingredients for further analysis.

Regarding the solvency measurement in this study, solvency ratio is computed upon the Directive 2002/83/EC for Life insurance undertakings and the Directive 2002/13/EC for Non-life insurance undertakings. Despite the fact that one must differentiate between the solvency regulations of life and non-life business, this study simplifies by using premium index and claim index for examining sample for a simple and prudent assessment. To compute the solvency ratio, first I calculate the solvency

margin as the maximum value between 18 percent of earned premiums and 26 percent of adjusted claims. Then, I divide the firm's book value of equity by the obtained results. The formula shown as:

$$SolvencyMargin = Max\{18\%EarnedPremiums,\ 26\%AdjustedClaims\}$$

$$SR = \frac{BookValueEquity}{SolvencyMargin}$$

Keeping in the line with chapter 3, I examine the following models to test my hypotheses:

$$\begin{aligned} SR_{it} = \gamma + \theta_1 LVRG_{it} + \theta_2 FA_{it} + \theta_3 FS_{it} + \theta_4 BLI_{it} + \theta_5 INTL_{it} \\ + \theta_6 BTY_{it} + \theta_7 TobinQ_{it} + \theta_8 LTIg_{it} + \theta_9 CR_{it} + \theta_{10} PrE_{it} \\ + \mu ERM_{it} + \eta_{it} \end{aligned} \tag{4.1}$$

The binary decision to adopt ERM in the year t is modeled as the outcome of an unobserved latent variable ERM^*_{it}. It is assumed that ERM^*_{it} is a linear function of the determinants of ERM adoption.

$$\begin{aligned} ERM^*_{it} = \alpha + \beta_1 LVRG_{it} + \beta_2 LTIg_{it} + \beta_3 FA_{it} + \beta_4 FS_{it} + \beta_5 INTL_{it} \\ + \beta_6 BTY_{it} + \beta_7 PrE_{it} + \beta_8 CR_{it} + \beta_9 SR_{it} + \beta_{10} EPS_{it} \\ + \beta_{11} ROA_{it} + \beta_{12} TobinQ_{it} + \beta_{13} IPP_{it} + \upsilon_{it} + \epsilon_{it} \end{aligned} \tag{4.2}$$

The observed ERM adoption in a particular year is expressed as follows:

$$ERM_{it} = \begin{cases} 1 & if\ ERM^* > 0 \\ 0 & if\ ERM^* < 0 \end{cases} \tag{4.3}$$

Variables discussion is the same as presented in Chapter 2 in Table 4.1:

The research sample in this Chapter is the same with previous chapters. It includes 101 publicly traded insurance firms in EU for the period 2007-2013. The process of

constructing database is illustrated in Chapter 1. Apart from variable definition and discussions presented in previous chapters, further explanations for the choice of variables in Model 4.1 as follows: Leverage (LVRG) is found as an important factor in study insolvency of insurers (Carson and Hoyt, 2000; Chen and Wong, 2004), so I predict that it would have the same impact on the EU sample. Diversification factors such as business line, business location (international operations) also are examined in previous studies. Therefore, in this study I complement another facet of diversification is business type (core vs. non-core insurance firm).

In regard to performance, aside from combined-ratio, I include TobinQ and PrE in the model and expect that they would shed more lights on the solvency study. Firm size and firm age also included in the model as they reflect clearly firm-specific factors

Table 4.1: Variables discussion

Variable	Definition	Expected sign
LVRG	is firm leverage, measured as the ratio of liabilities to book value of equity.	+
LTIg	is long-term investment, measured as the ratio of long-term investment to asset.	+
FS	is firm size, measured as natural logarithm of number of employees.	+
FA	is firm age, measured as years of operation.	+
INTL	is geographic diversification, if firm operates domestically, it takes on a value of 0, and 1 otherwise.	+
BTY	is business-type, if firm is a broker or insurance related services supplier, it takes on a value of 0, and 1 otherwise.	+
BLI	is business-line, if firm is mono-line, it takes a value of 0, and 1 otherwise.	+
PrE	is productivity of employee, measured as natural logarithm of the ratio of revenue to total employees.	+
CR	is combined-ratio, measured as the ratio of losses and expenses to earned premiums.	-
SR	is solvency ratio, measured as the ratio of book value of equity to the maximum value between 18 percent earned premiums and 26 percent losses-benefits-adjusted.	+
EPS	is earning per share, after diluted	+
ROA	is return on asset	+
TobinQ	is proxy for firm value, measured as the ratio of market value of equity and book value of liabilities to book value of asset	+
IPP	is insurance purchasing power, measured as the natural logarithm of premiums per capita.	+

and to some extents, representing the risk profile of a firm.

Although Chen and Wong (2004) found that macro determinants do not support their hypotheses at the macro level, I want to verify this aspect by examining another macro determinant which is the premium per capita of each market (IPP). Previous studies (Santomero and Babbel, 1997; Smithson and Simkins, 2005; Yow and Sherris, 2008) argue that macro factors such as interest rate risk is one major risk category of insurers. Nonetheless, other macro factors also play their roles on insurance insolvency. For example, inflation, economic growth, GDP per capita, premiums per capita, etc. are among these factors. In this study, I examine one important and direct macro factor in the relation with solvency: insurance purchasing power (premium per capita - IPP) of each market. I conjecture that IPP captures and reflects the macroeconomic environment, including GDP growth, and demand side of the insurance market.

Therefore, I include the IPP variable in the Equation 4.1:

$$\begin{aligned} SR_{it} = \gamma + \theta_1 LVRG_{it} + \theta_2 FA_{it} + \theta_3 FS_{it} + \theta_4 BLI_{it} + \theta_5 INTL_{it} \\ + \theta_6 BTY_{it} + \theta_7 TobinQ_{it} + \theta_8 LTIg_{it} + \theta_9 CR_{it} + \theta_{10} PrE_{it} \\ s + \theta_{11} IPP_{it} + \mu ERM_{it} + \eta_{it} \end{aligned} \tag{4.4}$$

Prior research shows that investment in real estate and rating also affect insurance solvency. For insurance firms, long-term investments usually placed in the bond market, however intuitively, another important portfolio is real estate. Due to the unavailable data on real estate investment of each observed firm, I employ long-term investment (LTIg) as an alternative determinant.

Importantly, although the ERM variable in this study is binary, ERM adoption does convey implications of ratings when major rating agencies such as S&P, A.M. Best, Moody's included ERM in their ratings of insurers. As a result, examining the relationship between ERM adoption and solvency not only finding out the risk management aspect but also the rating aspect.

4.3.2 Empirical analysis

To find out the different effects on SR between two ERM groups in the primary analysis, I employ seemingly unrelated estimation and Chow test. As I cannot have a suitable tool for panel data, I have to use OLS as the last resort with an understanding of its shortcomings.

Table 4.2 compare results from regressions of Equation 4.1 with pooled-OLS. With ERM-adoption group, the coefficients on LVRG, FS, INTL, BTY, PrE and IPP are significant. Except for the variables INTL and IPP, all others are negative. The negative correlations between LVRG, FS, BTY, PrE and SR suggest that with the presence of ERM, the insolvency of insurance firms increases when firms have a higher leverage, bigger, focusing on core-insurance business and higher employee productivity. Meanwhile, insurance firms operate internationally and located in developed markets have a higher solvency ratio. Among other insignificant factors, FA and LTIg have positive signs, implying that older and investing more in long-term firms have a higher solvency ratio.

Regarding non-ERM adopting firms, statistics show that the correlations between FA, TobinQ, IPP with SR are significant. Similarly with ERM-adopting group, the coefficient on IPP is positively significant. The negative signs of the coefficients of FA and TobinQ suggesting that with no-ERM, the solvency of firms decreases when firms are older and over-valued.

There are common findings in Table 4.2 regardless ERM factor. The negative signs are found on the coefficients of FS, BLI, BTY, TobinQ, and PrE. However, the significance of these coefficients is inversely for two groups which means that if one is significant in this group, it is not in another. Interestingly, the coefficient on IPP is positively significantly in both groups. This implies that there is no difference between ERM and non-ERM to the extent of the effect of IPP on solvency ratio.

Overall, pooled-OLS results documented in Table 4.2 show a negative relationship between solvency ratio and examined factors, depending on ERM situation. It is

exceptional for IPP where the coefficient is positive significant not matter what ERM status.

In the next step, I conduct Chow-test to investigate the difference between the coefficients estimated in two groups. Findings shown in Figure 4.2 indicate the difference is insignificant. The pattern of this test implies that with pooled-OLS estimation, I cannot conclude a different between ERM-adopting firms and non-ERM firms in terms of solvency and related factors.

One possible explanation is the problem of endogeneity and/or sample selection

Table 4.2: Seemingly unrelated estimation

	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
wERM_mean						
LVRG	**-.0419584**	**.0109413**	**-3.83**	**0.000**	**-.0634029**	**-.0205139**
FA	.0003376	.001432	0.24	0.814	-.002469	.0031442
FS	**-.4821217**	**.0777815**	**-6.20**	**0.000**	**-.6345706**	**-.3296729**
BLI	-.4873882	.3067358	-1.59	0.112	-1.088579	.1138028
INTL	**1.395446**	**.2257585**	**6.18**	**0.000**	**.952968**	**1.837925**
BTY	**-6.384765**	**.3036008**	**-21.03**	**0.000**	**-6.979812**	**-5.789719**
TobinQ	-.2691526	.2223286	-1.21	0.226	-.7049087	.1666034
LTIg	.5070995	.5320258	0.95	0.341	-.5356519	1.549851
CR	-.0014077	.0380576	-0.04	0.970	-.0759992	.0731839
PrE	**-.2941773**	**.1373857**	**-2.14**	**0.032**	**-.5634484**	**-.0249063**
IPP	**.4773226**	**.1974597**	**2.42**	**0.016**	**.0903088**	**.8643365**
_cons	13.53257	2.501103	5.41	0.000	8.630495	18.43464
wERM_lnvar						
_cons	1.491122	.1382133	10.79	0.000	1.220229	1.762015
woERM_mean						
LVRG	.0962805	.1474427	0.65	0.514	-.192702	.3852629
FA	**-.0632073**	**.0218384**	**-2.89**	**0.004**	**-.1060097**	**-.0204049**
FS	-.2235575	.900683	-0.25	0.804	-1.988864	1.541749
BLI	-2.68537	1.965079	-1.37	0.172	-6.536853	1.166113
INTL	-3.100196	2.744201	-1.13	0.259	-8.478731	2.278339
BTY	-4.659139	6.772511	-0.69	0.491	-17.93302	8.614739
TobinQ	**-23.89032**	**8.114064**	**-2.94**	**0.003**	**-39.7936**	**-7.987048**
LTIg	-.8230721	5.17871	-0.16	0.874	-10.97316	9.327012
CR	.9487574	.8111069	1.17	0.242	-.6409828	2.538498
PrE	-1.030449	.8849056	-1.16	0.244	-2.764832	.7039342
IPP	**3.767983**	**1.490966**	**2.53**	**0.011**	**.845744**	**6.690222**
_cons	27.59368	16.42998	1.68	0.093	-4.608483	59.79584
woERM_lnvar						
_cons	6.529955	.4459689	14.64	0.000	5.655872	7.404038

bias. Therefore, I will investigate further with the following estimations.

In the first approach, I regress Equation 4.1 without macro factor IPP via different estimation methods: treatment effects, Heckman-two step, Hausman-Taylor and treatment effects with IMR. Explications of these methods are presented in Chapter 3, with ERM Probit model obtained from Chapter 2.

Table 4.3 reports results from four estimations. With treatment effects method, the coefficient on ERM is positively significant. This implies that endogeneity does exist. After correction, the coefficients on BLI, BTY, and TobinQ are found to be negatively significant correlated with SR. These results are similar with those reported in Table 4.2 except for the significance of BTY. The findings on BLI, BTY and TobinQ suggest that firms with less business diversification and lower TobinQ would have higher solvency. The positively significant coefficient on combined ratio implying that firms with a higher combined ratio are more likely to have a higher solvency-ratio. One possible explanation for this phenomena is that when firms experience with high loss history, apparently they would increase their own capital before break the threshold of regulation and placed in 'special supervision'.

Figure 4.2: Chow test

```
( 1)  [wERM_mean]LVRG - [woERM_mean]LVRG = 0
( 2)  [wERM_mean]FA - [woERM_mean]FA = 0
( 3)  [wERM_mean]FS - [woERM_mean]FS = 0
( 4)  [wERM_mean]BLI - [woERM_mean]BLI = 0
( 5)  [wERM_mean]INTL - [woERM_mean]INTL = 0
( 6)  [wERM_mean]BTY - [woERM_mean]BTY = 0
( 7)  [wERM_mean]TobinQ - [woERM_mean]TobinQ = 0
( 8)  [wERM_mean]LTIg - [woERM_mean]LTIg = 0
( 9)  [wERM_mean]CR - [woERM_mean]CR = 0
(10)  [wERM_mean]PrE - [woERM_mean]PrE = 0
(11)  [wERM_mean]IPP - [woERM_mean]IPP = 0

           chi2( 11) =   16.85
         Prob > chi2 =    0.1125
```

Except for CR and ERM, all other variables have negative signs on coefficients. These results are consistent with the primary analysis in terms of signs of most coefficients. However, with correction of treatment effects, FA, INTL and LTIg are negative. Although these results are insignificant, to some extents they inform that firms those are older, more diversified and invest more in the long-term (supposed with real estate) would likely to have lower solvency.

With Heckman two-step, the obtained results are mostly identical with treatment effects method. The coefficients on LVRG, FS, BLI, BTY, TobinQ, PrE all have negative signs while the coefficient of CR is positive. Not as in previous estimation, LVRG, FS, BLI and PrE are significant at least at 5 percent level. Nonetheless, the coefficient on CR is positive but insignificant. Surprisingly, PrE is negatively significant correlated with solvency ratio, suggesting that firms with lower employee productivity more likely to have a higher solvency ratio. This may happen when solvency margin calculation is based on 18% earned premiums. So, lower productivity means lower earned premiums, then lower solvency margin and resulting higher solvency ratio.

In addition, the coefficient on INTL is positive (1.420) and significant at 1 percent level. This result indicates that firms operate more internationally tend to have a higher solvency ratio. One possible explanation for this pattern is that international firms usually have strong capacity in the capital. Furthermore, with more resources, they can develop their internal models as proposed by Solvency II in 2009. It is believed that big insurance groups have more advantages not only in capital but also in costs of capital. Indeed, they can 'persuade' regulators that their internal models are adequate while smaller insurers have to adopt standard models, which often cause capital allocation inefficiencies.

Importantly, the coefficient on lambda is negative (-1.404) and significant at 5 percent level. The significance of lambda indicates that correction for sample selection bias is plausible. If not, estimated results with OLS will be biased. The negative sign of lambda suggests that error terms in selection equation and the regression on SR is negative correlated. Moreover, unobserved factors of ERM adoption more likely tend

to associate with lower solvency ratio.

Column (5) reports the treatment effects including inverse Mills ratio estimation. The findings of this estimation method are almost similarly to treatment effects and Heckman two-step. The coefficients on examining variables are negative, excluding

Table 4.3: SR estimation without IPP

	TE	Heckman	HT	TE_IMR
	Coef./SE	Coef./SE	Coef./SE	Coef./SE
main				
LVRG	**-0.080**	**-0.047*** **	**0.018**	**-0.084**
	(0.05)	(0.01)	(0.06)	(0.05)
FA	-0.003	0.001	-0.017	-0.000
	(0.01)	(0.00)	(0.07)	(0.01)
FS	**-0.528**	**-0.601*** **	**-4.939*** **	**-0.466**
	(0.52)	(0.09)	(1.86)	(0.53)
BLI	**-3.240***	**-0.762** **	**6.474**	**-3.804** **
	(1.71)	(0.30)	(8.91)	(1.81)
INTL	**-0.863**	**1.420*** **	**8.427**	**0.101**
	(1.92)	(0.30)	(8.98)	(2.11)
BTY	**-6.704** **	**-8.983*** **	**-0.248**	**-5.754***
	(3.34)	(2.17)	(15.92)	(3.49)
TobinQ	**-10.903*** **	**-0.669** **	**-4.889** **	**-11.455*** **
	(1.79)	(0.31)	(2.09)	(1.88)
LTIg	-0.968	0.667	2.731	-0.148
	(2.94)	(0.46)	(4.26)	(3.07)
CR	**0.839*** **	**0.002**	**-0.065**	**0.830*** **
	(0.15)	(0.05)	(0.14)	(0.16)
PrE	**-1.837**	**-0.620*** **	**-0.731**	**-2.212***
	(1.14)	(0.21)	(1.26)	(1.20)
ERM	**8.481***		**1.424**	**14.395** **
	(4.66)		(3.42)	(6.80)
ROA			**73.725*** **	
			(11.37)	
EPS			-0.094	
			(0.07)	
Invmills				**11.697**
				(9.68)
Constant	48.066***	26.281***	44.962*	42.505**
	(16.41)	(4.93)	(24.32)	(17.31)
hazard				
lambda	**-4.680**			**-7.995** **
	(2.86)			(3.97)
mills				
lambda		**-1.404** **		
		(0.63)		

* p<0.1, ** p<0.05, *** p<0.01

Notes : this table reports 4 estimations of SR without macro control (IPP): Treatment effects, Heckman two-step, Hausman-Taylor and Treatment effects with inverse Mills ratio. Variables are the same in Chapter 2.

CR, ERM, INTL and Invmills. Although the coefficient on ERM is significant at 10 percent level, the coefficient on Invmills is insignificant. This pattern implies that endogeneity exists but not enough evidence of sample selection issue.

Results reported in column (4) presents Hausman-Taylor estimation. With strict assumptions (none of the explanatory variables are correlated with the idiosyncratic error and some of the explanatory variables are correlated with the individual level random effects), the obtained results on coefficients are mostly insignificant. However, I cannot figure out exact violations which cause insignificant statistics. Only coefficients on TobinQ and FS are significant at 5 percent level and 1 percent level respectively. Furthermore, the signs of the coefficients on important factors are opposite with with other estimations. For instance, coefficients on LVRG, LTIg and BLI are positive while coefficient on CR is negative.

In general, empirical results from Table 4.3 suggest that correction for endogeneity and sample selection bias is plausible. ERM adoption is a factor of firm solvency. Moreover, with the presence of ERM, solvency is negatively correlated with LVRG, FS, FA, BTY, BLI, LTIg, and PrE. Meanwhile solvency is positive correlated with INTL, CR and ERM. In other words, firms have a higher solvency ratio more likely to have less leverage, younger, smaller, mono-line business, not core-insurance business, invest less in long-term and lower productivity of employees. Firms with higher combined ratio and operate more outside their home country tend to have a higher solvency ratio.

My findings, overall, are consistent with (Carson and Hoyt, 2000; Chen and Wong, 2004). These empirical results support partially my hypotheses. First, ERM has a positive effect on firm solvency. Second, firms with higher solvency are less leveraged. However, empirical evidence in this study shows some results that I did not expect: firm solvency is negatively correlated with combined ratio, TobinQ and PrE. Additionally, insolvency is negatively correlated with geographic diversification (INTL).

When including IPP, the estimation of Equation 4.4 with four different methods shows results in Table 4.4 as follows

Column (2) reports treatment effects estimation when controlling for IPP. The results are almost similar to the case without IPP except for ERM. The coefficient on ERM is negative (-2.918) and insignificant. This implies that ERM adoption is negatively correlated with solvency. However, as statistics is not significant, the

Table 4.4: SR estimations with IPP

	TE	Heckman	HT	TE_IMR
	Coef./SE	Coef./SE	Coef./SE	Coef./SE
main				
LVRG	**-0.047**	**-0.045*** **	**0.018**	**-0.051**
	(0.05)	(0.01)	(0.06)	(0.05)
FA	-0.005	0.000	-0.027	-0.001
	(0.01)	(0.00)	(0.07)	(0.01)
FS	**-0.340**	**-0.569*** **	**-4.845*** **	**-0.251**
	(0.51)	(0.10)	(1.84)	(0.52)
BLI	-1.232	-0.630*	7.755	-1.886
	(1.77)	(0.33)	(8.87)	(1.81)
INTL	**-1.052**	**1.402*** **	**4.643**	**0.206**
	(1.88)	(0.30)	(9.31)	(2.04)
BTY	**-0.472**	**-8.283*** **	**0.470**	**1.048**
	(3.70)	(2.39)	(15.73)	(3.82)
TobinQ	**-8.827*** **	**-0.540**	**-4.676** **	**-9.461*** **
	(1.84)	(0.34)	(2.09)	(1.89)
LTIg	-1.857	0.564	2.921	-0.818
	(2.89)	(0.47)	(4.26)	(2.97)
CR	**0.832*** **	**0.002**	**-0.061**	**0.820*** **
	(0.15)	(0.05)	(0.14)	(0.15)
PrE	-1.065	-0.540**	-0.795	-1.523
	(1.13)	(0.23)	(1.26)	(1.17)
IPP	**3.926*** **	**0.265**	**3.960**	**4.098*** **
	(1.08)	(0.29)	(3.05)	(1.09)
ERM	**-2.918**		**1.121**	**4.352**
	(5.55)		(3.43)	(7.20)
ROA			73.856***	
			(11.36)	
EPS			-0.089	
			(0.07)	
Invmills				15.368
				(9.71)
Constant	5.129	21.871***	16.874	-4.060
	(20.00)	(6.92)	(32.26)	(20.81)
hazard				
lambda	**1.610**			**-2.470**
	(3.31)			(4.19)
mills				
lambda		**-1.039**		
		(0.75)		

* p<0.1, ** p<0.05, *** p<0.01

Notes : this table reports 4 estimations of SR with macro control (IPP): Treatment effects, Heckman two-step, Hausman-Taylor and Treatment effects with inverse Mills ratio. Variables are the same in Chapter 2.

evidence does not support the argument that ERM adoption is not associated with firm solvency. TobinQ is negatively significantly correlated with solvency at 1 percent level. In addition, CR is positively significantly associated with solvency at 1 percent.

With Heckman two-step estimation reported in column (3), the coefficient on lambda is negative and insignificant. Therefore, the evidence does not support the argument of sample selection bias. One difference of this estimation is the significance of the coefficient on INTL. The positive sign (1.402) and significant at 1 percent level indicates that geographic diversification has a positive impact on firm solvency. That is to say firms operate internationally would have higher solvency. Other important statistical results are the significance of correlations between BTY, BLI, FS, LVRG, PrE with solvency. Take into account that all the signs of the coefficients are negative, firms with higher solvency show an association with lower value of these factors.

Similarly with treatment effects estimation, results in column (5) with treatment effects included IMR show nearly the same statistics. It is important to note that coefficients on Invmills and lambda are both insignificant, suggesting that evidence do not support the argument of endogeneity and sample selection bias. However, with bias corrections, results are coherent across estimations. The coefficient on ERM, unlike with column (2), is positive. However, it is also insignificant, implying that empirical evidence does not support the argument that ERM is a significant factor of firm solvency.

Results reported in column (4) with Hausman-Taylor estimation shows some difference with other estimation methods. First, the coefficients on LVRG and BLI are positive, (0.018), (7.755) respectively, and insignificant. Second, the coefficient on CR is negative (-0.061) and insignificant. If assumptions of Hausman-Taylor are not violated, these results imply that firms with higher leverage would have higher solvency. Economically, it is difficult to understand this phenomena because higher debt indicates higher risk and higher insolvency. However, as the statistics are not significant, I cannot have a clear conclusion on these correlations.

In general, with corrections for endogeneity and sample selection bias, results from

estimation methods when including macro factor IPP are rather coherent. The empirical evidence does not support the argument of supposed endogeneity and sample selection bias when coefficients on lambdas, Invmills and ERM are not significant. Meanwhile, economical significance can give several inferences. First, LVRG is negative correlated with solvency, suggesting that more leveraged firms tend to have lower solvency. Older and bigger firms also supposed to have lower solvency. Second, performance factors such as TobinQ, PrE are found to be negatively associated with solvency, implying that higher valued and productivity firms have lower solvency. Third, firms with a higher combined ratio are more likely to have a higher solvency. Finally, firms in developed market with higher premium per capita and operate outside their home country tend to have higher solvency.

4.4 Conclusion

This chapter studies the impact of ERM adoption on insurance firm solvency during the period from 2007-2013 for a sample of 101 publicly traded insurers in the EU. I find that without controlling macro factor (IPP), ERM adoption is a significant factor of insurance firm solvency. Moreover, solvency of insurers is negatively correlated with LVRG, FS, FA, BTY, BLI, TobinQ and PrE. These findings imply that insurance firms with higher leverage, older, bigger, higher market value and business diversified tend to have higher insolvency. Meanwhile, a factor of diversification is INTL is positively correlated with solvency, suggesting that international insurers have higher solvency. In addition, combined-ratio is positive associated with solvency. This pattern indicates that insurance firms with a higher combined-ratio are more likely to have higher solvency.

I figure out that with controlling macro factor (IPP), ERM adoption also has a positive impact on solvency the evidence is not significant. In general, the findings of this specification are consistent with the prior specification in terms of signs of the coefficients. Furthermore, combined-ratio and IPP are positively significantly correlated with solvency. These findings suggest that insurance firms with higher losses-expenses adjusted and located in developed market where higher IPP tend to

have higher solvency.

Importantly, specification without IPP shows the significance of the coefficients on ERM and lambdas. This empirical evidence implies that the correction for endogeneity and sample selection bias is plausible. Another evidence is the insignificance of Chow test of OLS regressions on solvency, which indicate there is no difference between adopt and non-adopt ERM firms.

By contrast, the coeffcients on ERM and lambdas in specification with controlling IPP all are insignificant. These patterns indicate that evidences do not support the argument of existing endogeneity and sample selection bias. Although there are differences in significant level, in general, the signs of the coefficients are identical between the two specifications.

Overall, findings of this chapter support partially my hypotheses. As I expected, ERM adoption has a positive impact on insurance firm solvency. Moreover, solvency is negatively correlated with leverage and combined ratio. However, unlike my expectations, firm size, firm age, operating margin and TobinQ are negatively correlated with firm solvency while operation internationally is positively associated with solvency.

There are several limitations in this study that have implications for future research. First the measurement ERM as binary would be better if it has numerical classification. At least, the several categories of ERM will reflect more exactly the maturity and development status of ERM. Furthermore, multiple categories ERM can apply multi-logit model with extended simultaneous equations. Similarly, the measurement of solvency ratio would be more informative if if presents exactly each firm's solvency, not based on a standard framework and regardless business lines. Indeed, many of EU insurance firm develop their own internal model.

Second, the sample size although represents nearly all publicly traded insurers in the EU, many insurers that adopted ERM are not in the sample because they are not listed (the case of France, most of the insurance companies are mutual corporations). If future research can enlarge the examined sample to other major economies in the Americas and Asia, results would be more informative and have more inferences.

Third, the correction of endogeneity and sample selection can be complemented with an instrumental variable of ERM adoption. Currently, I cannot find a suitable one and even yet in literature.

Finally, as suggested in the recent trend of finance research, a diversification method, including field study, a combination of quantitative and qualitative search would shed more lights in the study of ERM and solvency.

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Chapter 5

General conclusion

Contents

5.1 Summary and suggestions for future research

In this doctoral thesis, I study three research questions related to ERM adoption and insurance firm performance. What are the determinants of ERM adoption for insurers? Does ERM adoption has impact on TobinQ, ROA and EPS? What is the relation between ERM adoption and insurance firm's financial vulnerability?

There is a fact that ERM attracts more and more corporations and regulators, especially in the insurance industry. One of the benefits of ERM is the communication of firm's risk profile and risk management activities to outsiders. This helps to reduce the opacity of complex firms and then reduce the capital cost. As a result, identifying the characteristics of firms that adopt ERM not only facilitate outsiders to assess but also provide references for firms that want to implement ERM. Although ERM is said to enhance firm performance, there is still a need for more empirical studies on this subject to persuade risk managers who are still hesitated. In addition, scrutiny regulation for insurance firms focusing the solvability with ERM is an important factor induce the question on the relation of ERM and financial vulnerability of insurance

firms.

In Chapter 2, I investigate the determinants of ERM adoption in the insurance industry for a sample of 101 publicly traded insurers in the EU. I find that insurance firms more likely to adopt ERM when they are more leveraged, bigger, and focus more on their core-business. I also find that adopting ERM firms have higher productivity, firm value and invest more in the long-term. Adopting firms are mostly located in developed markets. Both logit/probit regressions report significant coefficients of these factors, implying that ERM-adopting firms in general have a more competitive profile than others.

I argue that firm with more resources have advantages in ERM implementation. Through the patterns of ERM adoption, we can see the two-speech Europe phenomena. Although the empirical results generally support my hypotheses, some results remain unexplained. The hypothesis that adopting firms have higher operational performance is justified with some variables but not with others. I conjecture that it is the result of heterogeneous policies applied with the reporting standards.

There are several limitations in this Chapter that future studies can examine to extend our knowledge of ERM adoption. First, although there are firms that implement ERM before 2007, the sample does not include this period due to the unavailability of data. Moreover, generalization of my results is limited and the findings may be different for insurers in countries other than the EU. Therefore, future studies should enlarge the sample to capture more statistic proprieties. Second, I suggest that more complex firms would adopt ERM but the indications for risk management strategies, e.g. reinsurance activities or hedging portfolios are not included in the model specification. Including these indicators can contribute to our knowledge about ERM and risk management strategy in the insurance industry. Third, as ERM maturity is classified with different levels, the model specification should use multi-level logistic regression. However, as the limits of sample and data availability, further research should take issue in consideration. Finally, a combination with qualitative method, i.e. surveys will give a more robust result. One of the explanations may be that with

questionnaires, researchers can access other aspects of ERM, especially perception assessments.

Chapter 3 studies the impact of ERM adoption on insurance firm's performance via three financial indicators: TobinQ, EPS and ROA. I find that ERM adoption has a significant impact on TobinQ, ROA and EPS. Indeed, empirical evidences show a positive correlation between ERM adoption and TobinQ/ROA. Meanwhile, ERM adoption is negatively correlated with EPS.

An important contribution of my study is that I examine the relation between firm's performance and ERM adoption by using four different estimation techniques. I find that results remain largely similar among estimations. These empirical results support my hypothesis that with the presence of ERM, the performance of insurance firm is enhanced. Therefore, my study complements evidence that ERM adoption has a positive impact on firm performance. Moreover, the significance of lambdas and the added inverse Mills ratio supports my prediction that correction for endogeneity and sample selection bias is necessary and plausible.

Although the empirical results generally support my hypotheses, some results remain unexplained. Lambdas of Heckman two-step estimation on all three examined variables all are negative and insignificant. The negative signs have implication that unobserved factors causing participation are more likely to be associated with lower performance. The insignificance of all Heckman's lambdas suggesting that the evidence of sample selection bias is not confirmed. Meanwhile, I cannot reject my prediction that correction for sample selection bias is necessary.

From the obtained results, my study suggests several questions that future studies can examine. First, I claim that ERM adoption enhances firm performance (TobinQ/ROA). Future studies should test whether results remain similarly when enlarging the data sample, including other major insurance markets such as the US and Japan. Second, it is interesting to know whether the maturity level of ERM has the same effects on firm performance. A proposed approach for this research question is using multi-logit for two-step extended model, which is employed by Wu and Shen (2013).

However, this requires a rich ERM index data. Third, researchers should look to understand how insurance firms with (with different level) and without ERM adoption react with important events such as crucial change in regulations, natural disasters by using event study with different windows. Finally, finding an instrumental variable for ERM adoption as well as find out important omitted variables can provide more insights into the answer of what and how ERM adoption affects firm performance.

In Chapter 4, I study the impact of ERM adoption on insurance firm solvency on the same research sample of previous chapters. I find that without controlling macro factor (IPP), ERM adoption is a significant factor of insurance firm solvency. Moreover, solvency of insurers is negatively correlated with LVRG, FS, FA, BTY, BLI, TobinQ and PrE. These findings imply that insurance firms with higher leverage, older, bigger, higher market value and business diversified tend to have higher insolvency. With controlling macro factor (IPP), ERM adoption also has a positive impact on solvency the evidence is not significant. In general, the findings of this specification are consistent with the prior specification in terms of signs of the coefficients. Furthermore, combined-ratio and IPP are positively significantly correlated with solvency. These findings suggest that insurance firms with higher losses-expenses adjusted and located in developed market where higher IPP tend to have higher solvency.

It is important to know that specification without IPP shows the significance of the coefficients on ERM and lambdas. This empirical evidence implies that the correction for endogeneity and sample selection bias is plausible. Another evidence is the insignificance of Chow test of OLS regressions on solvency, which indicates there is no difference between adopt and non-adopt ERM firms. Meanwhile, the coefficients on ERM and lambdas in specification with controlling IPP all are insignificant. These patterns indicate that evidences do not support the argument of existing endogeneity and sample selection bias. Although there are differences in significant level, in general, the signs of the coefficients are identical between the two specifications.

Overall, the findings of this chapter suggest that ERM adoption has a positive

impact on insurance firm solvency. Moreover, solvency is negatively correlated with leverage and combined ratio. However, unlike my expectations, firm size, firm age, operating margin and TobinQ are negatively correlated with firm solvency while operation internationally is positively associated with solvency.

There are several limitations in this study that have implications for future research. First the measurement ERM as binary would be better if it has numerical classification. At least, the several categories of ERM will reflect more exactly the maturity and development status of ERM. Furthermore, multiple categories ERM can apply multi-logit model with extended simultaneous equations. Similarly, the measurement of solvency ratio would be more informative if if presents exactly each firm's solvency, not based on a standard framework and regardless business lines. Indeed, many of the EU insurance firms develop their own internal model. Second, the sample size although represent nearly all publicly traded insurers in the EU, many insurers that adopted ERM are not in the sample because they are not listed (the case of France, most of the insurance companies are mutual corporations). If future research can enlarge the examing sample to other major economies in the Americas and Asia, results would be more informative and have more inferences. Third, the correction of endogeneity and sample selection can be complemented with an instrumental variable of ERM adoption. Currently, I cannot find a suitable one and even yet in literature. Finally, as suggested in the recent trend of finance research, a diversification method, including field study, a combination of quantitative and qualitative search would be plausible, shedding more lights in the study of ERM and solvency.

5.2 Implications for major stakeholders

My thesis suggests some implications for risk managers and shareholders/investors.

First, although I do not totally agree with what prominent consulting firms have advocated much for ERM adoption, I claim that the answer for the question 'Does ERM enhance insurer' s performance' is yes, but the evidence is fairly limited as yet. The findings of my thesis complement evidence that ERM adoption has a positive impact on firm value, ROA and firm solvency. In general, adopting ERM firms have a

more attractive business profile. However, the arguments of Mikes and Kaplan (2015) are noticeable. Indeed, the effectiveness of risk management ultimately depends less on the guiding framework than on the people who set up, coordinate, and contribute to risk management processes. Moreover, successful ERM initiatives also depend on risk management culture of the firm. ERM is a holistic manner of risk management, so risk management practices must be viewed at all firm levels, holistically too. In addition, it is also important to note that risk management practices vary considerably across firms, even within an industry, therefore, more than all others, top risk managers must do understand their firm's risk management *in situ*.

Top risk managers should balance the culture of 'quantitative enthusiasm' - with emphasis on extensive risk measurement and risk-based performance management, and the culture of 'quantitative skepticism' - focusing instead on qualitative discourse and the mobilization of expert opinions about emerging risk issues. Furthermore, risk managers should go beyond the "variance minimization" mode, paying attention to costly lower-tail outcomes - those that would cause financial distress (Stulz, 1996), as well as the upside risks. For risk managers, adopting and developing ERM is really a managerial incentive. Nonetheless, ERM is influenced by the manager's willingness and career concerns. As a consequence, harmonizing the benefits of top managers, shareholders and other stakeholders not only the question in practice but also a pertinent research question.

Second, my doctoral thesis figures out major characteristics of adopting ERM firms, such as leverage, firm size, business diversification, performance indicators, location of head-office etc. Investors/shareholder can use these patterns to verify the ERM implementation of the firms they invest in, together with firm' reports/announcements on ERM. Moreover, as ERM is associated with firm performance and solvency, ERM can be used as a quickly synthesized screening tool for firm evaluation. However, for more explicit results, one must conduct comprehensive analysis, both ERM evaluations and financial ratios evaluations.

Finally, regarding insurance firm solvency, apart from the positive correlation with

ERM adoption, solvency can be addressed via several factors. Investors/shareholders could use information on leverage, combined-ratio, firm-size, firm-age, TobinQ and international operations as an alternative or complementary indicators for firm insolvency evaluation.

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ANNEX

List of insurance firms

Firm	Country	Firm	Country
UNIQA Insurance AG	Austria	Hannover Rueck SE	Germany
Vienna Insurance AG	Austria	Munich Re	Germany
AGEAS SA	Belgium	Nuernberger Beteiligungs AG	Germany
Bobar Osiguranje ad Bijeljina	Bosnia and Herzegovina	RheinLand Holding AG	Germany
Dunav Osiguranje ad Banja Luka	Bosnia and Herzegovina	Cash Life AG	Germany
Croatia Lloyd dd	Croatia	Talanx AG	Germany
Croatia osiguranje dd	Croatia	Wuerttembergische Lebensversicherung AG	Germany
Euroherc osiguranje dd	Croatia	Wuestenrot & Wuerttembergische AG (W&W)	Germany
Jadransko Osiguranje dd	Croatia	Eurobrokers SA	Greece
Atlantic Insurance Public	Cyprus	European Reliance General Insurance Company SA	Greece
Cosmos Insurance Public Co	Cyprus	Koumbas Synergy	Greece
International Life General	Cyprus/Greece	Tryggingamidstodin hf	Iceland
Interlife General Insurance SA	Cyprus/Greece	VIS Insurance (Vatryggingafelag Islands hf)	Iceland
Liberty Life Insurance Public	Cyprus	FBD Holdings	Ireland
Minerva Insurance Public	Cyprus	Societa Cattolica di Assicurazione Sc	Italy
Alm. Brand A/S	Denmark	Fondiaria SAI SpA	Italy
Topdanmark A/S	Denmark	Assicurazioni Generali SpA	Italy
Tryg A/S	Denmark	Mediolanum SpA	Italy
Sampo Oyj	Finland	Milano Assicurazioni	Italy
April SA	France	Premafin Finanziaria Holding SpA	Italy
CNP Assurances SA	France	Unipol Gruppo Finanziario SpA	Italy
Axa SA	France	Vittoria Assicurazioni SpA	Italy
Euler Hermes SA	France	Aegon NV	Netherlands
Scor SE	France	Delta Lloyd NV	Netherlands
Allianz SE	Germany	Gjensidige Forsikring ASA	Norway
Generali Deutschland Holding	Germany		

List of insurance firms

Firm	Country	Firm	Country
Protector Forsikring ASA	Norway	Chesnara	United Kingdom
Storebrand ASA	Norway	Charles Taylor	United Kingdom
Powszechny Zaklad Ubezpieczen SA	Poland	Direct Line Insurance	United Kingdom
Societatea Asigurare-Reasigurare Astra SA	Romania	Esure	United Kingdom
Dunav Osiguranje Ad Beograd	Serbia	FBD Holdings	United Kingdom
Pozavarovalnica Sava dd	Slovenia	Gable Holdings Inc	United Kingdom
KD dd	Slovenia	Hansard Global	United Kingdom
Zavarovalnica Triglav dd	Slovenia	Hiscox	United Kingdom
Mapfre SA	Spain	Helios ex.Hampden Underwriting	United Kingdom
Grupo Catalana Occidente SA	Spain	Insetco	United Kingdom
Insplanet publ AB	Sweden	Jelf	United Kingdom
Baloise Holding AG	Switzerland	Jardine Lloyd Thompson	United Kingdom
Helvetia Holding AG	Switzerland	Lancashire Holdings	United Kingdom
Schweizerische National-Versicherungs-Gesellschaft AG	Switzerland	Novae	United Kingdom
Swiss Life Holding AG	Switzerland	Old Mutual	United Kingdom
Swiss Re AG	Switzerland	Personal	United Kingdom
Vaudoise Assurances Holding SA	Switzerland	Phoenix	United Kingdom
Zurich Insurance AG	Switzerland	Prudential	United Kingdom
Abbey Protection	United Kingdom	RQIH	United Kingdom
Admiral	United Kingdom	RSA Insurance	United Kingdom
Amlin	United Kingdom	Resolution	United Kingdom
Aviva	United Kingdom	Sagicor Financial	United Kingdom
Beazley	United Kingdom	St. James's Place	United Kingdom
Brightside	United Kingdom	Pro Global ex.Tawa	United Kingdom
Catlin	United Kingdom	Torchmark	United Kingdom

Notes on Endogeneity

In a multiple linear regression, if at least one of the regressors is correlated with the residual, then the exogeneity assumption ($E(u|x) = 0$) is violated. We say that the regression suffers from endogeneity problem. The endogeneity problem occurs when (1) there is an omitted variable that is correlated with some regressors; (2) the dependent variable and at least one of the independent variables are determined simultaneously in a system; (3) there is measurement error in at least one of the regressors. When there is endogeneity problem, OLS estimates are biased and inconsistent. The effect of endogeneity is bias in estimates and hence: rejecting a hypothesis that in fact is true (Type I Error) or fail to reject a hypothesis that in fact is false (Type II Error).

Endogeneity is one of the most major challenges in econometric analysis in management and much of social sciences. Social sciences is about understanding the behaviour of people. As a consequence, much of the work done in social sciences are biased since it suffers endogeneity. To test endogeneity, Durbin-Wu-Hausman test (augmented regression test) is preferable. There are several methods to address endogeneity such as: Instrumental variables (IV), Panel data: fixed effects, random effects; Regression discontinuity; Natural experiments; Difference-in-differences; and Matching/Propensity score matching

Endogeneity and Sample Selection Bias: the conventional case of Union status and Wages[1]

Sample selection bias and endogeneity bias refer to two distinct concepts, both entailing distinct solutions. In general, sample selection bias refers to problems where the dependent variable is observed only for a restricted, nonrandom sample. Using the example above, one observes an individual's wage within a union only if the individual has joined a union. Conversely, one observes an individual's nonunion wage only if the individual does not belong to a union. Endogeneity refers to the fact that an independent variable included in the model is potentially a choice variable, correlated with unobservables relegated to the error term. The dependent variable, however, is observed for all observations in the data. Here union status may be endogenous if the decision to join or not join a union is correlated with unobservables that affect wages. For instance, if less able workers are more likely to join a union and therefore receive lower wages ceteris paribus, then failure to control for this correlation will yield an estimated union effect on wages that is biased down.

The problem with unions and wages, and a host of other problems, can be treated either as a sample selection problem or as an endogeneity problem. The "appropriate" model depends on how one believes unions affect wages.

Model I. Endogeneity

If one believes union status has merely an intercept effect on wages (i.e. results in a parallel shift up or down for various wage profiles), then the appropriate model includes union status as a right-hand-side variable and pools the entire sample of union and nonunion workers. Because the entire sample is used, there are no sample-selection issues (there may be a sample selection issue to the extent that wages are observed only for employed workers; typically this is a cause for concern only in estimating wage equations for females). One can then proceed to estimate a typical wage regression equation via OLS. If you believe union status is endogenous and

[1] http://www.stata.com/support/faqs/statistics/endogeneity-versus-sample-selection-bias

workers self-select into union/nonunion jobs, then one should instrument for union status. One can use either two-step methods, as outlined in the question above, or use the Stata command etregress. Upon fitting the model, the union status coefficient answers the following question: 'Conditional on the Xs, what is the average effect on wages of belonging to a union?' Under this estimation technique, the betas (the coefficients on the Xs) are restricted to be the same for union and nonunion workers. For example, the return to education is restricted to be the same regardless of whether one is in a union.

Model II. Sample Selection

If one believes that union status has not only an intercept effect but also a slope effect (i.e., the betas differ according to union status as well), then a sample selection model is called for. To proceed, split the sample into union and nonunion workers and then estimate a wage equation for each subsample. If union status is the only potentially endogenous variable in the model, the two separate wage equations may be estimated via OLS, accounting for the fact that each sample is a nonrandom sample of all workers. This is accomplished via Heckman's selection correction model (using either ML estimation, or two-step estimation where in the first stage a probit model is used to predict the probability of union status and in the second stage, the inverse Mills' ratio [IMR] is included as a regressor). According to this type of model, the union effect does not show up as a dummy variable but rather in the fact that the constant term and betas may differ from the union to the nonunion sample. The difference in the constants yields the difference in average wages if a union and nonunion worker have X=0. The difference in the betas tells one how the returns to different observable attributes vary by union status. Essentially this model allows a full set of interaction terms between union status and the Xs. A Chow test could be used to test if the betas differ across by union status. If they do not, Model I is more efficient. This type of model is also known as an endogenous switching regime model.

Other references: Main and Reilly (1993) estimate a sample-selection model similar to Model II, where they split the sample depending on the size of the firm where the

individual works. Thus their first-stage involves an estimating an ordered probit for three classes of firm size (small, medium, or large), and then estimating three wage equations, each including the appropriate IMR term. Millimet (2000, SMU working paper) estimates the effect of household size on schooling using a similar modeling technique. Maddala (1983) also gives a good introduction to these issues.

Model III. Endogeneity and sample selection

One may also confront both types of biases in the same model. For example, say one wants to estimate the effect of union status on wages for women only. Thus one may choose to include union status as a right-hand-side variable (Model I) or wish to split up the sample (Model II). If one opts for Model I, one still has to confront the fact that wages for women are only selectively observed—for those women choosing to participate in the labor force. To fit this model, one would start by estimating a probit model explaining the decision of women to work or not. One would then generate the IMR and include the IMR and the union dummy in a second-stage wage regression, where one would instrument for union status if it was thought to be endogenous. Finally, if Model II were desired, then one would be confronted with a double-selection model. I believe one would estimate a probit for labor force participation first. Upon generating the IMR term, this would be included in a second probit equation explaining union status. The appropriate IMR term from this equation would then be included in the two final wage equations. (This topic is covered in Amemiya 1985.)

Identification

As in any model, one must be aware from where identification arises. While it is well known that for instrumental variables estimation one requires a variable that is correlated with the endogenous variable, uncorrelated with the error term, and does not affect the outcome of interest conditional on the included regressors, identification in sample selection issues is often not as well grounded. Because the IMR is a nonlinear function of the variables included in the first-stage probit model, call these Z, then the second-stage equation is identified—because of this nonlinearity—even if Z=X.

However, the nonlinearity of the IMR arises from the assumption of normality in the probit model. Since most researchers do not test or justify the use of the normality assumption, it is highly questionable whether this assumption should be used as the sole source of identification. Thus, it is advisable, in my opinion, to have a variable in Z that is not also included in X. This step makes the source of identification clear (and debatable). For the double-selection model discussed above in Model III, two exclusion restrictions would be needed (one for the labor force probit, one for the union probit).

Chow Test[2]

The Chow test is a statistical and econometric test of whether the coefficients in two linear regressions on different data sets are equal. The Chow test was invented by economist Gregory Chow in 1960. In econometrics, the Chow test is most commonly used in time series analysis to test for the presence of a structural break. In program evaluation, the Chow test is often used to determine whether the independent variables have different impacts on different subgroups of the population. Suppose that we model our data as:

$$y_t = a + bx_{1t} + cx_{2t} + \varepsilon$$

If we split our data into two groups, then we have

$$y_t = a_1 + b_1 x_{1t} + c_1 x_{2t} + \varepsilon$$

and

$$y_t = a_2 + b_2 x_{1t} + c_2 x_{2t} + \varepsilon$$

The null hypothesis of the Chow test asserts that a_1=a_2, b_1=b_2, and c_1=c_2, and there is the assumption that the model errors ε are independent and identically distributed from a normal distribution with unknown variance.

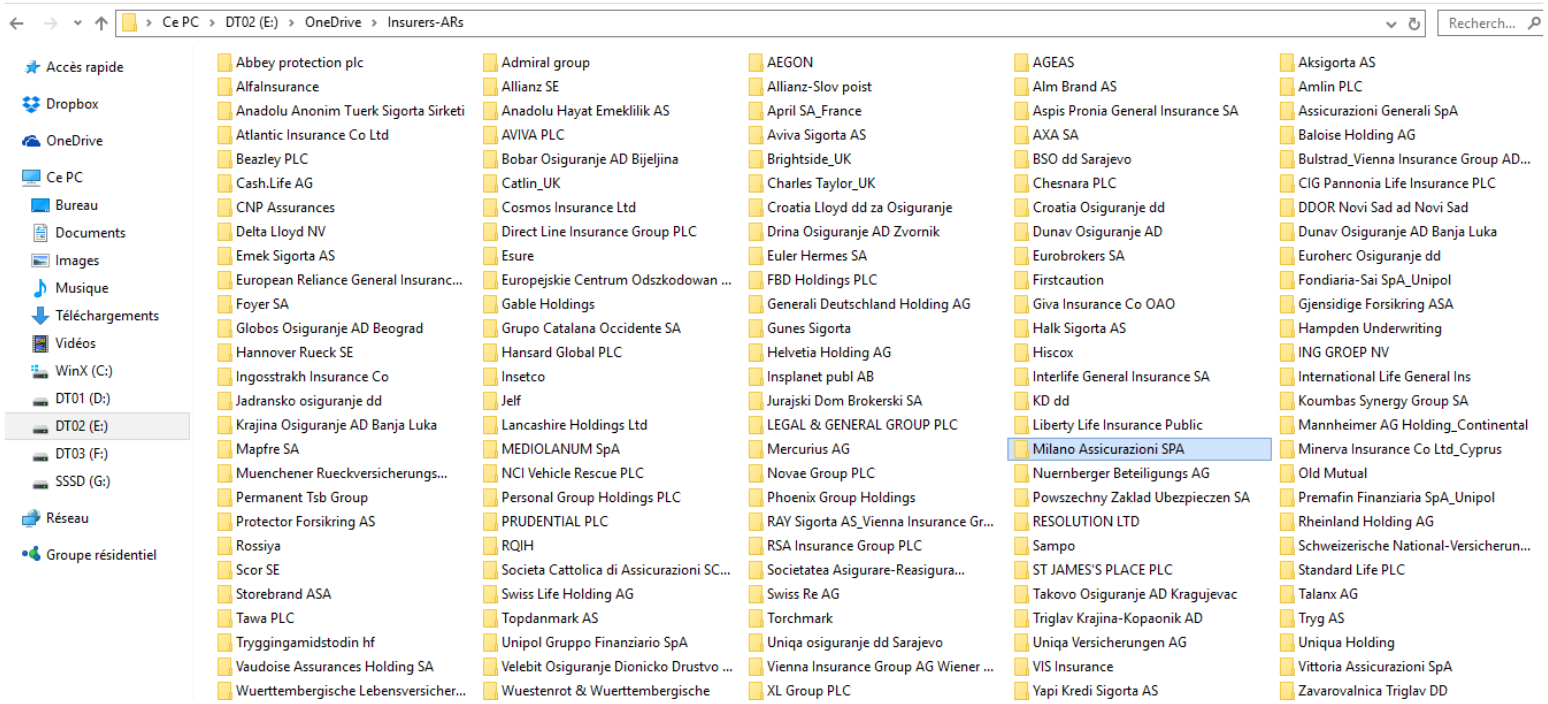
Let S_C be the sum of squared residuals from the combined data, S_1 be the sum of squared residuals from the first group, and S_2 be the sum of squared residuals from the second group. N_1 and N_2 are the number of observations in each group and k is the total number of parameters (in this case, 3). Then the Chow test statistic is

$$\frac{(S_C - (S_1 + S_2))/(k)}{(S_1 + S_2)/(N_1 + N_2 - 2k)}$$

The test statistic follows the F distribution with k and $N_1 + N_2 - 2k$ degrees of freedom.

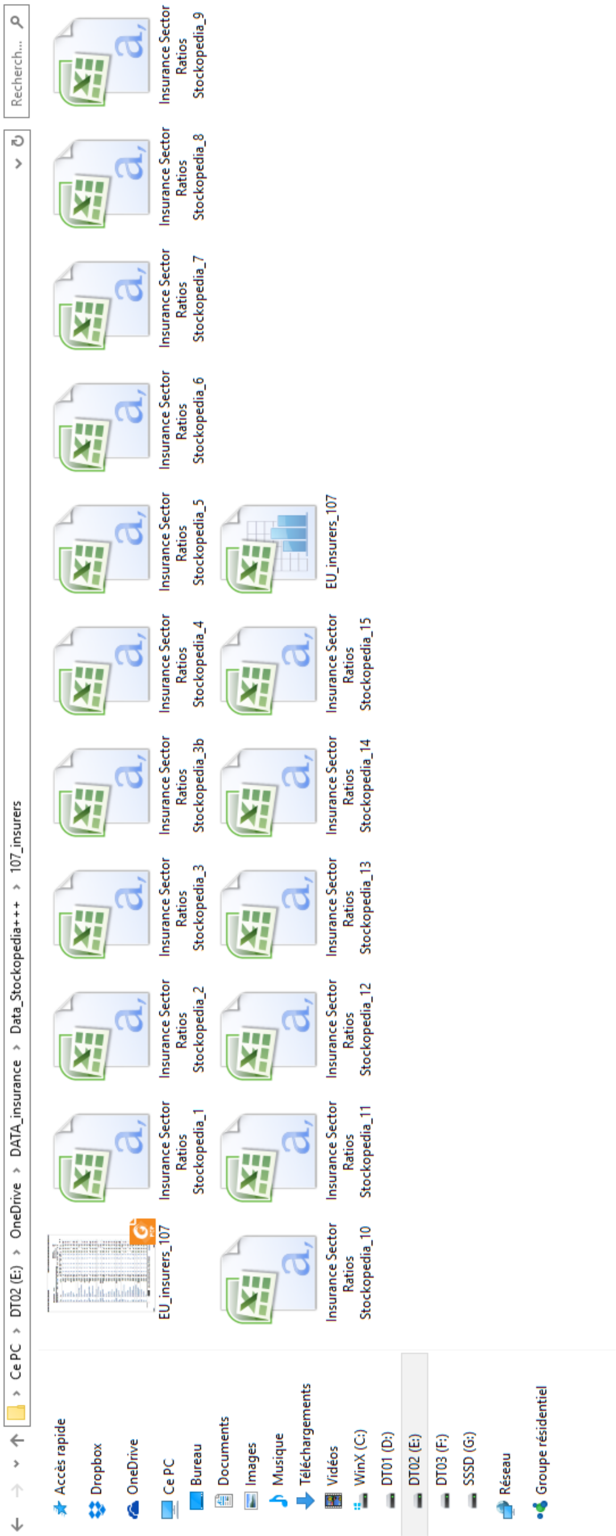
[2] https://en.wikipedia.org/wiki/Chow_test

Annual Reports of Firms

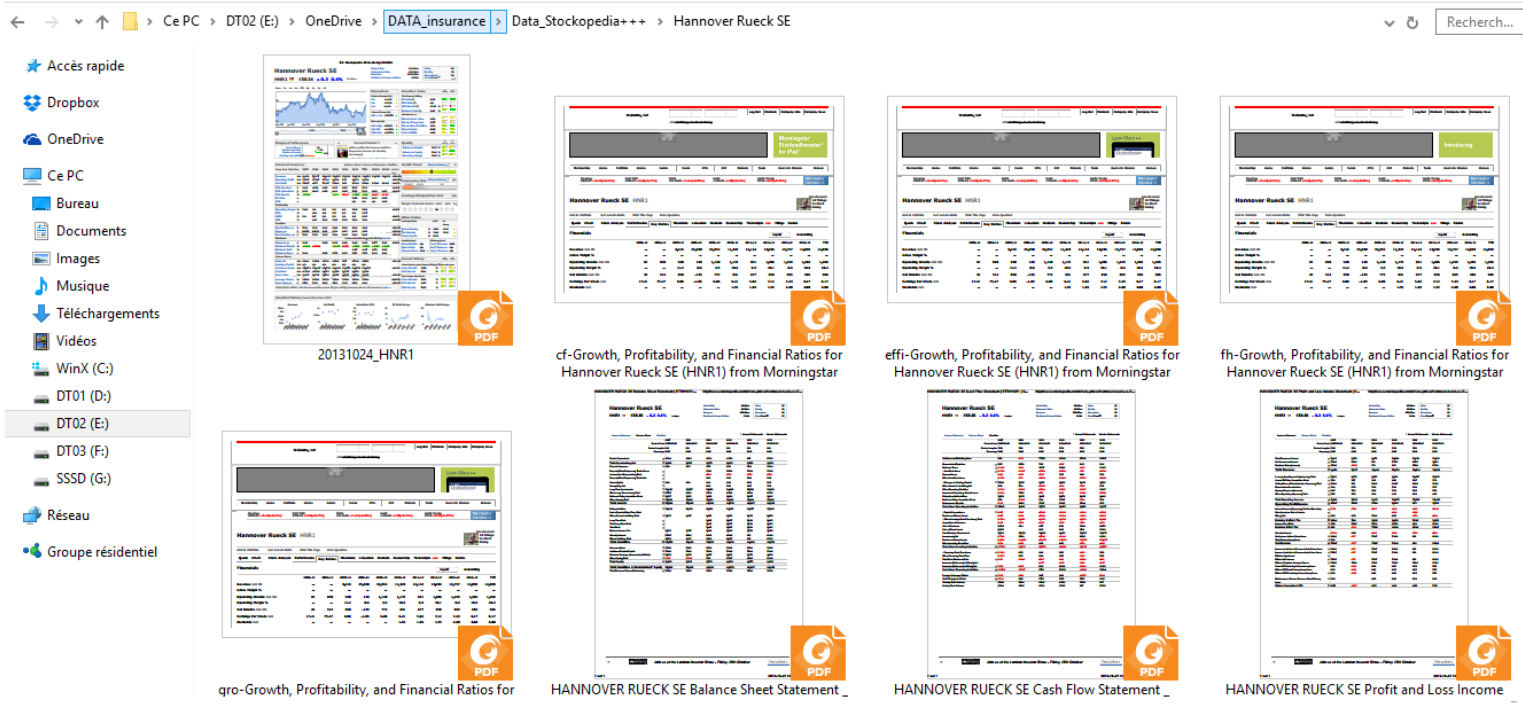


Annual Reports of an example

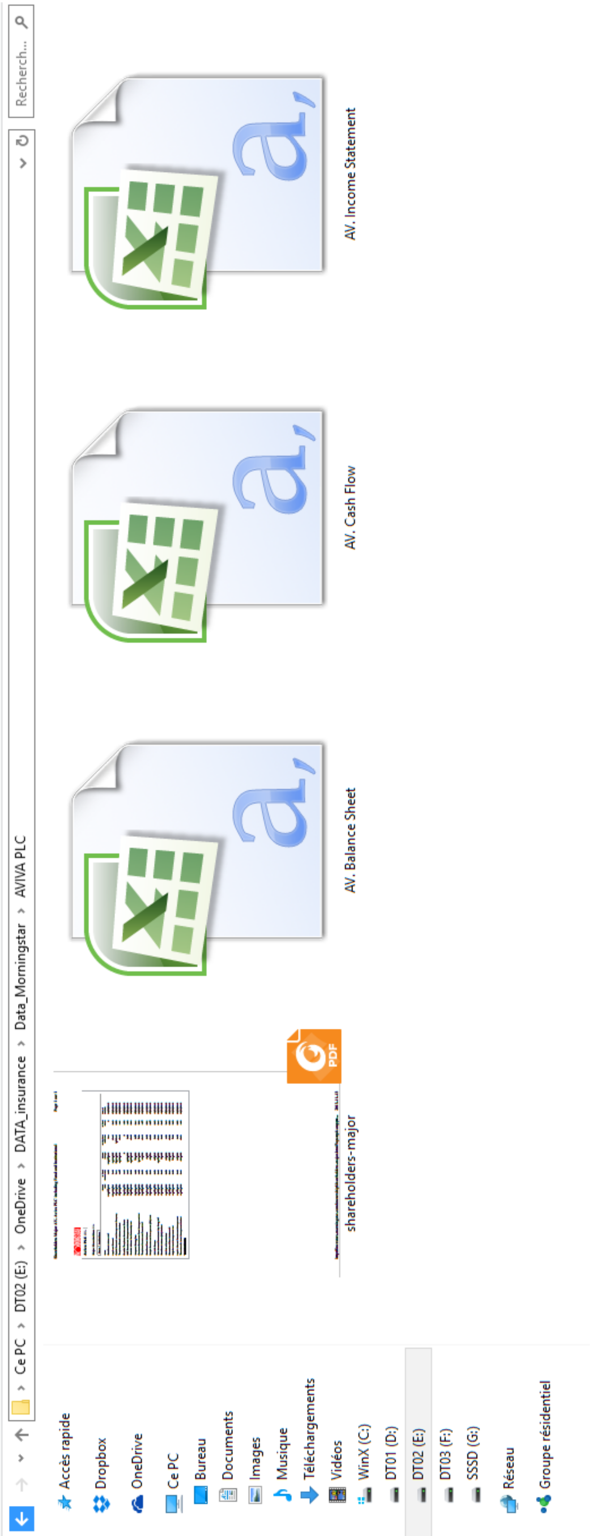
Data from Stockopedia



An example from Stockopedia



An example from Morningstar



Endogeneity dedecting

```
regress ERM PrE ROA CR EPS SR LVRG FS FA LTIg BLI INTL BTY IPP
```

Source	SS	df	MS	Number of obs	= 615
Model	78.3515855	13	6.02704504	F(13, 601)	= 57.03
Residual	63.5118292	601	.10567692	Prob > F	= 0.0000
Total	141.863415	614	.231047907	R-squared	= 0.5523
				Adj R-squared	= 0.5426
				Root MSE	= .32508

ERM	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
PrE	.1362593	.0152514	8.93	0.000	.1063068	.1662118
ROA	.5035684	.2533174	1.99	0.047	.0060735	1.001063
CR	.0000599	.003068	0.02	0.984	-.0059654	.0060851
EPS	-.0010543	.001134	-0.93	0.353	-.0032813	.0011727
SR	-.0016344	.0008279	-1.97	0.049	-.0032604	-8.48e-06
LVRG	.0023781	.0009808	2.42	0.016	.0004518	.0043044
FS	.0395351	.00896	4.41	0.000	.0219383	.0571319
FA	.0004135	.0002443	1.69	0.091	-.0000662	.0008932
LTIg	.0028592	.0580879	0.05	0.961	-.1112208	.1169393
BLI	.0271103	.033659	0.81	0.421	-.0389933	.093214
INTL	.1084759	.0357559	3.03	0.003	.0382543	.1786975
BTY	.3159808	.0627614	5.03	0.000	.1927224	.4392392
IPP	.1012191	.0186511	5.43	0.000	.0645899	.1378484
_cons	-2.678326	.175429	-15.27	0.000	-3.022854	-2.333798

Endogeneity dedecting

```
predict ERM_res, res
regress TobinQ ERM PrE ROA CR EPS SR LVRG FS FA LTIg BLI INTL BTY IPP ERM_res
```

```
      Source |       SS       df       MS              Number of obs =     606
-------------+------------------------------           F( 14,   591) =   14.38
       Model |  31.4310558    14  2.24507541           Prob > F      =  0.0000
    Residual |   92.282018   591  .156145547           R-squared     =  0.2541
-------------+------------------------------           Adj R-squared =  0.2364
       Total |  123.713074   605   .20448442           Root MSE      =  .39515
```

TobinQ	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ERM	.2642664	.0504549	5.24	0.000	.1651737	.3633591
PrE	-.1160535	.0198057	-5.86	0.000	-.1549516	-.0771555
ROA	1.743617	.3109384	5.61	0.000	1.132938	2.354296
CR	.0005806	.0037301	0.16	0.876	-.0067453	.0079066
EPS	-.0028928	.0013823	-2.09	0.037	-.0056076	-.000178
SR	-.0073044	.0010103	-7.23	0.000	-.0092887	-.0053201
LVRG	-.0017383	.0012022	-1.45	0.149	-.0040994	.0006229
FS	-.0157851	.0113302	-1.39	0.164	-.0380375	.0064673
FA	.0007156	.0002987	2.40	0.017	.000129	.0013022
LTIg	.1445651	.0710122	2.04	0.042	.0050982	.284032
BLI	-.2322868	.0416728	-5.57	0.000	-.3141317	-.150442
INTL	-.0086682	.0447177	-0.19	0.846	-.0964932	.0791568
BTY	-.3007743	.0780497	-3.85	0.000	-.4540629	-.1474856
IPP	-.0429451	.0233172	-1.84	0.066	-.0887397	.0028495
ERM_res	0	(omitted)				
_cons	3.258535	.2539774	12.83	0.000	2.759727	3.757344

Endogeneity dedecting

```
. test ERM_res

 ( 1)  o.ERM_res = 0

       Constraint 1 dropped


       F(  0,   591) =       .

            Prob > F =         .
```

The small *p*-value indicates that OLS is not consistent.

université PARIS-SACLAY
ÉCOLE DOCTORALE
Sciences de l'homme et de la société (SHS)

Titre : Essais sur la gestion du risque d'entreprise: le cas du secteur de l'assurance Européenne

Mots-clés: Gestion des risques de l'entreprise (ERM), la performance d'entreprise, Tobin's Q, vulnérabilité financière, solvabilité, secteur des assurances, endogénéité.

Résumé

Dans un monde de plus en plus intégré, les entreprises doivent affronter un grand nombre de risques avec une plus grande complexité. Gérer les risques complexes avec une vision globale, holistique à tous les niveaux est vital pour les assureurs car le risque est dans leur cœur de leur métier. Toutefois, à périmètre réglementaire constant, les différentes stratégies de gestion de risques ne donneraient toujours pas les mêmes résultats. Cette thèse de doctorat cherche à examiner trois aspects de la gestion des risques des entreprises (ERM) pour le secteur de l'assurance européenne:

i) les typologies s des compagnies d' assurance qui mettent en œuvre l'ERM,

ii) l'impact de l'ERM sur les performances de l'entreprise,

et iii) la relation entre ERM et solvabilité.

Bien que le marché européen de l'assurance représente un tiers du marché mondial, la majorité des études empiriques portant sur l'ERM dans le marché de l'assurance sont basées sur des données américaines. En outre, les exigences de Solvabilité II ont poussé les assureurs en Europe de se conformer à l'ERM.

La premier essai de la thèse étudie les caractéristiques de (101) cent-un compagnies d'assurance cotées dans l'Union Européenne, comprenant notamment la taille, l'ancienneté, l'effet de levier, le type d'entreprise, la diversification des activités, les investissements à long terme, et certains indicateurs de performance (les ratios combinés, ROA, Tobin's Q, et EPS). En utilisant le modèle Probit sur des données de panel avec les effets aléatoires, les résultats obtenus montrent que les compagnies d'assurance ont tendance à adopter l'ERM lorsqu'elles ont un niveau d'endettement élevé, une taille importante et une concentration sur leur cœur de métier. De plus, ces entreprises investissent davantage sur le long terme, ont une valeur de marché

élevée, et se trouvent dans les marchés développés. Ces résultats corroborent les conclusions de plusieurs études dans la littérature i.e. Pagach and Warr (2011), Hoyt and Liebenberg (2011).

Dans le deuxième essai, j'étudie l'impact de l'ERM sur la performance de l'entreprise au regard de deux indicateurs: valeur de marché et valeur comptable. Suivant les résultats de l'identification des éléments déterminant l'adoption de l'ERM (premier essai), l'échantillon de base peut être divisé en deux groupes de compagnies d'assurance: un groupe avec ERM et un groupe sans ERM. Afin de tenir compte d'éventuel problème d'endogénéité entre la performance et l'ERM, et de possibles biais relatifs à la sélection de l'échantillon, l'approche d'estimation en deux étapes de Heckman (avec le ratio de Mills inversé) et les instruments internes de Hausman-Taylor sont utilisés. Les résultats obtenus sont en faveur de l'hypothèse selon laquelle l'ERM a un impact positif et significatif sur la performance des entreprises. Ces résultats complètent les études précédentes qui préconisaient l'adoption de l'ERM i.e. Nocco and Stulz (2006), McShane et al. (2011), Hoyt and Liebenberg (2011), Eckles et al. (2014).

Le troisième essai examine la solvabilité des compagnies d'assurance qui disposent d'un système de gestion des risques - l'ERM. Avec une approche similaire à celle du deuxième chapitre, je confirme que l'adoption de l'ERM a un impact positif sur la solvabilité de la société d'assurance. Cette nouvelle approche par la solvabilité des compagnies d"assurance contribue à une vision alternative de la valeur de l'ERM.

Les résultats de cette thèse ont des implications pour les parties prenantes majeures telles que les gestionnaires de risques, les régulateurs et les actionnaires: l'adoption de l'ERM a un impact positif et significatif sur la performance de l'entreprise et sa solvabilité. Par ailleurs, l'adoption de l'ERM est corrélée à certaines typologies des entreprises telles que le niveau de la dette, la taille de l'entreprise, l'investissement à long terme et la diversification.

Title : Essays on Enterprise Risk Management: the Case of European Insurance Industry

Keywords: Enterprise Risk Management (ERM), firm performance, Tobin's Q, financial vulnerability, solvency, insurance industry, endogeneity.

Abstract

In a world that becomes more and more integrated, every firm has to cope with increasing complexity of different risks. Managing complex risks with a global view, holistic at all firm levels for insurers is vital because risks are their businesses. Over the last two decades, enterprise risk management (ERM) has become a crucial framework to provide firms with methods and processes to manage risks and augment the likelihood of business success. However, even within the same regulatory framework, different risk management strategies and risk management activities would lead to different outcomes.

This doctoral thesis aims to examine three aspects of ERM in the European insurance industry:

i) the characteristics of insurers that implement ERM,

ii) the impact of ERM on firm performance,

and iii) the relationship between ERM and solvency.

Although the market share of the EU market is more than one-third of the world's maket share, most of empirical studies on ERM in the insurance industry based on the US data. Moreover, the Solvency II pushed insurers in this continent more close to ERM.

The first essay investigates the characteristics of 101 publicly traded EU insurers, including firm size, firm age, leverage, business type, diversification, long-term investment, and some performance indicators (combined ratio, ROA, Tobin's Q and EPS). Using a Probit model with random-effects panel data, the obtained results show that European insurance firms are more likely to adopt ERM when they are more leveraged, bigger, and focus more on their core businesses. In addition, they have higher firm value, invest more over the long-term horizon and are mostly located in developed markets. Our evidence is consistent with the findings of some previous studies, i.e. Pagach and Warr (2011), Hoyt and Liebenberg (2011).

In the second essay, I study how ERM impacts firm performance via both market value and book-value indicators. With constraints in the identification of ERM evidence, I have two groups of ERM insurers and non-ERM insurers. As a result, I have to solve the problems of endogeneity (included reverse causality) and sample selection bias by using comprehensive methods: Heckman's two-step (with inverse Mills ratio), Treatment Effects, and Hausman-Taylor estimators. With comprehensive methods employed, the findings support the hypothesis that ERM have a positive impact on firm performance. These results thus complement previous studies advocating ERM adoption i.e. Nocco and Stulz (2006), McShane et al. (2011), Hoyt and Liebenberg (2011), Eckles et al. (2014).

The third essay examines the solvency of insurers that have adopted an ERM system. Using a similar approach as in the second essay, I find that ERM adoption has a positive and significant impact on insurance firm solvency. This new investigation into insurance solvency contributes an alternative view of the value of ERM.

The findings of this thesis have some implications for major stakeholders such as risk managers, regulators, and shareholders: ERM adoption does have a positive and significant impact on firm performance and firm solvency. Moreover, ERM adoption is associated with certain firm characteristics such as leverage, firm size, long-term investment, and diversification.