

Enterprise Risk Management in the
South African insurance industry

W.N. Reynecke

13032585

Dissertation submitted in partial fulfilment of the requirements for the degree
Magister Scientiae at the Potchefstroom-campus of the North-West University

Supervisor:

Prof. D.C.J. de Jongh

November, 2008

Abstract

The purpose of this dissertation is to investigate Enterprise Risk Management (ERM) in the South African insurance industry. Firstly, this dissertation attempts to ascertain the current composition of the different facets of ERM. These different facets are discussed in detail in the dissertation.

The first of these include the insurance industry's definition of ERM followed by the tools and techniques involved in implementing ERM-driven risk management programmes. The third facet is the regulatory measures which form part of the industry. This provides a proper link with the fourth facet, namely that of the exponents applying ERM and how their roles are governed by regulatory bodies. Another facet is the training programmes that exist to educate insurance industry players and entrants to efficiently use ERM. The sixth facet motivates why ERM is actually used by delineating the benefits connected with ERM processes.

The dissertation furthermore investigates the extent to which ERM is already incorporated in the South African insurance industry. A questionnaire was completed by industry members in order to obtain an insight into the practical side of ERM that reigns in South Africa today.

Contents

List of Tables and Graphs/Figures.....	5
Afrikaanse Opsomming.....	7
1. Introduction to the ERM study.....	9
1.1. Problem statement and motivation.....	9
1.2. Research goals and endeavours.....	10
1.3. Research methodology.....	11
2. Defining ERM	12
2.1. Introduction.....	12
2.2. Enterprise Risk Management in Essence.....	12
2.3. Risk Dynamics.....	13
2.4. The Risks Involved.....	16
3. The Implementation of an ERM Framework: Tools.....	19
3.1. Introduction.....	19
3.2. The ERM Culture.....	19
3.3. Risk Taxonomy.....	23
3.4. Risk Metrics, Measures, Measurements.....	28
4. The Implementation of an ERM Framework: Techniques.....	35
4.1. Introduction.....	35
4.2. Risk Mitigation.....	35
4.3. Risk Modelling.....	43
4.4. Economic Capital.....	48
4.5. Value Creation.....	56
4.6. Operational Risk.....	59
5. A Regulatory Framework.....	66
5.1. Introduction.....	66
5.2. Financial Regulation in the ERM Context.....	66
5.3. The FSA's functions as blueprint for financial regulation.....	71
5.4. Regulation of Internal Models.....	74
5.5. Capital Regulation.....	77
5.6. Standard & Poor's ERM Rating Procedure.....	79
6. Exponents of ERM.....	83
6.1. Introduction.....	83
6.2. The Role of the Actuary.....	83
6.3. The Role of the Chief Risk Officer.....	88
6.4. The Role of the Internal Auditor.....	90

7.	Educating the Successors.....	93
	7.1. Introduction.....	93
	7.2. Setting the Scene: The Two Working Groups.....	93
	7.3. The ERM Working Syllabus.....	95
	7.4. New Developments: The CERA.....	99
8.	Benefits of ERM.....	102
	8.1. Introduction.....	102
	8.2. Study of the U.S. Insurance Industry.....	102
	8.3. Unexpected Indicators of Benefits.....	105
9.	Trends in South Africa.....	108
	9.1. Introduction.....	108
	9.2. Background to the Analysis.....	108
	9.3. The Analysis and Comparison.....	110
	9.4. Comments on Results.....	130
10.	Conclusion.....	134
	10.1. Introduction.....	134
	10.2. Consolidating a Final Impression.....	134
	10.3. Closing Remarks.....	138
	Acknowledgements.....	140
	Appendix A.....	143
	Appendix B.....	154
	Bibliography.....	155

List of Tables

Table 9.1.	Business Classes.....	111
Table 9.2.	Firm Ownership.....	112
Table 9.3.	Bancassurance.....	112
Table 9.4.	New Business Incentive.....	113
Table 9.5.	Risk Function Leader.....	117
Table 9.6.	Risk Management Skills (1).....	118
Table 9.7.	Risk Management Skills (2).....	119
Table 9.8.	Risk Committee Leadership.....	120
Table 9.9.	Composition of Risk Function.....	120
Table 9.10.	Risk Organisation Structure.....	121
Table 9.11.	Responsibility of Risk Identification.....	123
Table 9.12.	Risk Identification Frequency.....	123
Table 9.13.	Risk Measurements Calculated.....	124
Table 9.14.	Applied Risk Measures.....	125
Table 9.15.	Implementation of Risk Information.....	126
Table 9.16.	Allowance for Diversification Benefits.....	127
Table 9.17.	Uses of Risk Measurement Information.....	128
Table 9.18.	Obstacles to ERM Implementation.....	129
Table 9.19.	Risk Management Expenditure.....	130

List of Graphs

Figure 4.1	Radon-Nikodym Derivative.....	42
Figure 4.1.	Internal Risk Modelling.....	62
Figure 9.1.	Firm Size.....	113
Figure 9.2.	ERM Framework Development.....	114
Figure 9.3.	Linkage with Objectives.....	115
Figure 9.4.	Reasons for ERM Implementation.....	116
Figure 9.5.	Risk Identification Approach.....	122
Figure 9.6.	Diversification Benefits.....	127

Afrikaanse Opsomming

Die doelwit van hierdie verhandeling is om lig te werp op die begrip van “Enterprise Risk Management” – ERM. Die probleemstelling van die teks is dus om te poog om duidelikheid te verkry oor ‘n besliste omskrywing van ERM, hoe dit ingespan word in die Suid-Afrikaanse versekeringsomgewing, hoekom dit ‘n bruikbare ontwikkeling is en wie by hierdie proses ingesluit word.

Oplossing vir hierdie onderskeie probleme word verskaf deur ERM te definieer, die bestaansrede daarvoor te ondersoek, hoofeksponente te identifiseer en om die huidige tendense rakende ERM in Suid-Afrika asook die wêreld te ondersoek. Daar word ook ‘n hoofstuk ingesluit wat spesifiek die kriteriaraamwerk ontleed wat deur kontrolerende en opsieneragentskappe gebruik word. Die onderskeie probleemstellings word vervolgens hier weergegee.

Die benadering wat gevolg is om ERM te definiër, bestaan uit ‘n uiteensetting van die definisies wat die gebruikers van ERM aanhang. Hierdie definisies moet vergelyk word om ‘n generiese, maar ondubbelsinnige omskrywing saam te stel. Die vergelykingsproses word ondersoek in hoofstuk een. In ooreenstemming met die tema van hoofstuk een, word die nodige terminologie van die ERM-omgewing verklaar en waar moontlik, deur voorbeelde, aan die leser meegedeel.

Die implementeringmoontlikhede van ERM blyk duidelik in hoofstuk twee. In hierdie hoofstuk word onderafdelings afgestaan aan onderwerpe soos die ERM-kultuur wat maatskappye moet vestig onder werknemers, die verskillende risiko’s wat betrokke is in die ERM-poging, die bepaling van hierdie risiko’s, die risikomodelleringsproses asook ‘n uitgebreide omskrywing van *ekonomiese kapitaal* en die bestuur daarvan.

Hoofstuk drie verskaf ‘n inleiding tot die raamwerk, waarvan gradering- en opsieneragentskappe gebruik maak, om te bepaal tot watter mate ‘n maatskappy ERM alreeds geïmplementeer het, asook die opvolgende sukses daarvan. Die uiteindelijke resultate van hierdie evaluasies dien terselfdertyd as ‘n aanduiding van die maatskappy se ontwikkeling en progressie wat vanselfsprekend ‘n beduidende indikatormiddel is vir buitestaanders.

Die identifisering van die hoofeksponente van ERM word uitgevoer deur 'n onthulling van die rolle wat onderskeidelik gespeel word deur aktuarisse, opsienerkomitees, graderingsagentskappe, hoofrisikobestuurders (CRO – chief risk officer) en ander eksterne belanghebbendes. Aangesien hierdie verhandeling op die versekeringsmilieu gerig is, geniet die sentraal-geankerde rol van die aktuaris die meeste aandag.

In hoofstuk vyf word die vraagstuk van die opleiding van die volgende generasie ERM-gedrewe risikobestuurders, aangespreek. Twee verskillende programme word bespreek, naamlik dié van die *International Actuarial Association* en die *Society of Actuaries*. Die belangrikheid van ERM is tans so integraal tot die aktuariële opleidingprogram dat daar nou 'n eksklusiewe sillabus opgestel is in die vorm van 'n aktuariële vak ST9 – *Enterprise Risk Management Specialist Technical*.

Dit word duidelik in hoofstuk ses dat ERM se bestaansrede gewortel is in die implementeringsgevolge wat dit teweeggebring het. Die stukrag vir die aanwending van ERM in risikobestuurtegnieke word blootgelê deur die sukses van ERM-programme weer te gee. Twee empiriese studies word bespreek om die suksesse van ERM te illustreer.

Twee dele word onderskei in die tendense wat in hoofstuk sewe aangebied word. Die een deel handel oor die resultate van 'n ERM-navorsingprojek deur die *Life Research Committee of the Faculty and Institute of Actuaries* in die Verenigde Koninkryk. Die restante deel bestaan uit die resultate van 'n vergelyke projek wat onderneem is deur die outeur self in die Suid-Afrikaanse (lebens)versekeringindustrie.

Die teks sluit af deur vas te stel of die aanvangsprobleemstellings beantwoord is en tot in watter mate. Die gevolgtrekking kyk ook na verdere aanbevelings met opsommende besprekings van vae ondersoekvelde.

Die benadering in die verhandeling is deurgaans 'n inspeksiemetode. Dit is bewerkstellig deur sleutelkonsepte en –dryfkragte uit te lê, gevallestudies te bestudeer en aanbevelings van kenners weer te gee. 'n ERM-vraagstuk staan tot die kern van hoofstuk sewe wat beantwoord is deur betrokke individue in lewensversekeringmaatskappye in Suid-Afrika. Die statistiese resultate en verklarings van die response word omsigtig bespreek.

1. Introduction to the ERM study

1.1. Problem statement and motivation

The endeavour of this text is to present clarity on the concept of Enterprise Risk Management – ERM. The problem statement is defined as an attempt to determine exactly what ERM is, i.e.:

- How is ERM defined?
- How should ERM be applied?
- Why it is useful?
- Who is involved in its application?
- What is the status quo of ERM in South Africa?

There exists extensive literature on the topic with respect to specific methodologies – especially in the case of the Casualty Actuarial Society Committee’s database. The leading authors are identified to be Shaun Wang and Gary Venter. Given the fact that the literature covers a wide range of topics concerning ERM, there is no apparent *guidebook* on the ERM principle which summarises the notion in order to provide an overview of ERM. The main goal of the research undertaking is therefore to inspect the various sources with the objective of compiling such a guidebook for the entire ERM process by means of answering the question as stated above.

As a concomitant factor of this study, the ERM situation in the South African insurance industry will come under scrutiny. The idea for this complementary perspective on the ERM topic was found with a succinct outlook on the work of Acharyya (2006:1). The latter’s work consisted of an empirical study of four key insurance firms in Europe. It is therefore deemed a fitting endeavour to include an empirical study with the same standpoint on ERM for the South African industry.

To conclude; this study aims to compile a type of reference framework which provides an overview of ERM along with an empirical motivation for ERM in the South African insurance industry.

1.2. Research goals and endeavours

The endeavour of this study is in accordance with the motivation of the preceding section, i.e. to provide a meticulous summary of ERM with a uniquely South African perspective.

This endeavour will naturally be fulfilled by completing the goals indicated in this section.

The main goals are given here as well as their specialised problem statements:

- Define ERM and the relevant terminology
 - What is included under the term ERM?
 - What additional terminology is necessary for a fuller comprehension of the topic?
- Inspect recent developments in ERM application and techniques
 - Taking note of the indicated authors (Wang, Venter), what are the improvements and refinements for risk management operation?
 - Are specific solutions applied to specific problems or is there a sense of generality?
- Assemble an employee manual
 - Who is responsible for the realisation of ERM in a firm?
 - Are employees merely a group of skills clones or are distinctive and specialised capabilities required?
- Why is ERM necessary (useful)?
 - Are there any benefits involved in implementing ERM?
 - Is ERM enforced through government bodies? Might this be the case in the future?
- What is South Africa's stance on ERM?
 - Are South African firms making full use of the ERM tools and techniques that are available?
 - What is the future of ERM in South Africa?

1.3. Research methodology

1.3.1. An analysis of the literature and sources

The commencement for the literature study at this introductory stage centred on the subsequent two main sources: the research databases of the Enterprise Risk Management Institute International and Casualty Actuarial Society. The Internet addresses for these two databases are given:

- www.ermii.org
- www.casact.org

As mentioned in section 1.1., the literature sources will be scoured with the intention of obtaining a perspective that summarises ERM with all its components. Taking account of this, it is still indispensable to leave room for areas of dynamic development – new concepts that arise through the research process.

1.3.2. An empirical investigation

It was established that there is an immense lack of empirical knowledge in South Africa concerning ERM and its implementation. It was therefore decided to undertake this supplementary part of the research in appreciation of the success of Acharyya in the European insurance industry.

Acharyya (2006:1) propose five key factors pertaining to ERM for his empirical study: understanding, motivation, design, challenges to implementation and performance measurement. It is clear that these factors cover many different parts of the ERM process and will therefore present a vaulting view. These factors will be taken as the base elements for a questionnaire which will be sent out to appropriate respondents at insurance firms in South Africa.

The data obtained from the respondents will be analysed to delineate a clear perception of the South African insurance industry's stance on ERM. The expectation for this part of the research is to give the actual motivation for the implementation of ERM.

2. Defining ERM

2.1. Introduction

Enterprise Risk Management is quintessentially a holistic approach to risk management, in contrast to the silo approach used in previous decades.

This chapter defines the core of Enterprise Risk Management as well as all the relevant terms and concepts. Wang and Faber (2006:4) express ERM as a notion with diverse interpretations for different people. Education, career level, actual risk exposures and professional training predetermine the interpretation of ERM. This being said, ERM is a mechanism of organised corporate responses to external and internal forces – the risk dynamics. These ideas shape the bulk of chapter one.

2.2. Enterprise Risk Management in Essence

Enterprise Risk Management is quintessentially a holistic approach to risk management, in contrast to the silo approach used in previous decades. The practitioner of ERM attempts to manage a firm's various risks with a single methodology. Being a holistic approach, the nature of this methodology ought to be generic to the extent that any department of a firm could utilise it for risk management; albeit a legal or even accounting department. ERM is no longer a vague and merely instinctive process; it has grown into its own and become a worthwhile discipline.

In a research project overseen by Wang and Faber (2006:4) and jointly supported by the Casualty Actuarial Society, the ERM International Institute and the Joint SOA/CAS Risk Management Section, several definitions were scrutinised in order to obtain a generic explanation that encompasses all fields influenced by ERM.

The CAS definition is given as (Wang and Faber, 2006:4) :

“ERM is the process, by which organisations in all industries assess, control, exploit, finance and monitor risks from all sources for the purposes of increasing the organisation's short and long term value to its stakeholders.”

Since ERM is a discipline, it is considered an organised pattern of conduct which is usually in agreement with predetermined rules and regulations. The key word in this definition, however, is ‘exploit’. This is one of the characteristics of ERM that makes it a unique risk management approach. The term ‘exploit’ implies that the approach does not merely attempt to reduce risk, but actually exploits the risk mitigation opportunity as one of value creation. It is a cardinal trait that will feature again.

The definition employed by Standard & Poor’s is also deeply interwoven with its evaluation of insurance companies. The evaluation procedure that Standard & Poor’s apply is discussed in detail in chapter three. A comprehensive definition is supplied (Wang and Faber, 2006:5) :

“An insurer has extremely strong capabilities to consistently identify measure and manage risk exposures and losses within the company’s predetermined tolerance guidelines. There is consistent evidence of the enterprise’s practice of optimising risk-adjusted returns. Risk and risk management are always important considerations in the insurer’s corporate decision-making.”

In the previous CAS definition, there is the implication that ERM is a process requiring not only the strategic decision-making of the firm’s senior management, but also inputs from all levels throughout the organisation. Juxtaposing Standard & Poor’s definition with the CAS definition, this attribute is now explicitly mentioned and it is also examined as such during their rating procedures. Otherwise, the latter definition simply solidifies the ideas presented in the CAS definition of long-term views and value creation.

2.3. Risk Dynamics

Wang and Faber (2006:6) view ERM as “the discipline of studying the risk dynamics of the enterprise, the interactions of the internal/external players and forces and how players’ actions influence the behaviours of the risk dynamics, with the ultimate goal of improving the performance and resiliency of the system.” They emphasise the fact that ERM has value creation, not value preservation, as one of its core objectives. Another feature in their explanatory notes is the concept of the *enterprise*. The *enterprise* might be a firm, a public body or a business in any industry. This indirectly includes the

enterprise's operations and dealings with other entities. The CAS definition touches on the subject with consideration of the "value to its stakeholders", but Standard & Poor's version makes no overt mention of it. This leads to a noteworthy technicality identified by Wang and Faber (2006:7). They point out the distinct disposition of the insurance industry where the product is a promise to pay for taking on someone else's risk, as opposed to other industries where only the risks applicable to that specific business line is managed.

In retrospect of the preceding definitions, a generic and vaulting, but unambiguous definition could be summarised as follows: "ERM is a holistic and consistent approach to an organisation's risk management at all levels of the organisation for all the stakeholders of the organisation (including employees, management, shareholders and clients) to reduce risks to predetermined levels and create new value."

One can regard the notion of *risk dynamics* as the actively defining element of ERM. It refers to the risks themselves, their interactions, their sources and the resulting repercussions. Wang and Faber (2006:7) categorise five principles of risk dynamics that could possibly form a conjectural basis for ERM:

- Different states of nature
- Interactions among risk dynamics
- Valuation scope
- Risk metrics and models
- Risk management team members

The first principle regards risk dynamics as different *states of nature* similar to those of stochastic processes. The information about these states increases over time through observation, insights and modelling of the internal drivers. A diversification approach may be distorted without sufficient knowledge about the risk dynamics which would in turn lead to risky undertakings. This principle seems straightforward, but the underlying problem of assessing and forecasting the nature of risk dynamics is a broad and sometimes vague endeavour.

The next principle addresses the inherent interactions of risk dynamics. These interactions exist at all levels and are driven by multiple forces. The reason for

inspecting these relations is to generate a reconciled view of them. Sources of the interactions can exist on a micro level and are primarily derived from the organisation's business operations, i.e. the local market and business culture. At a macro level identification of the interactions is a much more complicated task since the driving forces are impacting the enterprise as well as the economic sector and the entire economy. This overarching analysis is naturally necessary to determine the correlated risks. The final step concerning this principle would be to merge the global views obtained with the local views from the prior principle.

The third principle concerns the scope of valuations – either of an external or internal nature. The external market valuations influence the assets and liabilities of the organisation, whereas the internal valuations are more often than not applied to manipulate the conduct of the enterprise. The impact of market valuation is now further supported by the acceptance of fair value accounting practices by the International Accounting Standard Board. This subsequently drives organisations to expand their asset and liability management.

Principle four concentrates on how suitable risk metrics and valuation models can be drawn on to explore the behaviour of risk dynamics. The ideal is that every organisation should develop its own internal model, using information at different levels and afterwards applying these models as the base tools to steer the firm's business operations. The models should first estimate the risk appetite of the organisation and its capital requirements and finally assist in directing the resource allocation.

The fifth principle ascertains what is the extent of the actions which prominent players of risk dynamics can cause. A great number of risks are involved in this principle alone. There is the predicament of disparity among the levels of expertise of the decision-making personnel; this is also interconnected with the misrepresented incentives that will give rise to the agency theory. Chapter two delves deeper into other lesser known risks such as model and methodology risk. As expected, hardly any of the decisions carried out by senior management in a firm is performed with the aid of complete and perfectly accurate information. Wang and Faber (2006:12) quoted Warren Buffet who commented that “at the beginning it is driven by fundamentals, after that speculation takes over.” As

the term itself implies, risk dynamics are dynamic; the only constant factor is constant change.

With these five principles it has now become clearer what the driving forces behind risk dynamics are and therefore the dynamic element of ERM. This understanding of the underlying tumult of risk management sets the overall scene, but the separate components are the most significant factors. It is therefore imperative to comprehend the individual risks which cause these compound interactions. These individual risks are discussed in the following section.

2.4. The Risks Involved

The risks involved will determine the extent, to which an internal ERM model can be implemented along with its thorough risk analysis. Risks can be catalogued to fall under any of the following categories: hazard risks, financial risks, operational risks and strategic risks. Further divisions of each of these categories are possible if distinction between internal and external causes and effects become an indispensable feature of the ERM model at hand.

Hazard risks include a series of events that incur losses on account of the organisation. These events specifically refer to physical damage of either the plant or equipment of the organisation. Physical damage could also be in the form of personal injury of employees during business operations or personal injury of visitors to the establishment or users of a product supplied by the firm.

Financial risks are risks which have accounting implications. These are varied, but also well-documented. Examples include commodity risk or foreign exchange risk. A risk can be classified under this category especially when it affects prices – either of the firm's assets or liabilities. Other subcategories consist of liquidity risk, credit risk and market risk.

Operational risks have only recently been receiving due attention. These risks cause the most bankruptcies of organisations and the greatest losses and yet it is poorly documented. As expected there is a reason for this. Operational risks are extremely difficult to measure and quantify. In an area consisting mostly of human judgement and experience,

assessment sheets with tick boxes and pure analytical estimation prove unsatisfactory. Thus, risks that incorporate human judgement, knowledge and even ethics are operational risks.

Strategic risk concerns the decisions made regarding corporate success and development. This comprises how well the organisation's final product is selling, future expansion of the enterprise and commercial functions in the economy as a whole. The key players in this risk field are the senior management of an organisation. The management team has to take account of such wide-ranging problems as reputation damage, customer preferences, technological improvements and sometimes political trends as well.

A meticulous and more applicable outline to the insurance industry is given by Calandro, Füßler and Sansone (2008:117). For insurance, very specific risks exist and the identification of these is imperative in establishing risk dynamics. A few of the risk specific to the insurance industry are mentioned in their discussion. These include *premium risk, investment activities, claim payments* and *cross-discipline risks*.

Premium risk is a straightforward development in the insurance industry. It does nevertheless form a starting point for the assessment of more precise and recognised risks. Calandro *et al* (2008:118) stipulate that these consist of pricing risk, solvency risk and customer relationship risk. Under the first component pricing risk, it is understood that the premium loading on the insurance sold will not be ample to cover losses sustained over time. The next component solvency risk is equivalent to the credit and default risk that fall under the category of financial risks. The third component, customer relationship risk, has of late developed into a noteworthy risk. The latest drive to make insurance a more direct business means that the relationships previously maintained by insurance brokers and agents will become obsolete. This naturally has the implication that customer service may be of a lower standard.

Investment activities are a salient determinant of an insurance organisation's value. No exclusive risk is defined here, but the reference to the archetypal systemic risks such as interest rate and market risk is evident.

Claim payments are the largest expense experienced by an insurance organisation. This 'claim risk' has three building blocks: catastrophe risk, reserve risk and inflation risk.

Catastrophic events cause corporal harm and property losses. These events are not foreseeable and therefore not accounted for. Reserve risk is probably the greatest difficulty in this instance according to Calandro *et al* (2008:119). Values of future claims may be grossly underestimated leading to obligations that cannot be met. Inflation risk can develop from the normal price inflation or it can be of a social nature. Changes in national legislation or adverse regulation acts by supervisory boards can be the source of social inflation risk.

A novel perspective is given under the section entitled “cross-discipline risks”. An embedded risk which appears is human resource risk. It is the apparent choice of any organisation to retain employees with superior performance rates. A firm that ignores this risk is in danger of not only losing capable employees, but also of holding onto weaker staff members.

The aforementioned insurance-specific risks clearly illustrate why Calandro *et al* (2008:121) stress the fact that the silo approach to risk management in the insurance industry cannot be totally discarded. It serves a purpose in economic cycles with lower volatility since some departments in an insurance industry simply don't relate when the focus is solely on premium growth and the reduction of operation costs.

The reader should now have a clear and personal definition of ERM and understand that ERM may mean different things to different parties. Naturally, the definition of ERM cannot be extricated from the actual risks involved in the risk management process or the accompanying risk dynamics.

The following chapter provides the tools and techniques to understand and manipulate these underlying components of risk management. Chapter two also follows through on the risk taxonomy which was touched on in this chapter.

3. The Implementation of an ERM framework: Tools

3.1. Introduction

The implementation of Enterprise Risk Management follows the same route as any risk management procedure. Nevertheless, there are a few additions to the process and these are the key to ERM's significance. Normally a risk management procedure determines the firm's risk appetite, the concomitant risk philosophy and the risk objectives. The next step is implementing an ERM culture which is entwined with the preceding risk definition. Risk definition is followed by risk mitigation and is carried out by means of aggregating risks and subsequently modelling them. After all these processes have been performed the final goal is elucidated and obtainable; realising optimal economic capital for the organisation.

The difference in the case of ERM is that the identification and mitigation of all possible risks are conducted through a generic internally-fabricated methodology and model(s) that will be discussed in this section. Probably the most vital component of ERM is the risk culture it commands from the organisation's corporate structure.

3.2. The ERM Culture

3.2.1. Introduction

As mentioned in virtually every definition in the previous chapter, *all* levels of an organisation's corporate structure should be involved in the risk management procedures. Although this involvement is imperative, the ERM culture is a far broader venture. The ERM Committee of the Casualty Actuarial Society provides a comprehensive set of sensible considerations for the implementation of ERM in Miccolis *et al* (2003:133). Four of these considerations are integral to the *culture* aspect that is to be implemented.

3.2.2. The Four Pillars of an ERM Culture

The first consideration is appointing an advocate of ERM. At first this may seem an alien task, but in chapter seven it will be illustrated that a champion for ERM in South African

organisations has already become an indispensable member of the personnel. This individual might initially be the Chief Financial Officer or the Chief Actuary, but the long-term goal is to designate a Chief Risk Officer. Two factors contribute to the efficiency of the CRO; authority and the position within the organisation. The CRO should fill a position from which it is feasible to observe all the risks that affect the firm. The authority attributed to the CRO must also be sufficient to initiate amendments in the business' operations which are deemed fit for ERM improvement.

A further consideration is the eradication of the partial approach that is currently prevalent. In the traditional sense the human resources department is responsible for employee compensation and benefits, the risk department covers hazard risks, information technology departments are mostly in charge of operational risks and the marketing department toils with strategic risks. Here the ERM culture becomes clear: the purpose is to instigate not only greater vertical communication within an organisation, but especially greater horizontal communication. The ideal is that the risk management methodology reaches a level of generality that all departments can conduct a risk correspondence with each other as well as senior management. Scale calibration, assessment methods and terminology along with the associated timeframes must become subject to an amalgamation process.

The third consideration is one of evolution. The implementation of ERM is not a once-off incident. It has to develop over time and include many changes and alterations that are monitored and reported to the relevant managers. The fourth consideration is fused with the third; the introduction of ERM ought to be conducted gradually, but scrupulously. Naturally the complexity that the partial approach has achieved cannot be removed with immediate effect. Since resources allocated to the ERM will probably be minimal in the preliminary stages, it is best to build upon small successes and let the endeavour produce its own drive and fervour.

3.2.3. Internal Threats

There are business operations problems that naturally apply to the insurance process as well. These problems can be eliminated in time with a fully-integrated ERM culture. An example of these is the well-known dilemma of the agency-problem. Feldblum (2007:4) states the conventional perspective was that organisations insure against external risks

and therefore incentives for appropriate conduct by risk managers were never required. It is now clear that great sources of risk are located within the organisation. A risk manager may have opposing motivations when running business operations.

The ERM framework needs to address this predicament of opposing incentives. A variety of suggestions are made by Feldblum (2007:8). The possible modifications include developing a relationship with a high level of trust between the managers and the ERM champion as well as between the ERM champion and the shareholders. In this way the ERM champion becomes the solution to the opposing motivations which the risk managers initially faced. Probably the most difficult of the proposed modifications is that the ERM champion should successfully move away from the mitigation of financial risks – which are dealt with by the risk managers – to that of business risks.

Lewin (2005:1) classifies three rules of successful ERM; a decisive corporate risk strategy supported by senior management; a robust and holistic risk management framework and an effective risk culture and procedures. A considerable part of the ERM culture is the mind-set of the players involved. The ubiquitous two-way communication among the organisation's players should be of an open and consultative nature. Lewin (2005:2) emphasises that the disciplinary facet of the culture must be accountability and not blame; the risk management exponents should learn from near misses.

3.2.4. The Project Management Office

These rules classified by Lewin (2005:1) formed an appropriate introduction to the proposals of Gorvett and Nambiar (2006:2). The notions of holistic risk management and enterprise-wide communication form the base of the latter authors' study. Gorvett and Nambiar (2006:2) propose that every firm should set up a PMO – Project Management Office – with the explicit objective of extracting micro-level operations onto macro-level projections and then providing aid for enterprise-wide interpretation and understanding of the results.

As expected, the proposal is easier said than done. Risks that influence firm-wide fluctuations are particularly difficult to manage and the customary corporate culture that employers apply creates barriers for holistic approaches to risk management. Thus in order to counteract this situation the new field of *project management* has come into

existence. Gorvett *et al* (2006:3) stress that Project Management attempts to coordinate resources. It then also addresses the question of successfully extracting business operations to the macro-level and successfully completing these, e.g. mitigating risks.

Gorvett and Nambiar (2006:3) isolate five principles to achieve effective macro-level project management. The first principle is clearly specifying a purpose or mission for the PMO. The next principle involves receiving support from a high-level patron. A governance statement forms the third principle in which the PMO must affirm the procedures and operations it intends to utilise in its functions. The fourth principle attends to the assimilation of the PMO into the firm; the PMO cannot function as a separate entity within the ERM culture. The last principle calls for the education of employees with regards to understanding and making use of the PMO.

If these principles are borne in mind when setting up a PMO certain accompanying factors naturally develop from its functions and prove to be beneficial to the firm. The firm can now react more rapidly to market changes and adjust their resource deployment for maximum efficiency. Another factor is that greater enterprise-wide communication will induce greater holistic risk management approaches.

The last significant factor that Gorvett and Nambiar (2006:5) identify is the enhancement of employee morale. When the employees experience more enterprise-wide participation in business operations the successful completion of assigned tasks acts as a natural incentive.

3.2.5. Conclusion

From the previous subsections it is evident that laying an ERM culture is an extensive undertaking, but it the entire venture also has far-reaching consequences. It is therefore a positive step for ERM progression within the firm. However, the real work of ERM implementation only becomes apparent once the ERM culture is completely rooted in the organisation.

The first problem a risk management team faces is the determining the threats that the company are subject to. Naturally risk identification is indispensable to solve this problem. The following section starts with this topic which was hinted at in section 2.4.

3.3. Risk Taxonomy

Risk taxonomy involves defining risk for the organisation. This process has various phases consisting of the identification of risks, producing a quantitative depiction of these risks and determining the interdependencies that may exist between the risks by integrating them.

3.3.1. The Taxonomy Process

The taxonomy process which is discussed in detail in the guidance paper – ERM for Capital Adequacy and Solvency Purposes (IAIS, 2007b:4) – can be summarised in three steps:

- Identification of risks
- Analysis and quantification of risks
- Integration of risks

3.3.1.1. The Taxonomy Process: Step 1

The first step is the identification of the risks. This can be performed in any appropriate manner; brain-storming sessions, surveys and assessments or *risk correspondence* among the firm's operational levels. Many risks are specific to a business department's operations and the input of the various line managers is therefore a vital contribution. In its guidance paper on capital adequacy and solvency purposes, the International Association of Insurance Supervisors (IAIS, 2007b:9) stipulates that risk identification should consist of recognising and tackling all the anticipated and applicable risks to which the organisation itself, or as part of a group, might be exposed to now or in the future. The risk management team should then concentrate on the key risks taking account of their principal indicators.

Two features were mentioned in the prior stipulation which require some clarification; risks exposure *now or in the future* and as *part of a group*. It is important to have a clear picture of the implication of these phrases.

The first feature poses the question of what an appropriate time perspective may be. This naturally incorporates numerous linked questions. The most basic example of a problem

that could arise is a future risk with an extremely long recurrence cycle that will produce a present value of zero. The *Comité Européen des Assurance* and Mercer Oliver Wyman Ltd. (2005:20) prepared an essential groundwork paper for the Solvency II project where this time perspective difficulty is further defined and then utilised in the project. The time perspective questions include:

- Over what time period should capital protect against losses?
- Should assets and liabilities be valued over the same time period?
- Should the time perspective be retrospective or prospective?
- What is the optimal assessment frequency?

Most of the companies compared for the paper concluded with having a capitalisation period, i.e. a period where capital covers losses for a year and some even up to three years. A valuation horizon was not taken into account since the models are all static and asset and liability values are merely their corresponding book values. The majorities of companies favoured the retrospective approach basing their required capital measurement on historic volumes. The same companies also used an assessment frequency of a year.

The second feature determines the effects on an organisation of being part of a group – contagion. This refers to the instance where the business operations are changing simply because the organisation is part of a group. Risk distress experiences a direct contagion among the different firms through inter-firm operations and this is the origination of systemic risk. Giesecke and Weber (2003:3010) have done detailed research on modelling contagion, specifically credit contagion. Mixture models are used to model loss distributions, but a Normal approximation is given as well. These modelling practices are discussed in section 4.3.4.

3.3.1.2. The Taxonomy Process: Step 2

The second step in risk taxonomy is the analysis and quantification of risks. The analysis of most risks is a fairly straightforward chore and would preferably comprise of obtaining a probability distribution of possible outcomes for each of the risks identified. Losses, which are synonymous with risk, can be categorised according to their frequency and severity. High frequency losses with low severity are usually covered by the organisation's capital requirements and it is the losses with high severity and low

frequency which are often overlooked. These risks are captured in the tails of loss distributions. Quantification of qualitative risks, however, is a much more complicated procedure. It requires subjective human judgement and draws on a great deal of personal expertise on the part of different business managers.

3.3.1.3. The Taxonomy Process: Step 3

The integration of the risk is risk taxonomy's third and final step. This step entails determining the correlations that exist between the various identified risks and then aggregating their distributions. An intuitive way of determining these correlations is the construction of a covariance matrix. This method, however, has a great drawback since the number of estimates increase as the squared value of the number of risk identified. Copulas have turned out to be the chosen alternative since the cause and effect relationships applied in these models are based not only on the observed data, but also expert opinion. This provides a significant advantage in view of the fact that the modeller now has the ability to inspect the causes of many results and can directly model outcomes corresponding to different decisions.

3.3.2. Copulas

Even though the previously proposed models have many implementation and analysis advantages, there exists a field of study of the correlation structure between risks and how they influence the collective portfolio, namely the simulation of copulas. These correlation models are often statistically constructed from historical data. The Normal copula makes use of the Normal distribution, but this proves to be deficient in the sense that the tail correlations are not extreme. Two advantages are also in consideration: the Normal copula is fully-specified by a correlation matrix and the simulation routines are well-documented and related software is available. Naturally it is possible to fit a parametric copula to empirical multivariate data. Wang (2002:69) conversely notes that the estimation of the copula's parameters then depends on the choice of the marginal distributions. His rectification proposal is therefore to use an empirical copula that is not influenced by the selection of the risks' marginal distributions. This is done by enhancing the historical multivariate data with scenario-based simulations.

One of the most popular copulas is the multivariate Archimedean copula. The research of Wu, Valdez and Sherris (2006:1) extends the copulas from lower dimensions to n -dimension algorithms by using Jacobian techniques for deriving distributions of transformed stochastic variables. The authors criticise their own work by pointing out that in most of the copulas presented in the paper, nearly all the functions have a single parameter representing all the correlations among the variables. The reason for this is calculation simplicity and tractability.

An added advantage of the Archimedean copula is the use of a single-value generator function. On the other hand these generators occasionally make the simulated Archimedean copulas non-unique. Wu *et al* (2006:2) quote Nelsen when it is stated that a function φ is an Archimedean generator if $\varphi(1) = 0$, φ is monotonically decreasing and φ is convex. Subsequently express $\mathbf{u} = (u_1, \dots, u_n)'$ as an n -dimensional unit vector where $u_k \in [0,1] \forall k = 1, \dots, n$. Then, if there exists a generator function φ such that C can be defined as $C(\mathbf{u}) = \varphi^{-1}(\varphi(u_1) + \dots + \varphi(u_n))$, then C is an Archimedean copula.

This short simulation algorithm provided by Wu *et al* (2006:6) consists of five steps:

- (1) Generate n independent continuous stochastic variables with a Uniform distribution – $U(0,1)$, indicating these as w_1, \dots, w_n .
- (2) Set $s_k = w_k^{1/k}, \forall k = 1, \dots, n - 1$
- (3) Set $t = F_T^{-1}(w_n)$, where F_T is the marginal distribution function of the copula where $T = C(\mathbf{U})$ ¹
- (4) Set $u_1 = \varphi^{-1}(s_1 \dots s_{n-1} \varphi(t))$, $u_n = \varphi^{-1}((1 - s_{n-1}) \varphi(t))$ and for $k = 2, \dots, n$ set $u_k = \varphi^{-1}(r)$, where $r = (1 - s_{k-1}) \prod_{j=k}^{n-1} (s_j \cdot \varphi(t))$
- (5) The results are then: $x_k = F_k^{-1}(u_k)$ for $k = 1, \dots, n$

Wu *et al* (2006:7) give an example of an Archimedean copula is the Frank copula where $\theta \neq 1$:

¹ See Appendix A

$$\varphi(u) = -\log \frac{e^{-\theta u} - 1}{e^{-\theta} - 1}$$

In the case of $\theta = 1$, the copula obtained is the independence copula. In Wu *et al* (2006:15) a case study comparing the Frank and Gumbel-Hougaard copulas reveals an intuitive expectation; different copula produce different dependence structures. Interestingly, the Frank copula produced negative implied dependencies whilst the Gumbel-Hougaard copula produced positive dependencies. This is of significant concern since it will naturally have varied impacts on the firm's capital requirements.

Another useful application of copulas is the aggregation of different risk types with the Gaussian copula. In Böcker and Hillebrand (2007:7) the authors first construct a joint Normal one-factor model where the single factor fully describes the two separate risks, i.e. credit and market risks where all their distinctive features of the both the original credit and market models are independent. Then using Sklar's Theorem² one can use the marginal distributions of the separate risk types to aggregate the total risk distribution by means of either Monte Carlo simulation or numerical methods.

A feature of the joint Normal factor model is that it can be translated into a Gaussian coupling model. If the two risks are coupled by a Gaussian copula with parameter $\tilde{\gamma}$ and the inter-risk correlation is denoted by $corr(L, Z)$ with L the credit risk and Z the market risk, then the relationship among the parameters is given by:

$$\tilde{\gamma} = \frac{corr(L, Z)}{\psi}$$

where ψ is a large homogenous portfolio approximation for the inter-risk correlation bound. The Gaussian copula is applied in this form since the results lead to distributions with heavier tails which in turn produce more conservative quantile estimates. The inter-risk correlation that accompanies this copula is a breakthrough since the modeller now has a means to test how correlation between different risks influences model risk.

² See Appendix A

3.3.3. Conclusion

Subsections 3.3.1. and 3.3.2. enable the risk management team to identify and categorise the risks they are dealing with. It is already a major advance to be able to delineate risks and their interactions. In addition, copulas are useful aids in this aspect since they provide the kit for simulation scenarios concerning different risk settings.

Given these instruments at the risk management team's disposal, the next step is to measure the risks which have been identified. The measurement of risks seems to be centred on merely calculating frequency and severity of risk instances, but the following section explains that there are many intricate details involved in the risk measurement process.

3.4. Risk Metrics, Measures and Measurements

3.4.1. Introduction

The three terms in the title of this section all signify different parts of a risk's substance. Holton (2002) was the first to distinguish between these terms. A risk metric is a *concept* defined by a modeller. The risk measure is the *process* through which a value is allotted to the risk metric. The *result* from applying the risk measure is the risk measurement. Risk measures should also adhere to a set of consistency prerequisites which are provided in subsection 3.4.5.

Risk measures are usually catalogued according to the risk metric that they embody, e.g. risk measures applicable to the volatility, beta or duration of an organisation's portfolio. The register used by Gupta and Chatiras (2003:4) first determines whether the risk measure is absolute or relative, the second distinguishing characteristic being if the measure is based on return, risk or risk-adjusted return. Risk measures include the well-known Value-at-Risk, Tail Value-at-Risk, the Sharpe ratio, the Treynor ratio, standard deviation, skewness, kurtosis and many more. The CAS Committee (Miccolis, 2003:117-118) further defines these risk measures to be either solvency-related – the measures focus primarily on the tail of the probability distribution – or performance-related – these focus on the mid-region. VaR is an example of a solvency-related measure whereas skewness is performance related.

The most prominent measures applied include annualised return, standard deviation and the Sharpe ratio. Lesser known measures like the Wang and Esscher transforms and Normalised exponential tilting deserve more attention and are therefore presented here.

3.4.2. The Wang Transform

Wang (2002:52) derives the Wang transform which is attributed of being a collective risk measure that can be applied to assets and liabilities. It is a derivation of the Capital Asset Pricing Model with its standard deviation loading which states that:

$$E[R] = r + \lambda\sigma[R] \quad \text{Eq. 3.1.}$$

where r is the risk-free rate, $E[R]$ is the expected return, λ is the market price of risk and $\sigma[R]$ is the standard deviation of return. Also note that solving equation eq. 3.1. for λ produces the Sharpe ratio. Making use of the standard deviation has its problems; the loading method does not reflect the skewness associated with loss distributions. Wang (2002:52) resolves the problem by defining a loss variable X with a general loss exceedance curve $G(x) = \Pr\{X > x\}$, where x is some predetermined level of losses incurred. The extension is then given by Wang (2002:52) as:

$$G^*(x) = \Phi(\Phi^{-1}(G(x)) + \lambda) \quad \text{Eq. 3.2.}$$

where Φ is the standard cumulative Normal distribution function. This transformation still incorporates the Sharpe ratio and was derived through reinsurance pricing by layer. For any loss variable X with loss exceedance curve $G(x)$, the Wang transform produces a risk-adjusted loss exceedance curve $G^*(x)$. The greatest advantage of using the Wang transform is the similarity in the distributions. If $G(x)$ is normally distributed with (μ, σ^2) , then $G^*(x)$ is also normally distributed with $\mu^* = \mu + \lambda\sigma$ and $\sigma^* = \sigma$. A further adjustment is made for parameter uncertainty by discarding the Normality assumption in favour of a Student-t distribution.

Defining $F(x)$ as the cumulative distribution function of the variable X and the degrees of freedom to be $k = m - 2$, the Wang transform now takes account of parameter uncertainty by utilising the Student-t distribution (Wang, 2002:53) :

$$F^*(x) = Q(\Phi^{-1}(F(x))) \quad \text{Eq. 3.3.}$$

The very final result is produced by combining eq. 3.2. and eq. 3.3. to obtain a two-factor model that integrates the risk-adjustment in the first step of the Wang transform as well as the parameter uncertainty of the second modification. Let $H(x)$ be a best-estimate probability distribution without any alterations to the model, the two-factor model with modifications is then given in Wang (2004:23) as:

$$H^*(x) = Q(\Phi^{-1}(H(x)) + \lambda) \quad \text{Eq. 3.4.}$$

3.4.3. The Esscher Transform

This transform is comparable with the Wang transform for the reason that it relates *variance*-based risk-adjustments to risks with non-Normal distributions whereas the Wang (2002:64) transform relates *standard deviation* loading to risks with non-Normal distributions. The problem of standard deviation not distinguishing between upside and downside skewness is also present with this variance-based measure. The Esscher transform is given as:

$$f^*(x) = \frac{f(x)e^{(\lambda x)}}{E[e^{(\lambda X)}]} \quad \text{Eq. 3.5.}$$

The connection with the CAPM in eq. 3.1. becomes clear when risks are normally distributed since the Esscher premium then indicates a variance loading:

$$H_{Esscher}[X; \lambda] = E[X] + \lambda Var[X] \quad \text{Eq. 3.6.}$$

The Esscher transform is a natural prelude to exponential tilting since it represents a portfolio of aggregated risks in terms of the structures defined for exponential tilting.

3.4.4. (Normalised) Exponential Tilting

Exponential tilting is discussed in two separate papers by Wang (2002:65, 2006:1). In the first paper the procedure is explained briefly, but it is in the second paper that the *Normalisation* of the reference variable is introduced.

Define a risk X and a reference portfolio with aggregated risk Y . The reference portfolio could either be a company portfolio, an industry portfolio or the financial effect. The exponential tilting of X induced by Y is then defined as:

$$X^*(\omega) = X(\omega) \frac{e^{\lambda Y(\omega)}}{E[e^{\lambda Y(\omega)}]} \quad \text{Eq. 3.7.}$$

for every possible state ω in the probability space Ω . Wang (2006:65) then continues by defining:

$$H_\lambda[X, Y] = \frac{E[X \cdot e^{\lambda Y}]}{E[e^{\lambda Y}]} \quad \text{Eq. 3.8.}$$

The link with the Esscher transform is now apparent when the exponential tilting is done over the aggregated risk:

$$H_\lambda[Y, Y] = \frac{E[Y \cdot e^{\lambda Y}]}{E[e^{\lambda Y}]} \quad \text{Eq. 3.9.}$$

This could also be interpreted as exponential tilting of the variable with respect to itself.

The refinement of the exponential tilting involves Normalising the reference variable, which is the aggregate risk; whether it is a company or in industry portfolio. This is necessary to achieve a constant interpretation of λ . Wang (2006:2) suggests Normalising the reference variable Y by percentile-matching to a standard Normal variable Z . This means that $Y = F_{Y^{-1}}(\Phi(Z))$, where Φ is the cumulative distribution of Z and it is implied that $F_{Y^{-1}}(p) = \inf \{y | F_Y(y) \Rightarrow p\}$. Regarding $f(x)$ and $f^*(x)$ respectively as the partial distribution functions of variable X before and after the exponential tilting, the Normalised exponential tilting is then defined as:

$$f_X^*(x) = f_X(x) \cdot \frac{E[e^{\lambda Z} | X=x]}{E[e^{\lambda Z}]} \quad \text{Eq. 3.10.}$$

3.4.5. Prerequisites for Risk Measures

Wang (2006:5) applied the same four prerequisites as those revisited by Heyde, Kou and Peng (2007:3). The introductory definition identifies risk measures to be a mapping from a set of risks X , to the real line $\rho(X)$. The four measures have the following mathematical representation:

- Translation invariance: $\rho(X + a) = \rho(X) + a$
- Positive homogeneity: $\rho(\lambda X) \leq \lambda \rho(X), \lambda \geq 0$

- Monotonicity: $\rho(X) \leq \rho(Y)$, if $X \leq Y$
- Subadditivity: $\rho(X + Y) \leq \rho(X) + \rho(Y)$

VaR is the one of the risk measures that does not satisfy these consistency rules; merely producing subadditive risk measures when the confidence level is between 95% and 99%. Heyde *et al* (2007:4) propose to extend the subadditivity requirement to *comonotonic* subadditivity. Two variables X and Y are comonotonic if and only if it holds that $\forall \omega_1, \omega_2 \in \Omega : (X(\omega_1) - X(\omega_2))(Y(\omega_1) - Y(\omega_2)) \geq 0$. The situation can also be remedied by the Wang transform. This transform satisfies all the consistency rules and is applied by first deciding on a security level α and then defining $\lambda = \Phi^{-1}(\alpha)$. Subsequently applying the Wang transform produces the result of $F(x) = \Phi(\Phi^{-1}(F(x)) - \lambda)$. A risk measures that is especially appropriate for determining capital requirements is obtained by calculating the expected value under function F : $WT(\alpha) = E^*[X]$.

3.4.6. Extended Risk Measures

A relatively unknown perspective for extended risk measures features in Artzner, Delbaen, Eber and Heath (1998:20) once the prerequisites of the previous subsection have been defined. Even though VaR can signify that a given situation is poor, it cannot determine the extent of the problem. The measure used for this approach is the calculation of a *shortfall*. Artzner *et al* (1998:20) define this concept as:

$$\mathbf{E}_{\mathbb{P}}[\min(0, -VaR_{\alpha}(X) - X)]$$

This equation calculates the expected value of risk X on the probability space \mathbb{P} where a confidence level of α is applied. Making use of this definition, two follow-up measures are defined, the first of which is the *tail conditional expectation* – also known as the TailVaR. \mathbb{P} is once again taken to be a subset probability space on the overall probability space Ω and the confidence level is taken to be α . Let r be the total return which was obtained from a reference instrument, TCE_{α} is then given as:

$$TCE_{\alpha}(X) = -\mathbf{E}_{\mathbb{P}}[X/r \mid X/r \leq -VaR_{\alpha}(X)]$$

The second risk measure is that of *worst conditional expectation*. Utilising the same terms as in the previous definition this risk measure is defined as:

$$WCE_\alpha(X) = -\inf \{ \mathbf{E}_\mathbb{P}[X/r | A] | \mathbb{P}(A) > \alpha \}$$

In the latter equation the term A is indicative of the portfolio held by the insurer.

These definitions provide an introduction to the proposition given by Artzner *et al* (1998:22); if a coherent risk measure ρ merely depends on the discounted risk's distribution and if it is greater than the measure VaR_α , then it will also be greater than WCE_α . The proof of this proposition follows as:

- (1) With X as the given risk, $-VaR_\alpha(X)$ is denoted by q , whilst X/r is defined as Y . Afterwards define the set $A = \{\omega | Y(\omega) \leq q\}$ which will have cardinality $p > n \cdot \alpha$. A is then rewritten as $A = \{\omega_1, \omega_2, \dots, \omega_p\}$ where $Y(\omega_i) \leq Y(\omega_{i+1})$ for $1 \leq i \leq p - 1$.
- (2) An average $\bar{Y}(\omega_i)$ for $i \leq p$ can then be defined as $y^* = (Y(\omega_1) + \dots + Y(\omega_p)) / p$, which is in turn equal to $\mathbf{E}[Y | Y \leq q]$, otherwise the average is defined to be equal to $Y(\omega_i)$.
- (3) Y^σ is then defined as $Y^\sigma(\omega_i) = Y(\omega_{\sigma(i)})$ for the case $1 \leq i \leq p$ where σ is a permutation of the first p integers. For the case $p + 1 \leq j \leq n$ the value of Y^σ is given by $Y^\sigma(\omega_j) = Y(\omega_j)$. It holds true that \bar{Y} is also the average of the $p!$ stochastic variables Y^σ .
- (4) The initial assumption that the risk measure $\rho(Z)$ for any risk Z only depends on the distribution of Z/r has the implication that all the $\rho(r \cdot Y^\sigma)$ are equal to $\rho(X)$. Since ρ is a convex function it follows that $\rho(X) \geq \rho(r \cdot \bar{Y})$.
- (5) From (4) the further implication follows that $\rho(r \cdot \bar{Y}) \geq VaR_\alpha(r \cdot \bar{Y})$.
- (6) It is then noted that $VaR_\alpha(r \cdot \bar{Y}) = -y^* = \mathbf{E}[-Y | Y \leq q]$, since it is known that $\bar{Y}(\omega_i) \leq Y(\omega_p)$ for $i \leq p$. Thus it follows that $\mathbf{E}[-X/r | X \leq q \cdot r]$.
- (7) An earlier result of Artzner *et al* (1998:21) already stated that $\mathbf{E}[-X/r | X \leq q \cdot r] = WCE_\alpha(X)$, and therefore it holds true that $\rho(X) \geq WCE_\alpha(X)$.

In this chapter the reader became familiar with the tools used by an ERM team. It is clear how to identify and specify individual risks and how to simulate interaction correlations using copulas. The actual measurement tools and means were explained and the reader has good insight into the latest developments in ERM tools. The next step then is to apply these tools in conjunctions with ERM practices.

In the next chapter the ERM techniques are presented. These include various modelling methods, diversification options as well as value creation. The chapter then closes with a summary of the chapter three in four with respect to operational risk. All the tools from chapter are combined the techniques from chapter in order to construct an ERM mitigation plan operational risk faced by the organisation.

4. The Implementation of an ERM framework: Techniques

4.1. Introduction

This chapter inspects the prospects a risk management team has given that an ERM approach will be followed. The prospects which are presented here explain the role that risk mitigation plays within the ERM context along with all the different options of mitigation available.

The chapter continues with an investigation of risk modelling techniques. Special attention is given to extreme value theory and mixture models. Further modelling practices are looked with particular detail extended to economic capital and its modelling implications. Linked to these modelling sections is a section on value creation which is based on risk models where the risk management team is taught to exploit risks to create wealth.

The chapter concludes with a section on operational risk. This section can serve as a summary of the entire implementation procedure of this and the preceding chapter, but with regards to the unique risk that is operational risk.

4.2. Risk Mitigation

4.2.1. Introduction

Risk mitigation signifies a much more pro-active and pre-emptive operation as opposed to risk reduction. Whereas risk reduction can be seen as a responsive action to loss that has already been incurred due to the risk not being neutralised, risk mitigation strikes first since it is an investment made to neutralise or transfer the risk hopefully before the loss can actually occur.

Kunreuther, Deodatis and Smyth (2003:2) identify a few benefits to taking the mitigation approach. Under risk mitigation direct losses will be significantly reduced; these may arise from hazard or financial risks. Indirect losses attributed to operational and strategic

risks will also see a reduction in total. The third benefit is reduction in losses for neighbouring structures. In other words, this is the mitigation of systemic risks that affect all the members of an industry group. Kunreuther *et al* (2003:4) broaden the benefit-scope by taking account of the long periods over which mitigation benefits become apparent. For this reason, it is necessary to discount the values to present estimations using appropriate rates to determine the merits of trade-offs. The net present value of the benefits must obviously outweigh expenses undertaken to mitigate the risks.

The possibilities for applying risk mitigation are endless. The few discussions presented here signify the areas in which the most recent and useful research has been conducted; optimal debt and equity values, cat bonds and risk allocation.

4.2.2. Optimal Debt and Equity Values: Introduction

With respect to default and credit risk, the paper by Broadie, Chernov and Sundaresan (2006:1) is an attempt to develop a *first-best outcome* in the case of bankruptcy and/or liquidation which also ‘improves’ the organisation’s value after the processes have been completed.

The authors identify three goals of an effective bankruptcy procedure (Broadie *et al*, 2006:1). The first goal is maximisation of the firm’s value ex-post. The model presented resolves this problem by initially solving to maximise the value of the firm and only then transferring control from the equity to the debt entities. The second goal according to Broadie *et al* (2006:2) is the encouragement for organisations to fulfil their debt obligations more often; prior to any bankruptcy or liquidation proceedings. This is achieved through penalties on equity holders in bankruptcy situations. The enforcement of so-called APR – absolute priority rules – greatly advances the latter goal, e.g. suspended dividends are used to pay coupon accumulations or all the residual value is attributed to the creditors when liquidation commences. Incentives to avoid liquidation, especially when the organisation is already conducting bankruptcy proceedings, are the third goal (Broadie *et al*, 2006:2). Debt forgiveness, along with some *post-bankruptcy* value for the shareholders, should be allowed for as well.

Regarding the first goal, it is clear that reconciliation between *first-best outcome* and maximisation of the firm’s equity value is a problematic endeavour. The authors define a

lower boundary for liquidation and an upper boundary for default status in terms of the firm's value which are not equal. The upper default boundary maximises the firm's value subject to limited liability. When one compares strategies which maximise equity or debt values to the bankruptcy boundary, it will reveal that reconciliation of the opposing sides relies heavily on where control of the proceedings is centred.

Since the creditors take control of the decision to initiate the liquidation process the alternative is suggested by Broadie *et al* (2006:3) to leave this decision to the organisation and only transfer control to the creditors once it has been made. Another factor to incorporate is the length of the *grace period* – the period between reaching bankruptcy status and finally initiating liquidation if re-emergence becomes impossible. The creditors usually choose this period to maximise the debt value. The debtors (the defaulted firm) will in turn choose their upper default boundary to maximise equity value while taking account of the creditors' choice concerning the grace period.

The APR proposed in goal two disclose their significant impact on the bankruptcy procedure. The likelihood of re-emerging from a default state is determined by the firm's ability to pay the accumulated debt obligations. In the model proposed by Broadie *et al* (2006:6) dividends are not paid to the shareholders in a default state and the entire EBIT – earnings before interest and taxes – is allowed to accumulate as well. If the firm surfaces from the default the accumulated debts must be paid with the accumulated EBIT. Only if the accumulated EBIT is insufficient to cover all the debts, will equity be diluted to raise the difference.

The third goal pertaining to incentives to avoid liquidation is closely tied with the first goal of achieving first-best outcome. At the same time as the creditors wish to achieve a first-best outcome that favours them, the debtors will diverge away from it if concessions are given. These concessions include debt forgiveness or reduced distress costs (costs involved with remaining in a default state) which the creditors can naturally grant. The selection of a long grace period by the creditors implies that the default boundary selected by the debtors will be higher in order to obtain debt respite earlier. The creditors will then counteract this choice by restricting the debt respite. A long grace period is conceded to the debtors in the hope that they surface solvent, since the costs associated

with liquidation want to be avoided by the creditors. If the distress costs are low or zero it is more beneficial to remain in the bankrupt state rather than liquidate the organisation.

4.2.3. Optimal Debt and Equity Values: Modelling Implications

Broadie *et al* (2006:4) derive a model from the steps undertaken by Goldstein, Ju and Leland (2001:489). The initial model derived by Goldstein *et al* (2001:489) is presented here with the additional assumptions and techniques as well as notation of Broadie *et al* (2006:4) featuring in-between, before the model used by Broadie *et al* (2006:8) is continued.

Broadie *et al* (2006:4) defined a fixed filtered probability space $\{\Omega, \{\mathcal{F}_t\}, \mathcal{F}, \mathbb{P}\}$ and like Goldstein *et al* (2001:489) the primitive variable is indicated by δ_t which is the earnings before interest and tax which will be representative of the firm's cash flow. An EBIT-process is defined under the *risk-neutral* measure of \mathbb{Q} as:

$$\frac{d\delta_t}{\delta_t} = \mu dt + \sigma dW_t(\mathbb{Q})$$

where μ and σ are assumed to be constants. The constant μ is defined by Broadie *et al* (2006:4) as the risk-adjusted growth rate of the earnings. A similar application of this constant is found in Goldstein *et al* (2001:489).

Since any asset can be priced by simply discounting the cash flow under the risk-neutral measure, let r denote the risk-free rate; it then follows that a claim on the entire payout is given as:

$$V_t = \mathbf{E}^{\mathbb{Q}} \left(\int_t^{\infty} e^{-r(s-t)} \delta_s ds \mid \mathcal{F}_t \right) = \frac{\delta_t}{r - \mu}$$

It is given that r and μ are constants with $\mu < r$, which implies that V_t and δ_t must have the same dynamics. The next step in the model development is thus explained by:

$$\frac{dV_t}{V_t} = \mu dt + \sigma dW_t(\mathbb{Q})$$

Broadie *et al* (2006:5) now continue on with their model by first defining two barriers for the variable V_t . The first barrier V^B represents the state at which the firm has reached

default level (i.e. classification) and the second V^L ascribes to the commencement of liquidation.

The firm will naturally issue a bond to finance its business operations at some point in time. The coupon rate c paid on this bond, will determine the firm's capital structure. Most bond agreements stipulate that the creditors are fully entitled to the principal along with accumulated interest on the bond even when the firm has been classified at default level. In order to shield the firm from this indenture it makes use of the *automatic stay* provision, whereby all interest accrual on unsecured debt is halted which in turn extends the maturities of the debt obligations. This accumulating provision and the interest in arrears thereon are denoted by the variable A_T .

When the firm then reaches a liquid state once again (i.e. $V_T = V^B$) then the firm will pay the creditors a value of θA_T where $0 \leq \theta \leq 1$. The term θ is defined to be a representation of a bartering agreement which will take place between the firm and the creditor, where the firm will expect proportional debt forgiveness equal to $1 - \theta$.

The firm will usually keep the EBIT cash flow to accumulate in a separate account S_T once the default state has been reached. If $S_T \geq \theta A_T$ then the amount in arrears will be paid from the separate account S_T , otherwise it will be necessary to dilute equity to obtain the difference.

At this stage it should also be noted that the firm will incur some kind of *distress cost* for the time it is classified as being in a default state. These costs – denoted by ω – can be of various types; it can represent the firm's legal fees, loss of human capital and public confidence. This value is naturally also linked to the duration for which the firm is in the default state; the *grace period* with notation d . When the allowed grace period is exceeded or the firm value reaches V^L liquidation sets in at a proportional cost of α .

Broadie *et al* (2006:8) then define all the implications of timing for the model building process. The most recent time at which the firm was in a default state is given by:

$$\tau_t^{V^B} = \sup \{s \leq t: V_s = V^B\}$$

As stated previously, there are two manners in which the liquidation state can be reached; exceeding the grace period d or actually reaching the liquidation barrier V^L . The timing implications according to Broadie *et al* (2006:8) for these two are represented respectively as follows:

$$\tau_t^d = \inf \{s \geq t: s - \tau_s^{V^B} \geq d, V_s \leq V^B\}$$

$$\tau_t^{V^L} = \inf \{s \geq t: V_s = V^L\}$$

This obviously implies that the liquidation time is the smaller of the two:

$$\mathcal{T}_t = \tau_t^d \wedge \tau_t^{V^L} \wedge \infty$$

Taking note of this lengthy explanation, Broadie *et al* (2006:8) then give the value of equity as:

$$\begin{aligned} E(t, \delta_t, \tau_t^{V^B}, \tau_t^{V^L}) &= \mathbf{E}^{\mathbb{Q}} \left\{ \int_t^{\mathcal{T}_t} e^{-r(s-t)} \left[(\delta_s - c) \mathbf{1}_{\{V_s \geq V^B\}} - \omega V_s \mathbf{1}_{\{V^L \leq V_s \leq V^B\}} \right. \right. \\ &\quad \left. \left. + (S_{s-} - \theta A_{s-}) \delta^{\mathcal{D}}(s - \tau_t^{V^B}) \right] ds \middle| \mathcal{F}_t \right\} \end{aligned}$$

where $\mathbf{1}_{\{x\}}$ signifies the indicator function for event x and $\delta^{\mathcal{D}}(x)$ is the Dirac delta function.³

The next step in the model development is to contrive an expression for the firm's debt position. This debt value is expressed as follows:

$$\begin{aligned} D(t, \delta_t, \tau_t^{V^B}, \tau_t^{V^L}) &= \mathbf{E}^{\mathbb{Q}} \left\{ \int_t^{\mathcal{T}_t} e^{-r(s-t)} \left[c \mathbf{1}_{\{V_s \geq V^B\}} + \theta A_{s-} \delta^{\mathcal{D}}(s - \tau_t^{V^B}) \right] ds \middle| \mathcal{F}_t \right\} \\ &\quad + (1 - \alpha) \mathbf{E}^{\mathbb{Q}} \{ e^{-r(\mathcal{T}_t - t)} (V_{\mathcal{T}_t} + S_{\mathcal{T}_t}) \middle| \mathcal{F}_t \} \end{aligned}$$

After having obtained expression for the value of both the equity and the debt, Broadie *et al* (2006:9) derive an expression for the value of the firm's assets on accounting principles:

³ See Appendix A

$$\begin{aligned}
v(t, \delta_t, \tau_t^{V^B}, \tau_t^{V^L}) &= D(t, \delta_t, \tau_t^{V^B}, \tau_t^{V^L}) + E(t, \delta_t, \tau_t^{V^B}, \tau_t^{V^L}) \\
&= \mathbf{E}^{\mathbb{Q}} \left\{ \int_t^{T_t} e^{-r(s-t)} \left[\delta_s \mathbf{1}_{\{V_s \geq V^B\}} - \omega V_s \mathbf{1}_{\{V^L \leq V_s \leq V^B\}} + S_s - \delta^{\mathcal{D}}(s - \tau_t^{V^B}) \right] ds \middle| \mathcal{F}_t \right\} \\
&\quad + (1 - \alpha) \mathbf{E}^{\mathbb{Q}} \{ e^{-r(T_t-t)} (V_{T_t} + S_{T_t}) \middle| \mathcal{F}_t \}
\end{aligned}$$

4.2.4. Catastrophe Bonds

Catastrophe (cat) bonds addresses the uncertainties related to catastrophe risk. These bonds are insurance-linked securities which convert catastrophe risks into credit risk. Cat bonds also make use of loss exceedance curves which can be derived from cat modelling software or defining payout functions according to external parametric indicators. Corporate bonds like cat bonds provide yield spreads to the investor, which are higher than the risk-free rate since they contain a loading for the uncertainties linked to default risk. The choice between corporate and cat bonds is decided on by applying the Sharpe ratio on the performance of the various assets.

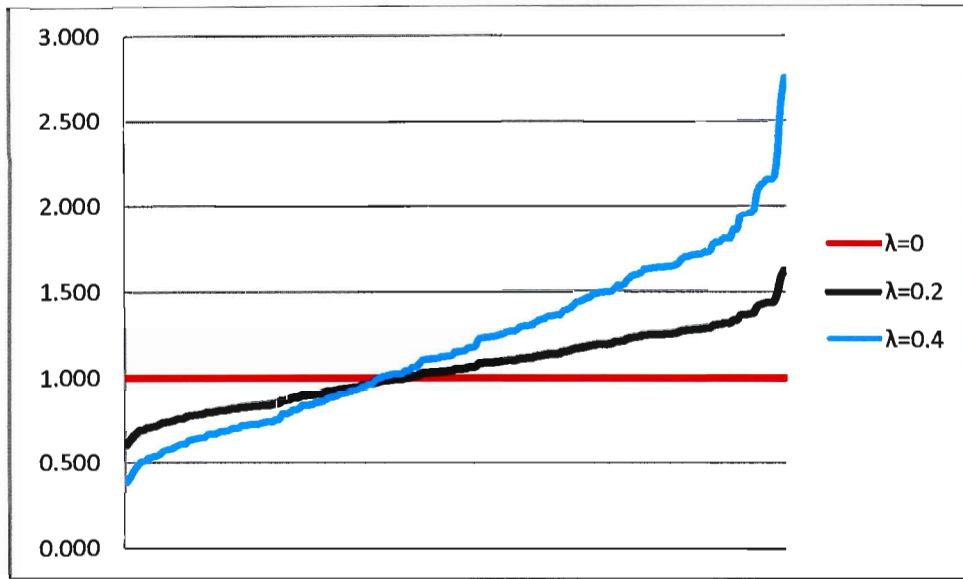
Use of the Sharpe ratio is, however, restricted to assets with Normal return distributions. Wang (2004:19) uses the transform of eq. 2.2. presented in section 3.4.2. to extend application of the Sharpe ratio to distributions which are skewed. The effectiveness of this transform is illustrated in figure 4.1.⁴ It is evident from the graph that the Wang transform escalates the probability density for unfavourable outcomes while the probability density for favourable outcomes is diminished.

Wang (2004:28) succinctly comments on the dynamics which influence the market prices of catastrophe bonds. Risk qualities such as the estimated default frequency and severity should be translated into the bond prices.

Another factor is the appeal of cat bonds which has grown considerably in the last decade with the increase of cat risks due to man-made or natural disasters. The yields offered by cat bonds do not exceed those of corporate bonds with the amount it previously did precisely because of the increased attractiveness of cat bonds.

⁴ See Appendix A

Figure 4.1. Radon-Nikodym Derivative



Source: Author

4.2.5. Risk allocation

Risk allocation can also be seen as an element of risk transfer. This is the crucial element of ERM that leads to the exploitation of risks and thus to value creation. In the presentation of Barrieu (2007:3), the question is posed of what an optimal structure should be in order to transfer or allocate the risks at hand. Schachermayer, Jouini and Touzi (2007:9) use a similar approach as Barrieu (2007:9) in constructing a Pareto-optimal risk allocation. The approach taken by Barrieu (2007:9) is given here.

The definition of a convex risk measure serves as a prelude to Pareto-optimal structures. If a risk measure ρ adheres to the three prerequisites of monotonicity, translation invariance and convexity it is a convex risk measure. The third prerequisite of convexity is described as follows:

$$\rho(\lambda X_1 + (1 - \lambda)X_2) \leq \lambda\rho(X_1) + (1 - \lambda)\rho X_2 \quad \text{for } 0 \leq \lambda \leq 1$$

The preference functionals used to describe Pareto-optimality can include expected utility functions, monetary utility function and convex risk measure among others. A noteworthy implication is that any utility function U is a monetary utility function if and only if $\rho := -U$ is a convex risk measure, i.e. U is monotone, translation invariant and concave.

The risk appetites of any two agents A and B are denoted by some preference functional U in terms of risks X and Y that satisfies the following (Barrieu, 2007:8):

$$X \succcurlyeq_i Y \leftrightarrow U_i(X) \geq U_i(Y) \quad \text{where } i = A, B$$

In the one-period case the risks X and Y are defined on a space L of random variables. Note that agents A and B are exposed to the individual risks X^A and X^B , which can be aggregated as: $X = X^A + X^B$. An allocation of risk between agents A and B consists of a pair (X^A, X^B) where the assumption of aggregation holds. Barrieu (2007:9) then states that any allocation (X^A, X^B) is *Pareto-optimal* if for any other allocation (Y^A, Y^B) it holds that:

$$U_A(Y^A) > U_A(X^A) \Rightarrow U_B(Y^B) < U_B(X^B)$$

$$\text{and } U_B(Y^B) > U_B(X^B) \Rightarrow U_A(Y^A) < U_A(X^A)$$

4.3. Risk Modelling

4.3.1. Introduction

The modelling process begins by incorporating the risks that have been identified, quantifying these risks using the measures discussed and then constructing a computational device – the risk model. Risk models can also form part of the quantification process. The risk model is applied as an explanatory structure; both for intra- and extrapolation. Each model is unique to the firm and risk management employees using it. However, as stated explicitly before, ERM procedures should be generic to facilitate overall use.

4.3.2. Model Types

Most risk models start out as deterministic models; i.e. the model's output consists of expected outcomes determined from a set of given inputs. When some of the input variables are given more scope the risk models are transformed into stochastic models. This transformation is virtually an obligatory alteration since many input variables follow stochastic trends over time. Once the stochastic model has been obtained a distinction is

made between statistical analytical models and structural simulation models. The CAS Committee (Miccolis 2003:120) contrasts 'statistical' with 'structural' to refer to the method by which the interrelationships of the model variables are represented, and then contrasts 'analytical' with 'simulation' to refer to the method by which the computations are conducted.

The statistical methods denote the statistical qualities observed in the variables and among themselves with total disregard to the cause-and-effect relationships. These methods obviously provide great simplicity in model parameterisation.

Structural methods are the opposite since they clearly centre on the cause-and-effect relationships. The input for these methods calls not only for a relevant data set, but also expert judgment. Making use of expert judgement, although risky in itself, is advantageous since it permits the examination of key drivers of certain outcomes. Statistical models are well-matched for an analysis of an entire industry, whilst structural should be applied to individual organisations.

Analytical methods are based on mathematical tractability and thus present results in a closed-form by solving a set of equations which were derived from strict assumptions. Even though these assumptions are restrictive on the flexibility of the model, the method provides the possibility of faster calculation. Simulation methods are comprised of a large number of computer-generated possible outcomes which approximate the final solution. These methods have become very popular since they can contain complex relationship that may exist among variables and are significantly less subject to cumbersome assumptions.

These precise classifications are a helpful guide to the numerous models that exist, but this precision is hardly ever applied in the construction of the models. The different models are more accurately compared on a continuum stretching from models purely based on historical data to models purely based on expert judgement.

An example discussed in the CAS Committee's paper (Miccolis, 2003:146) of the expert judgement end is the Delphi method. This method predicts future scenarios according to human judgement. Sources of the judgement or decisions are of an anonymous nature, they are presented to all the participants in a group as a combined perspective and the

prospect exists for adjustment of previous decisions. This method originates from military tactics and is thus applicable to any strategic risk that an organisation may face. It is investigated in more detail in section 4.6.3. An example of the data-input end is Extreme Value Theory. EVT focuses on the tail behaviour of the probability distributions. Tail behaviour is an important topic that necessitates a more in-depth explanation.

4.3.3. Extreme Value Theory and Tail Behaviour

Excessive expansion or contraction in business operations and the associated risks require not only a thorough understanding of the tail behaviour of distributions, but also an instrument to conduct further analysis into the extreme values of distributions. Thus an equivalent is obtained for empirical data not yet observed as well as a procedure through which the precision of estimated probabilities can be ameliorated.

LeBaron and Samanta (2004:2) mention that as the central limit theorem is the limiting distribution for the sample averages, a comparable limiting distribution exists for sample maxima. The Fisher-Tippet theorem uses the tail index to construct all the plausible depictions of the density function of an extreme value distribution. These density functions can decay in three different manners and can be mapped onto various *domains of attraction* represented by three limiting distributions. The Gumbel distribution is applied when the tail decays exponentially and all the moments are finite. When the tail is decaying by a power the Frechet distribution is applied. The final possibility is a tail that decays with a finite tail index for which the Weibull distribution is applied.

The first step is to obtain a sequence of stochastic variables X_1, X_2, \dots, X_n for which a maximum has been determined for each set of observations. The task at hand is to acquire a limiting distribution for these maxima. This is achieved by standardising the maxima; reduce the values by a location parameter ν and then apply a scale parameter σ to the results. This standardised extreme variable is non-degenerate and as the period over which the maxima are observed tends to infinity the extreme value distribution takes on one of three forms depending on Normalising constants $a_n > 0, b_n$. The definition given by LeBaron and Samanta (2004:3) states that the non-degenerate extreme variable distribution $G(x)$ is max-stable if there exist real constants $a_n > 0, b_n$ such that for all

real x and $n = 1, 2, \dots$ it holds true that $G^n(a_n x + b_n) = G(x)$. The function $G(x)$ is then portrayed by one of the following functions (LeBaron *et al*, 2004:3):

$$\begin{array}{ll} \text{I} & G(x) = e^{-e^{-x}} \quad -\infty < x < \infty \\ \text{II} & G(x) = e^{-x^{-\alpha}} \quad x > 0 \\ \text{III} & G(x) = e^{(-(-x)^\alpha)} \quad x < 0 \end{array}$$

The coalescent parameter in these functions is α which reconnects with the original stochastic variables X_1, X_2, \dots, X_n and indicates the weights of the tails of their distributions. This parameter is of the utmost importance since it relates the extreme value distributions with both the source distributions as well as the generalised extreme value distribution. The generalised extreme value distribution is connected to the shape parameter α by the tail index τ through the ratio $\tau = 1/\alpha$. This index now provides the key to distinguish between the three limiting distributions; $\tau = 0$ indicates a Gumbel distribution, $\tau < 0$ indicates a Frechet distribution and $\tau > 0$ a Weibull distribution. The generalised extreme value distribution is then given as (LeBaron *et al*, 2004:4):

$$\begin{array}{ll} F_x(x) = e^{-(1+\tau x)^{-1/\tau}} & \text{if } \tau \neq 0 \\ F_x(x) = e^{-e^{-x}} & \text{if } \tau = 0 \end{array}$$

4.3.4. Mixture Models

A model can be converted to a mixture model by making its primary parameters stochastic. Having performed this conversion it becomes an accessible venture to construct models with dependence, tail dependence, heavier tails as well as skewness. These models in turn have links with copulas. The example given here is of frailty models – where the survival times are conditionally independent – and its link with the Archimedean copula.

A definition of the most basic representation of mixture models is given in the presentation by McNeil (2007:4). Consider m (similar) risks events and define an indicator vector $\mathbf{Y} = (Y_1, \dots, Y_m)'$ where $Y_i = 1$ if the risk event is realised, otherwise $Y_i = 0$. It is assumed that some $p < m$ along with a p -dimensional random

vector where $\Psi = (\Psi_1, \dots, \Psi_p)'$. The indicator vector \mathbf{Y} then follows a Bernoulli mixture model with a factor vector Ψ if functions exist such that $p_i : \mathbb{R}^p \rightarrow (0,1)$ in order that, conditional on Ψ , the components of \mathbf{Y} are independent Bernoulli stochastic variables $P(Y_i = 1 | \Psi = \psi) = p_i(\psi)$.

McNeil (2007:5) illustrates an example of frailty models and how they link to the Archimedean copula. Define W to be a positive mixing variable where $P(W = 0) = 0$.

Let T_1, \dots, T_d be conditionally independent lifetimes such that (McNeil, 2007:10):

$$P(T_i > t | W = w) = S_i(t)^w$$

where $S_i(t)^w$ is a survival function.⁵ Note that W acts multiplicatively on the hazard function and the probability distribution is now obtained:

$$P(T_1 > t_1, \dots, T_d > t_d | W = w) = \prod_{i=1}^d S_i(t_i)^w$$

which is then equivalent to:

$$P(T_1 > t_1, \dots, T_d > t_d | W = w) = \exp(-w \sum_{i=1}^d -\log S_i(t_i))$$

The link with the Archimedean copula becomes clear when it assumed that ψ is the Laplace transform of the distribution function of W . The joint unconditional survival function is then given as:

$$F(t_1, \dots, t_d) = P(T_1 > t_1, \dots, T_d > t_d | W = w) = \psi\left(\sum_{i=1}^d -\log S_i(t_i)\right)$$

and the marginal survival functions are $F_i(t_i) = \psi(-\log S_i(t_i))$. It is then clear that:

$$F(t_1, \dots, t_d) = C(F_1(t_1), \dots, F_d(t_d))$$

$$C(u_1, \dots, u_d) = \psi(\psi^{-1}(u_1) + \dots + \psi^{-1}(u_d))$$

⁵ See Appendix A

4.3.5. The Banking Industry as Model Source

Enterprise Risk Management is a firmly-rooted practice in the banking industry. Its core components are the inspiration for ERM in the insurance industry, but especially its risk models are now receiving special attention from the insurance industry. These models present a starting point for developing insurance risk models. Taking this into account the difference between the industries as well as the products being sold has to be stipulated.

Venter (2006:2) states that the banking industry is mainly centred on standardisation whereas the insurance industry advocates highly unique approaches. It is also pointed out that bankers' main activity is financing, but insurers' main activity is risk.

Evidently insurers will require more detailed risk modelling along with thorough risk capturing. A proposal by Venter (2006:3) for improvement of banking models includes applying other risk measures and using substitutes for banking risk allocation and correlation definition. It is also discussed that tail-based risk measures like Tail VaR can be applied or the Wang transform. Unsurprisingly, copulas form the basis of correlation alteration. Models derived in the banking industry are centred on a sole risk measure, which is scaled with monetary units and then defined as *economic capital*.

Capital requirements and especially those for economic capital are an integral part of the criteria with which financial supervisory boards regulate financial institutions. These criteria receive further attention in the following section.

4.4. Economic Capital

4.4.1. Introduction

Economic capital provides greater precision to the risk management procedure. In essence it is a procedure where the risks faced by an organisation are quantified and then the capital needed to cover these risks is calculated. This provides the analyst with a more concise estimation of the real returns being made by business activities. Thus it is a useful tool when distinction needs to be made between various strategies and their potential future revenue generating abilities.

According to Scott (s.a.) firms make use of risk management systems that integrate economic capital due to four reasons. The first and foremost reason is to achieve a capital level which protects against (financial) predicaments as well as satisfies regulatory requirements. Another reason is to ascertain whether the management of risks is suitable and to determine if company policies concerning products are cost-efficient. The third reason is to guarantee that the firm is not over-capitalised. The final reason is to establish a framework where capital is applied in the most efficient fashion to generate the highest possible returns. Inside this framework, an assessment of future strategies and senior management decision processes is also evaluated.

The greatest hindrance is the difficulty in obtaining an optimal balance between the economic capital reserves and strategy funding. It is clear that regulatory requirements may be far too low with respect to a certain firm and its risk situation. On the other hand reserves which are unnecessarily high thwart business expansion and can do more harm than good.

4.4.2. An Economist's View

Gorge (2007:2), in a presentation on group risk management to the firm AXA, pointed out the high relevance of correct modelling approaches in connection with economic capital management. The tendency has existed that actuaries contrive statistical approaches heavily based on mathematical results without motivating these practices. Since this is very ineffective in the case of tail behaviour, it was urged in the presentation to concentrate on models as opposed to statistical approaches. These models should then also be closely tied to economic impressions and the causality implications. This means that amongst other factors market cycles and lapse rates ought to be incorporated in the modelling process.

It is constantly emphasised that economic capital must be *market consistent* in all respects. Gorge (2007:8) proposed that the risk horizon must be kept at one year to provide highly reasonable estimations of residual cash flows which are essential to the market consistency endeavour. This of course is an exigent task in particular for illiquid assets. Two further development areas are proposed; diversification at group level and measuring frictional costs in the case of price illiquidity.

4.4.3. Frictional Cost: an additional capital component

Frictional costs are losses written off by the equity holders of an organisation. They may include the transaction costs in raising equity capital, agency costs, financial distress costs, legal costs and additional taxation costs. A thorough understanding and manipulation of frictional costs is necessary since there is usually a balancing act between the firm's capital levels and the composition of frictional costs.

Capital might be the main instrument through which a firm conducts its business, but it is extensively regulated by some external author as well as scrutinised by another. Financial supervisory committees mostly determine the capital levels at which firms should operate and shareholders want to maximise long-term profitability. Often these two entities can cause opposing objectives within the firm, where the underlying part of any goal should actually be to achieve long-term solvency.

Chandra and Sherris (2005:2) developed a model to achieve an optimal long-term solvency based on earlier work of Estrella (*The cyclical behaviour of optimal bank capital, 2003*). This model attempts to obtain an optimal capital management stratagem such that frictional costs are at a minimum. This model is considered for a single as well as a multi-period case and is mainly founded on a VaR principle. As evident from the Estrella title, the banking industry was once again the source to develop the insurance model as modelled by Chandra and Sherris (2005:2).

Estrella (2003:2) along with Chandra and Sherris identify the same three components of capital costs. The first component is the cost of holding capital. There are two sides to this instance. On the one hand high levels of capital mean that the firm is loading the premium on their product with a significant amount for capital accumulation which might in turn lead to increased levels of agency costs. On the other hand low capital levels lead to financial distress costs which are also the second component of capital costs. These costs especially refer to the costs associated with the bankruptcy and liquidation processes. The third component is adjustment costs which lend a time dimension to the model since it is then possible to integrate when capital is being raised or shed. In the single-period model this component is left out for the reason that the capital costs are calculated for a single occasion and it will thus not be necessary to raise or shed capital to meet optimal capital levels.

The objective is realised by developing a function of these three components and then minimising it. The definition by Estrella (2003:7) of what exactly capital costs are has specific repercussions. Capital costs are not considered as the so-called *nominal return on capital* but the residual costs of equity funding. There is a similarity between the latter author's treatment of the capital requirements by external supervisory bodies and that of Chandra and Sherris (2005:28). Both solve the capital cost function first for capital requirements and then for pure minimisation. The level of capital which is equal to the more severe of the two results is then held by the firm.

4.4.4. Frictional Cost: Modelling Implications

Recall that Estrella (2003:4) developed a model for frictional costs in the banking industry which was referenced and then altered by Chandra and Sherris (2005:12) to accommodate the nature of the insurance industry. As the latter authors did, the model of Estrella (2003:5) will serve as introductory base in this dissertation. The notation of this model is, however, simplified for uniformity purposes.

Estrella (2003:5) expresses a model for the balance sheet of a firm in the banking sector with the following equation:

$$F_t + V_t = D_t + I_t$$

The variables in the equation are representative of the value of safe assets F_t , the value of risky assets V_t , value of deposits D_t and the value of initial capital I_t . The variable I_t is considered to be the sum of two capital sources; namely those of capital carried over from the previous period K_t and an amount raised from external sources R_t . The bank's income statement over any period of time where returns r_t^X on the various components are realised is then redefined as:

$$r_t^F F_t + r_t^V V_t + R_t = r_t^D D_t + \Delta K_t$$

Estrella (2003) defines the bank's losses to be the negative value of net income or profits:

$$L_t = r_t^D D_t - r_t^F F_t - r_t^V V_t$$

The final equation necessary for the model derivation is the expression for the capital situation at the end of a single period. This is given by:

$$K_t = K_{t-1} + R_t - L_t$$

Chandra and Sherris (2005:12) make use of the symbol (\sim) to indicative random variables and time subscripts along with a superscript (+) to indicate values at the end of the time period and a double time subscript suggests the passing of time over the period. The latter authors then improve on the previous model by adding another term A_t which denotes the total premium income that insurers will have in their line of business and serves as the embodiment of the firm's assets. The assets are assumed to be invested in some portfolio which will then yield a (rate of) return of $r_{t,t+1}^A$. In the case of the insurance industry the liabilities are simply defined as the provision for outstanding claims, premiums to be received (unearned as of yet) and naturally the equity capital.

Taking account of this background, the role of the firm's management now comes into play. The management need to attain the perfect balance between capital retained and capital used. When capital is increased, the frictional costs rise since associated factors will increase as well – e.g. agency costs can become a significant expense. On the other hand, a decrease in capital will cause the expected financial distress cost to augment. Clearly this trade-off of capital structure has a weighty impact on the firm's running costs and therefore profitability as well. With regards to the model notation this decision process is expressed as follows:

$$R_t > 0 \quad \therefore \text{new shares issued to raise capital}$$

$$R_t < 0 \quad \therefore \text{dividends payed to shed capital}$$

Chandra and Sherris (2005:14) now express their model by the equation:

$$\tilde{K}_t^+ = K_t + R_t + A_t(1 + r_{t,t+1}^A) - \tilde{L}_t^+$$

The authors then include a proportional value to indicate frictional cost of capital with a constant – c_c . They then continue to define frictional cost as the value:

$$C_c = \max(c_c \tilde{K}_t^+, 0)$$

This means that even though the proportional concept of frictional cost of capital is a constant the actual value is stochastic since \tilde{K}_t^+ is stochastic. The next step is to minimise

these costs which is achieved by minimising the overall expected costs. This procedure is given by the following equation (Chandra *et al*, 2005:14):

$$E_t(C_c) = c_c \int_0^{K_t + R_t + A_t(1 + r_{t,t+1}^A)} (K_t + R_t + A_t(1 + r_{t,t+1}^A) - \tilde{L}_t^+) f(\tilde{L}_t^+) d\tilde{L}_t^+$$

In this equation the function $f(\tilde{L}_t^+)$ denotes the probability density function of \tilde{L}_t^+ . Note that the previous minimisation procedure is an exclusive representation for minimising frictional cost of capital (not *frictional costs* as a whole). The next procedure addresses the problem of minimising the cost of financial distress.

The costs of financial distress might consist of legal fees, administration costs, the expenditure arising from a liquidation process or even ill-defined costs such as losses in franchise value or future profitability. The cost of financial distress is defined in a similar manner to that of frictional cost of capital. Financial distress cost (c_f) is first viewed as a fixed proportion of the end-of-period capital ($c_c \tilde{K}_t^+$), though the actual value is given stochastic properties:

$$C_f = \max(-c_f \tilde{K}_t^+, 0)$$

where $c_f \geq 0$. The expected value of the cost of financial distress is given as:

$$E_t(C_f) = -c_f \int_{K_t + R_t + A_t(1 + r_{t,t+1}^A)}^{\infty} (K_t + R_t + A_t(1 + r_{t,t+1}^A) - \tilde{L}_t^+) f(\tilde{L}_t^+) d\tilde{L}_t^+$$

Chandra and Sherris (2005:15) then describe *frictional cost* as the expected value of the sum of the frictional cost of capital and the cost of financial distress which is subject to a minimisation procedure:

$$\min_{R_t} E_t(C_c + C_f)$$

According to the preceding equations, it follows that (Chandra *et al*, 2005:15):

$$C = E_t(C_c + C_f)$$

$$= c_c \left\{ \int_0^{K_t+R_t+A_t(1+r_{t,t+1}^A)} (K_t + R_t + A_t(1 + r_{t,t+1}^A) - \bar{L}_t^+) f(\bar{L}_t^+) d\bar{L}_t^+ \right\}$$

$$- c_f \left\{ \int_{K_t+R_t+A_t(1+r_{t,t+1}^A)}^{\infty} (K_t + R_t + A_t(1 + r_{t,t+1}^A) - \bar{L}_t^+) f(\bar{L}_t^+) d\bar{L}_t^+ \right\}$$

This is then rearranged into the following differentiable equation:

$$C = c_c \left\{ \int_0^{K_t+R_t+A_t(1+r_{t,t+1}^A)} (K_t + R_t + A_t(1 + r_{t,t+1}^A) - \bar{L}_t^+) f(\bar{L}_t^+) d\bar{L}_t^+ \right\}$$

$$- c_f \left\{ \int_0^{\infty} (K_t + R_t + A_t(1 + r_{t,t+1}^A) - \bar{L}_t^+) f(\bar{L}_t^+) d\bar{L}_t^+ \right.$$

$$\left. - \int_0^{K_t+R_t+A_t(1+r_{t,t+1}^A)} (K_t + R_t + A_t(1 + r_{t,t+1}^A) - \bar{L}_t^+) f(\bar{L}_t^+) d\bar{L}_t^+ \right\}$$

Chandra and Sherris (2005:15) derive the function C with respect to R_t and equate the result to zero:

$$\frac{\partial C}{\partial R_t} = 0 = c_c \left\{ \int_0^{K_t + R_t + A_t(1 + r_{t,t+1}^A)} f(\tilde{L}_t^+) d\tilde{L}_t^+ \right\} - c_f \left\{ \int_0^\infty f(\tilde{L}_t^+) d\tilde{L}_t^+ - \int_0^{K_t + R_t + A_t(1 + r_{t,t+1}^A)} f(\tilde{L}_t^+) d\tilde{L}_t^+ \right\}$$

By making use of probability theory, it is easy to obtain the following equation:

$$\begin{aligned} c_c \left[1 - \Pr(\tilde{L}_t^+ > K_t + R_t + A_t(1 + r_{t,t+1}^A)) \right] &= c_f \left[1 - \Pr(\tilde{L}_t^+ \leq K_t + R_t + A_t(1 + r_{t,t+1}^A)) \right] \\ \Leftrightarrow \frac{1}{\Pr(\tilde{L}_t^+ > K_t + R_t + A_t(1 + r_{t,t+1}^A))} - 1 &= \frac{c_f}{c_c} \\ \Leftrightarrow \Pr(K_t + R_t + A_t(1 + r_{t,t+1}^A) - \tilde{L}_t^+ \leq 0) &= \frac{c_c}{c_c + c_f} \end{aligned}$$

The function $F_{\tilde{L}_t^+}(x)$ is defined as the cumulative distribution function of \tilde{L}_t^+ and therefore it is now possible to obtain the capital level of R_t where it is at an optimum R_t^* :

$$R_t^* = F_{\tilde{L}_t^+}^{-1} \left(1 - \frac{c_c}{c_c + c_f} \right) - K_t - A_t(1 + r_{t,t+1}^A)$$

where $F_{\tilde{L}_t^+}^{-1}$ is simply the inverse of the cumulative distribution function.

A multi-period case is also inspected by Chandra and Sherris (2005:19), but not presented here since the mathematics has no radically different implementation to the illustrated single-period model.

4.4.5. Diversification

The driving force behind the merit of diversification is obvious and uncontested: the risk associated with a firm's collective portfolios is less than the sum of the risk associated with the individual portfolios. Medina (2007:4) believes that diversification becomes beneficial to a firm when it leads to the firm holding less capital. From the previous subsection the motivation for this is clear to a certain extent since it involves lower costs of holding capital. Market consistency plays a big role in the overall efficiency of

diversification because the concomitant causal models are more accurate approximations of probable market mechanisms and allow for greater flexibility.

Medina (2007:7) indicates, however, that diversification may not always be economically beneficial to groups due to legal difficulties in moving capital or capital being fixed to certain units. Wang (2007:8) delves deeper into this diversification at group level and specifically calls for diversification at four levels. These four levels of diversification are in strict reference to the framework prepared by the CRO Forum – Chief Risk Officer Forum (Grondin, 2005:20-21).

The first level is diversification within the different risk types. The next level is as expected diversification across the different risk types. At the third level diversification across different business enterprises is necessary though contained within the same geographical disposition. The fourth level is an expansion of the third where diversification is now allowed to be induced over a variety of geographical locations and jurisdictions.

Some of the key findings of the CRO Forum as stipulated by Wang (2007:10) include the fact that disregard of diversification measures may lead to significant losses. A second finding that most regulatory assessments do not take account for diversification performed by firms is a new key theme in supervisory structures. There is also the incentive to recognise the movement of capital among units.

In response to these key findings the CRO Forum proposed the use of solvency tests, both as *Solo Entity* and at *Group Level*. These solvency tests must account for the effects of diversification, risk transfer and capital assistance provided by the individual companies within a group as well as distinguishes these effects and repercussions at the group level.

4.5. Value Creation

4.5.1. Introduction

Value creation is probably the most important goal of risk mitigation. In many instances a firm can create value for the shareholders by hedging the identified risks at little or no extra cost. This section investigates the theory of value creation in general and then discusses a specific case of value creation with the reduction of portfolio parameters.

4.5.2. The essence of ERM

The paper by Gorvett and Nambiar (2006:2) look into the endeavour of value creation. The instigation of viewing risk management as an instrument for value creation is to consider the true nature of risk management as that of a *financing* strategy.

For this purpose the Capital Structure Irrelevance Hypothesis of Modigliani and Miller is also taken into account. This hypothesis first assumes that for any firm both tax effects and bankruptcy costs are ignored whilst capital investment remains unchanged; it then states that the financial structure of the firm is irrelevant to the value of the firm. Obviously a breach of any or all of these assumptions implies that risk management will influence the firm's value.

Although it is not the outright objective of ERM to violate these assumptions the natural operation of an ERM framework flows into a limitless perspective and therefore implies that the assumptions of the irrelevance hypothesis are disregarded. For this reason risk management – as an underlying part of ERM – can be applied to move beyond risk mitigation towards value creation by exploiting the risks at hand.

At the same time other firm considerations which are essential to business operations can be addressed; especially those of regulatory requirements (chapter four) and information transparency throughout the firm.

Direct benefits with respect to value creation include the reduction of costs which originate from the risk management process along with a higher probability of achieving the firm's financial objectives. Indirect benefits of the value creation approach are closely linked with the benefits of setting up a PMO (subsection 3.2.4.); a highly enhanced holistic risk management methodology and enterprise-wide risk communication.

4.5.3. Reducing β for Value Creation

Gold (2006:2) discusses a specific example of value creation through risk mitigation with respect to the CAPM parameter of β – which denotes systemic risk in the CAPM methodology.

This methodology is characterised by the use of concave utility functions which embody the firm's risk aversion. Therefore, making use of *convex penalty functions* produces a

result that makes the firm's decision consistent with their risk aversion. Even though we assume that utility functions are concave over their entire area, Gold (2006:2) points out that this is not the case with the convexity of penalty functions. When a firm has limited liability the penalty function will at one stage reach an inflection point and the remainder of the function will be concave since the firm has lost all the value it possibly can.

Var^{uh} and Var^h represent the project variance of the unhedged and the hedged portfolios, σ_m^2 is the variance of the market portfolio and ρ_{pm} is the correlation coefficient between the market and the project portfolios. Gold (2006:4) hedges the systemic risk to minimise the cost of retained risk by considering a project portfolio with an investment value of \$1MM, a variance of σ_p^2 and $\beta = b$. The portfolio is hedged by shorting \$cMM of the market portfolio. The objective is to find a value of c for which the variance of the firm's portfolio is minimised. It is given that:

$$Var^{uh} = \sigma_p^2 \quad \text{and} \quad Var^h = \sigma_p^2 + c^2\sigma_m^2 - 2c\rho_{pm}\sigma_p\sigma_m$$

Taking into account that $\rho_{pm} = b \frac{\sigma_m}{\sigma_p}$, it then follows:

$$Var^h = \sigma_p^2 + c^2\sigma_m^2 - 2cb\sigma_m^2$$

$$\frac{\partial Var^h}{\partial c} = 2c\sigma_m^2 - 2b\sigma_m^2$$

$$\frac{\partial^2 Var^h}{\partial c^2} = 2\sigma_m^2 > 0$$

$$\frac{\partial Var^h}{\partial c} = 0 \quad \text{when} \quad c = b$$

The implication of this is that a minimum variance will be achieved when the firm shorts its own β . It was assumed that the firm possess positive β ; in the rare cases where the β are negative the firm should hedge by acquiring β . Whatever transaction is required by the nature of the firm, it will gain by diminishing the costs associated with the risk penalty.

4.6. Operational Risk

4.6.1. Introduction

This last on operational risk was postponed in order for the reader to acquire the ERM perspective concerning risk identification, measurement and modelling. This section draws on all these elements. The special treatment of operational risk is necessary due to the fact of the increasing occurrence of business failures from operational risk and its complex nature. The section delves into the identification and evaluation of operational risk and then focuses on the related modelling procedures.

4.6.2. Delineating Operational Risk

The Federal Deposit Insurance Corporation (FDIC) is a government entity that provides deposit insurance to the banking industry in the United States of America. One of their recent developments in operational risk is a set of guidelines conceived (FDIC, 2003:5) to address the prerequisites of the Basel II-Accord. In these guidelines operational risk is defined as the risk of losses arising from unsuccessful internal methodologies, employees or system operations or from external risk sources.

This definition seems vague, but it thereby encompasses a wide variety of possible loss events. Seven events are indicated which presents further elucidation to the operational risk concept. The first two events account for fraud; whether it is of an internal or external nature. For this case fraud is described as the efforts to ‘defraud, misappropriate property or circumvent regulations’. The third event concerns employee practices and safety in the workplace. The events that can occur under this specification are greatly diverse with instances ranging from working conditions which are unsuitable for personal health, to discrimination acts. The fourth event incorporates all types of losses that may arise due to business operations. This includes problematic clients, defective products or simply poor business practices; more often than not these events occur because of employee negligence. The fifth and sixth events cover disruptions of business operations; albeit damage to physical assets of the firm, trading disruptions or system failures. The seventh event is actually a specialisation form of events four through six. It calls for proper process management, i.e. maintaining good relations with all the parties involved and successfully completing all transactions at hand.

Summarising these event components, operational risk can be seen as risk associated with people, processes, systems and external factors. The FDIC (2003:6) also points out several key aspects that aggravate the occurrence of operational risk: inadequate employee instruction, poor control measures in the workplace and incomplete business mapping. Probably the most recent addition to these risk factors in international terms is the losses arising from acts of terrorism and perhaps hitting closer to home, vandalism. Fields where operational risk might materialise or escalate in the future could be the development of new and more complex products, higher automation in transaction processing and untried risk management techniques.

4.6.3. Risk Identification: The Delphi Method

McGrath (2007:2) proposes to use a technique for reaching consensus within a group, called the Delphi method. This method consists of providing a panel of subject experts with some questionnaire which they repeatedly complete as the responses of other panel members are revealed to them in order to attain a type of convergence of estimations.

Naturally this seems like a highly risky method, but according to Furlis (as referenced by McGrath, 2007:8) this method may be more suitable than the traditional estimation methods. Three features are proposed to enhance the accuracy of the Delphi method. The first feature is anonymity of the panel member from each other – identification of panel members should be avoided. The second feature is to control the feedback – responses must have a degree of uniformity. The third feature is the incorporation of a statistical element to the panel where the responses are weighted to recognise specialist knowledge or experience.

McGrath (2007:9) makes use of a central researcher to interview the panel members prior to the compilation of the questionnaire not only to assess the current risk management situation and personal perspectives, but also to create a questionnaire that covers all possible areas of risk management. The survey itself should basically comprise of questions which centre on the severity, probability and current mitigation of risk realisation. Panel members must also indicate which risks in their personal opinion are not valid or that they could not assess at all.

Once the risk management team has an idea of the nature of the risk they are dealing with and how to assess and evaluate it, the next step in the mitigation of operational risk is to model the risks incurred.

4.6.4. Modelling Operational Risk

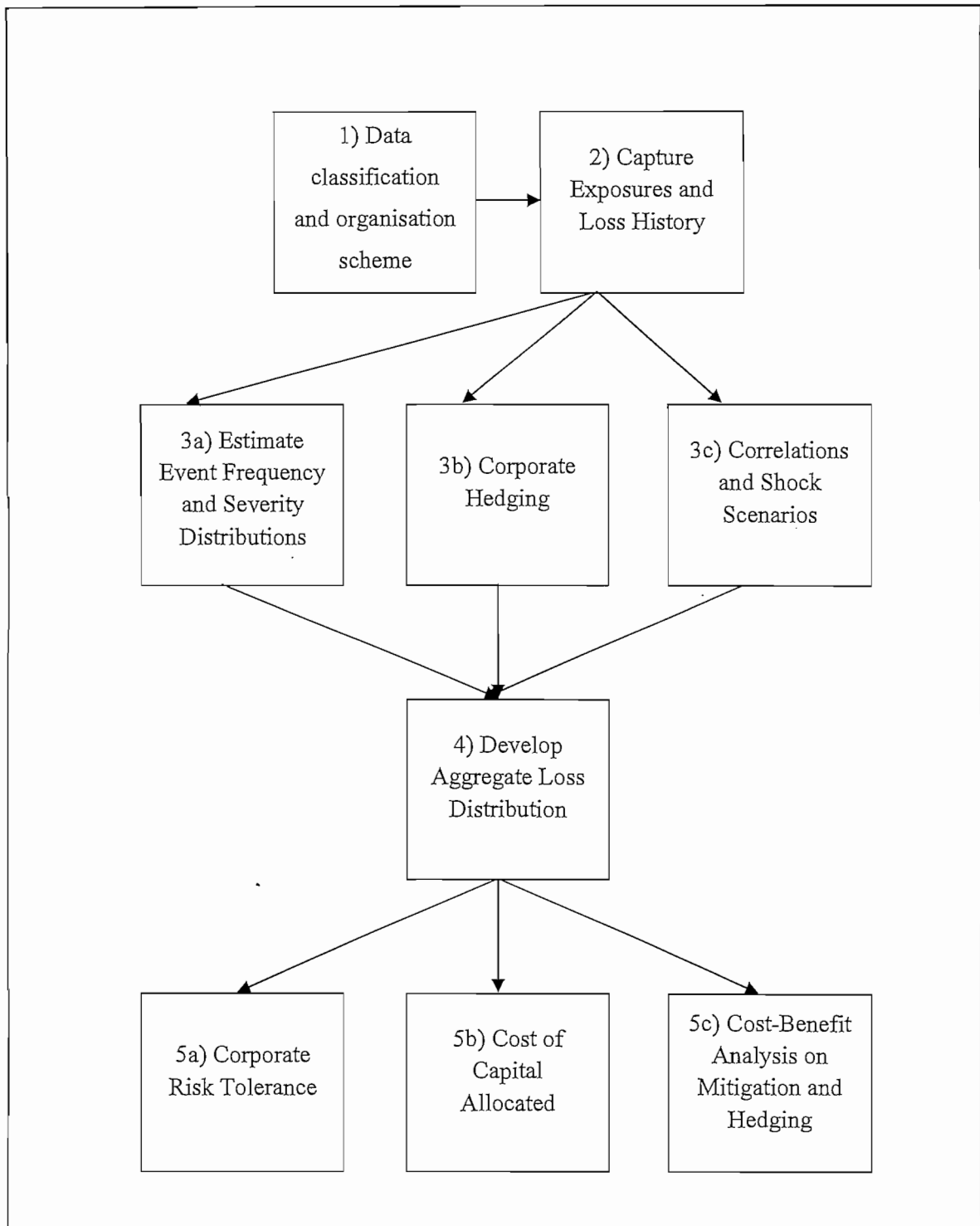
A detailed framework for the internal modelling of operational risk is presented by Mango (2006:9) and is summarised in figure 4.2.

In the first step the risk management team collects all the necessary data; i.e. they obtain sufficient information to construct frequency and severity distributions. This flows naturally into the second step where the current exposures are measured and the team reviews the loss history.

The third step involves completing three integrated parts. The first and most complex part is the actual estimation of the frequency and severity distributions. The expertise and experience necessary for the fitting of curves calls for substantial specialisation in this field. The second part is the requirement to accurately indicate the effect corporate hedging practices have on the mitigation endeavour. The last part is another troublesome procedure involving the interrelationships that exist among risks and the effects they cause. Determining correlations among the risk sources prior to realisation is usually a helpful approximation to the risk relationships. Shock scenarios are equally hard to construct since all possible risk realisations can never be suspected beforehand. The best way to apply shock scenarios is to make use of definitions and requirements as set out by regulatory bodies.

The fourth step is the accumulation of all the inspected losses into a single distribution. Details of these models are not presented, but the actuarial approach of *convolution* is proposed by Mango (2006:10) who refers to Wang (1998:848) for aggregate distribution models. (See next subsection.)

Figure 4.2. Internal Risk Modelling



Source: Mango (2006:9)

The fifth step in internal risk modelling also consists of three integrated parts. The first part of corporate risk tolerance is actually present throughout all the previous steps since it determines the firm's response mechanism for risk management and therefore its attitude towards risks. The response mechanism must quantify the impact of the aggregated risks, allocate the specific costs with the associated risks and finally ascribe the costs back to the original risk sources; this forms the second part of this modelling step. The final part is a result calculated from the previous parts to establish whether economic value was added by the modelling process.

This provides a clear framework for internal risk modelling and the concomitant decision making, but a specific more tangible approach is needed to answer the questions arising from the construction of aggregate loss distributions.

4.6.5. Aggregate Distributions: Convolutions

The methodology proposed by Wang (1998:853) to aggregate distributions making use of convolutions requires an introduction and explanation of the *Fast Fourier Transform* – FFT – as well as the step-by-step aggregation procedure.

The first part is to present an understanding of fast Fourier transform. These transforms are the mapping of n points onto n points. Keep in mind from the theory of complex numbers that $i = \sqrt{-1}$ and that $e^{iz} = \cos(z) + i\sin(z)$. Then, for any n -point vector $(f_0, f_1, \dots, f_{n-1})$ the fast Fourier transform is given by (Wang, 1998:853):

$$\text{FFT: } \mathbf{f} = [f_0, f_1, \dots, f_{n-1}] \rightarrow \tilde{\mathbf{f}} = [\tilde{f}_0, \tilde{f}_1, \dots, \tilde{f}_{n-1}]$$

The single elements of \tilde{f}_k are defined as:

$$\tilde{f}_k = \sum_{j=0}^{n-1} f_j \exp\left(\frac{2\pi i}{n} jk\right)$$

where $k = 0, 1, \dots, n - 1$. It is also possible to obtain an inverse mapping – IFFT – of the n points:

$$f_j = \frac{1}{n} \sum_{k=0}^{n-1} \tilde{f}_k \exp\left(-\frac{2\pi i}{n} kj\right)$$

where $j = 0, 1, \dots, n - 1$. The matrix representation of the mapping function is given below:

$$\tilde{\mathbf{f}} = \mathbf{W}\mathbf{f} = \begin{pmatrix} 1 & 1 & 1 & \dots & 1 \\ 1 & \omega & \omega^2 & \dots & \omega^{(n-1)} \\ 1 & \omega^2 & \omega^4 & \dots & \omega^{2(n-1)} \\ \vdots & \vdots & \vdots & \vdots & \vdots \\ 1 & \omega^{(n-1)} & \omega^{2(n-1)} & \dots & \omega^{(n-1)^2} \end{pmatrix} \mathbf{f}$$

where $\omega = \exp(2\pi i/n)$. Wang (1998:912) gives a lengthy discussion on how to improve calculation speed of these transform by enlarging the vectors (and thus matrix) through zeros added after the principal elements.

The FFT can be considered as a discrete version of the continuous Fourier transform which maps a continuous probability density function onto a continuous density function containing complex numbers.

Given the FFT introduction, the next part is the definition of what exactly a convolution is. Define N and K to be two discrete independent stochastic variables (i.e. risks) and J as the sum of these two variables (i.e. aggregated risk). The probability distribution of J then signifies the *convolution* of the probability distributions of N and K and is given by (Wang, 1998:857):

$$\Pr \{J = j\} = \sum_{n=0}^j \Pr \{N = n\} \Pr \{K = j - n\}$$

where $j = 0, 1, \dots$. Even though it is possible to define the convolution in terms of a probability generating function, the convolution by FFT is considered here.

Remember that it holds true for characteristic functions that they *always* exist (in contrast to moment generating functions) and the characteristic function of a sum of independent variables is merely the product of the characteristic functions of the individual variables.

Wang (1998:858) warns that the addition of extra zeros to the vectors now becomes an indispensable modification. The reason for this is that when there is not sufficient 'space' left in the vector the tail probabilities will wrap around the vector and appear at the front.

From this it follows that the characteristic function is given by:

$$\begin{aligned}\phi_{N+K}(t) &= \mathbb{E}[e^{it(N+K)}] = \mathbb{E}[e^{itN} \cdot e^{itK}] \\ &= \mathbb{E}[e^{itN}] \mathbb{E}[e^{itK}] = \phi_N(t) \phi_K(t)\end{aligned}$$

All the previous information is summarised by Wang (1998:859) in the subsequent FFT algorithm.

Let $\mathbf{f} = [f_0, f_1, \dots, f_{m-1}]$ and $\mathbf{g} = [g_0, g_1, \dots, g_{k-1}]$ represent two independent probability vectors, to obtain their convolution proceed as follows:

- (1) Add zeros to the two vectors such that each is of the length $n \geq m + k$.
- (2) Apply the FFT function to each of the vectors to obtain the functions $\tilde{\mathbf{f}} = \text{FFT}(\mathbf{f})$ and $\tilde{\mathbf{g}} = \text{FFT}(\mathbf{g})$.
- (3) Calculate the product of the two vectors: $\tilde{\mathbf{h}} = \tilde{\mathbf{f}} \cdot \tilde{\mathbf{g}}$.
- (4) Apply an IFFT to $\tilde{\mathbf{h}}$ to obtain a probability vector which is the convolution of \mathbf{f} and \mathbf{g} .

Projection of this algorithm is completed trouble-free by simply making use of more independent variables to account for the more complex scenario of various loss variables. The case inspected by Wang (1998:851), however, is where a single variable is used as a sum of the probable sum losses incurred, but follows the same steps as the algorithm given.

This chapter has enabled the reader to move from simply *understanding* ERM to truly *using* ERM. With a grasp of ERM culture within a firm it is possible to organise a risk team which effectively measures risks, models the probabilities of these risk and then either opts for mitigating the risks or exploiting them to achieve value creation for the firm.

That being said, the ERM endeavour is not restricted to the internal operations of a firm. External parties such as supervisory and regulatory bodies not only encourage the use of ERM, but are now starting to explicitly require its implementation. This fine balance of encouraging and regulating ERM is discussed in the following chapter where the functions and constraints of supervisory and regulatory bodies are presented.

5. A Regulatory Framework

5.1. Introduction

As stated before, chapter two discussed the appropriate tools to become a financial organisation making full use of ERM, but naturally all developments and procedures need to adhere to a certain set of rules – a regulatory framework. Performing regulatory services of financial institutions is a necessary function for various reasons. These may include simply applying the laws of the country within which the organisation is operating, to induce fair competitive market conduct, but above all to instil confidence in the financial system as a whole.

The compilation of a regulatory framework can be completed by a government department or an independent entity. The strict application of the prescribed practices, however, is mostly conducted by government entities. A by-product of the regulation procedure – which also serves an incentive – is the prevalence of a rating system. The rating system at first glance is indicative of the company's financial performance, but much more information is contained in the rating a company obtains.

5.2. Financial Regulation in an ERM Context

5.2.1. Introduction

Hiemstra (2007:3) delivers a comprehensive overview of financial regulation within an ERM perspective. Even though financial security and wellbeing is the first and foremost goal of financial regulation, information is the first product obtained from a regulatory procedure. This information usually takes on the form of a comparison of regulated firms concerning market competition, their risk management endeavours, compliance with legislation and requirements and the firm's financial performance.

The volatility of a firm's proceeds can be significantly reduced with an effective ERM system in place. Supervisors therefore attempt to encourage firms to focus on ERM through various means. One of the incentives includes ERM assessments to verify the sensitivity of business strategies to developments in risk factors.

Another incentive is to support firms in their creation of internal models with the aid of detailed loss data. It is stressed that the senior management and risk management personnel are the key individuals in the promotion and anchoring of an ERM framework.

5.2.2. New Perspectives, Old Methods

Whether the supervisors have government support or are an independent organisation, the methods of financial supervision remain the same. Supervisory bodies will ensure that a country's laws with regards to the financial sector are not broken. This will mainly consist of monitoring the firm on-site and off-site, requiring financial statements to be published, obliging the firm to maintain adequate levels of capital and reserves and in more severe situations administering the insurance funds themselves or imposing sanctions on the firm's personnel. The maintenance of appropriate capital levels is an important underlying factor for a favourable supervisory assessment and this receives more attention in section 5.5.

The dichotomy of the ERM parties becomes apparent when Hiemstra (2007:4) distinguishes between *supervisory* ERM and *firm* ERM. Supervisory ERM is the much broader aspect of risk management where the supervisors are concerned with both probability and loss, whereas stakeholders of the firm with a concern for firm ERM are usually only concerned with probabilities. The parties involved in a firm will only have singular considerations of the losses incurred; absolute investments amounts, debt obligations, employment. The regulators of a financial entity such as an insurance firm have a wider perspective on the loss event and take account of resulting risks as well. Supervisors' response considers the possibility of harmful effects on local economies, reduction of the provincial (or national) tax base and even intensification of community pressures.

Hiemstra (2007:5) develops the basic idea of Coase that the efficiency of a firm's operations determines whether it is a buyer or seller by suggesting that the value of ERM to a firm is a function of the market competition it validates. This perception connects with the goals of supervisors because they will thus be promoting ERM when they promote market competition. The next step for supervisors is then to advocate market competition.

Regulation can provide a natural origin for market competition by reviewing entry conditions to the market of new firms. Other modifications may be to fortify governance culture within the firm, but also – as mentioned earlier – to allow for greater vertical and horizontal communication. Transparency is definitely an immense feature of proficient market competition and it can refer to financial statements being made available to the public or increased independence of the different departments involved in the risk management procedure.

5.2.3. Supervisory Obstacles: the Peak Load Problem

All the goals seem to be achievable and the proposed methodologies applicable, but unfortunately the supervisory process is one with constant feedback and revision. A supervisory body may have identified a problem and decided on an appropriate response, but timing remains a crucial factor with the combination of objective and subjective judgement further complicating the decision-making process. An obstacle with particular time interaction is the peak load problem.

The empirical results in Hiemstra (2007:7) show that loss events tend to cluster together in short periods of time. The problem of uncertainty concerning peak load events is further intensified by the fact that management will not have perfect knowledge of their business and even less of future events. The two decisive matters are that average loss data do not give a true representation of the loss events and the probability of future loss events is not constant.

Another obstacle that originates from the peak load problem is the inconsistency between the short-term objective of probability and the long-term objective of solvency. A firm is interested in variable costs in a short-term perspective which implies taking account of short-term risks such as credit and market risks. For a long-term perspective the firm takes note of fixed costs along with operational and strategic risks. On the basis of diminishing marginal returns, firms pass on the (variable) costs associated with credit and market risks. Since the pricing of fixed costs is arbitrary, an inconsistency arises when the fixed costs associated with operational risks are not passed on.

Three attributes of the peak load problem give a better definition, if not a sense of tangibility, to the solution of clustered events. The first of these attributes is the fact that systemic events coerce the peak load problem. Since systemic events are clustered they are highly distinctive and cannot possibly be normally distributed or have regular tail behaviour. Precision in estimation becomes a very relative subject. The second attribute links with the first in view of the fact that the same clustering systemic events cause a significant level of correlation. This attribute puts great strain on the modelling procedures which assume stochastic distribution of the period. The third attribute is the failure of credit development that occurs due to systemic events and credit developments effect ratings. When a firm does not anticipate rating downgrades in the appropriate way the risk management process is undermined in several ways. Strategic planning, along with capital allocation, must have a very clear perception of how the firm's ratings might change over time.

5.2.4. Methodologies when Implementing ERM

A number of methods to implement ERM in the supervisory sense have already been cited in the first section, but before this process can commence the starting point needs to be redefined. Two areas of conflict which need to be harangued are identified by Hiemstra (2007:20): ERM is a new and vague approach for many supervisors and supervisors shouldn't be testing the *presence* of ERM in firms but the *quality* of the ERM already in place. The solutions proposed to eradicate the problems include the previously mentioned on-site and off-site assessments and the new feature of regulatory intervention.

An on-site assessment is one which principally consists of an examination. This examination can be a periodic occurrence but should preferably be an ongoing process. This inspection will check on a firm's historical data – especially accounting information – and analyse the condition of the equipment, property and the relationships and expertise of personnel associated with the firm's business operations. For this examination a supervisory body will make use of a bottom-up approach. With the supervisors/examiners having specialised in different risks the focus will be magnified on all the separate risks that a firm faces. A special function the supervisors need to keep in mind is to provide a forward-looking analysis of the firm. This is necessary because anticipation is the key idea; otherwise lagged reports by the regulatory committees will

lead to lagged responses by the firm's management, finally resulting in accrued losses. The outcome of this kind of assessment should be to develop certain expectations concerning the expertise of senior management but it should also include a greater sense of team work. Naturally expertise throughout the organisation can only be improved when there is an improvement in data collection and analysis.

The subsequent off-site analysis consists of producing financial and economic analyses with their concomitant models. Where the on-site analysis will ask 'who', the off-site analysis asks 'how much'. This question of 'how much' can be translated into an analysis of concentrations. The various concentrations – particularly those of resources – that exist in the firm could be indicative of developing problems. The allocation quantities of staff, funds and equipment among other things must justify the benefits obtained from the allocation. Hiemstra (2007:23) explains that a deeper understanding of the concentrations within the firm offers deeper understanding of the nature of risk events that threaten solvency. This is without doubt the case with operational risk. When efforts are temporarily concentrated in areas – thus diluting the operational risk undertaking – the problem will only escalate. Off-site assessment proves worthy in such situations due to the fact that it forms a *filler* to the on-site analysis by including external information and views of comparison.

Regulatory intervention can be used for a pre-emptive strike, but it also serves a purpose in the rectification of regulation violations. An earlier idea appears as part of regulation intervention: promoting competition means promoting ERM. The easiest way to do this is the removal of obstructions to market entry.

An additional possibility includes taking control of firms that do not meet the requirements or are already classified as insolvent. The value of competitive markets and firms forms a part of the original Basel agreement (Basel Committee, 2006:211) too. In this agreement it is noted that a basic standard for capital reserves can reduce the credit cycles that cause insolvency.

5.3. The FSA's functions as blueprint for financial regulation

5.3.1. Introduction

The Financial Services Authority is a financial supervisory entity based in the United Kingdom. It is an entity independent of government functions and regulates all financial services provided in that country, clearly encompassing insurance functions as well. The organisation has some judicial power now since it replaced certain legislation tasks. After the collapse of self-regulation by financial institutions, the FSA was born from a desire to have greater centralised control of the financial system. The FSA reports to the Treasury Ministers in the UK and through them to the British Parliament. The only funding source the FSA has is the income it receives by issuing fines, fees and levies to the organisations regulated by the FSA.

Since the actuarial profession in South Africa is closely associated with practices in the UK, the FSA is also taken as a vital source for supervisory practices. In this section there is constant reference to the FSA and it should actually be viewed as the embodiment and manifestation of any financial supervisory authority. It is presented in here in the light of an exemplary form of financial supervision as a whole.

5.3.2. Objectives and Principles

The objectives and regulation principles as set out by the FSA can be found on their website. The objectives (FSA.a, 2008) include instigating markets with fair and orderly trade, assisting consumers to realising a reasonable purchase, advancing business operations of the financial system.

Principles (FSA.b, 2008) identified are constructed around six basic concepts. Economic efficiency is the first principle where the FSA cites that a firm's resources should be allocated in an optimal fashion and reports concerning the final allocation be submitted to the Treasury. The second principle emphasises the role of management within the firm. This is a very significant principle since it shields the firm from unnecessary interference by the regulatory authority, but in turn holds the senior management responsible for making decisions regarding risk management. The subsequent principle calls for a certain amount of proportionality to exist between the limitations introduced and the

results they achieve. Concession for innovation is the fourth principle. Innovative new products and methodologies should not hinder the business' regulation process. In context of the ever-present globalisation the fifth principle highlights the competitive position that the FSA wishes the financial services in the UK should take. Co-operation with foreign regulatory bodies also features in this endeavour. The final principle has market competition as its starting point. The FSA subjects itself to monitoring by other entities such as the Treasury of the UK since the restrictions imposed by the FSA may have significant effects on business entry and expansion in the financial markets.

5.3.3. The Regulation Process

The regulation process used by the FSA is defined in the online handbook (FSA.c, 2008). The FSA makes use of a *risk-based* approach to supervision. This 'risk' refers to any risks that hamper the FSA from achieving its objectives as stipulated in the previous section. It means that the approach is a marriage of the supervisory results of the regulatory body and the risk mitigation responsiveness of the financial service provider being regulated.

The first step in the regulatory effort is to conduct an impact and probability assessment. The impact-component especially refers to the consequential factors of risk with reference to the objectives proposed. It thus entails the FSA to determine the impact which the realisation of a regulated organisation's risks will have on overall market operations. This means that the organisation itself and its clients can be subject to the risk impact. These risks can also lead to *financial crime* being committed. The probability-component refers to the causes that might hinder the FSA to accomplish its objectives. This part consists of a thorough analysis of the firm's inner workings; future strategies, financial security, business risks, risk management.

A combination of these two components is then used in the impact and probability assessment to establish a priority for the firm with the FSA as well as the relationship that will be maintained in the near future between the two parties. It is possible to include other factors to the initial regulatory procedure.

An example is the introduction of a level of confidence in the information used for the risk assessment and/or the anticipation of any changes to the impact and probability determinants.

The second step of the regulation process is to set a range for the risk assessment process. This is a significant return to the essential core characteristic of ERM; a function with a high level of generalness, but sufficient flexibility to include unique firm-specific elements. The FSA attempts to apply the risk assessment process to various firms, but allow for alterations from firm to firm. The second step then continues to respond to the results from the impact and probability assessment in step one and makes recommendations or call for corrective actions to be taken by the firm involved.

Communication is an imperative aspect in the second step. The FSA aspires to drive the organisations to raise their standards and exploit the success obtainable by keeping in line with the supervisory requirements. The two ends of this communication line consist of the FSA clearly stipulating prerequisites to the regulated firms and the firms understanding these instructions and responding appropriately. Conversely, the FSA strongly discourage the general (public) availability of these risk assessments since these might be interpreted in a misleading way. Parties which have legal rights to them include external auditors and they are permitted to make use of the assessments in their analyses.

The final step in the regulation process is the maintenance of relationships with the regulated firms. This step entails elements such as compliance of the firm with the supervisory requirements set up by the FSA. The two parties should also work together in order to compose an in-depth sectoral analysis of the firm where objectives and goals are much more detailed than those of the FSA. The risk categorisation is a vaulting idea since it refers to the risks identified in the different sectors, but also links with the priority the firm has with the FSA and thus the nature of the relationship between the parties.

5.3.4. Regulation Tools

The tools used by the FSA for regulation can be categorised into four groups. Diagnostic tools resemble the risk measure discussed earlier – they identify and assess the risk which the organisation faces. Monitoring tools keep record of the developments of the results

obtained from the diagnostic tools. Preventative tools form the counterpart of remedial tools; the former is used before the risks identified realise, and the latter after risks realise.

These tools may either imply a direct or an indirect relation with the regulated firm. Public declarations do not involve personal contact with the firm whereas individual requirements of a firm will. The online FSA handbook (FSA.c, 2008) suggests several tools to determine whether a firm is complying with all the requirements. Some of these tools were discussed in the previous section and include but are not restricted to management reviews, contact with other regulatory bodies, on-site inspection, sporadic performance analyses, interpretation of historical operations and the use of auditors.

In this subsection the FSA was used as the epitome of a financial supervisory body. The key points of section 5.2. were given tangible examples here and became less abstract. Even though the FSA may be regarded as an entity to set the tone, there exists a body superlative to all in these matters – the International Association of Insurance Supervisors (IAIS). The requirements and guidance as set out by the IAIS receives attention in the following two sections.

5.4. Regulation of Internal Models

5.4.1. Introduction

The use of internal models had been briefly mentioned before but is definitely an intricate part of the successful implementation of ERM. Considering the imprecision coupled with the modelling process, an element of certainty needs to be integrated into the process. This is crucial to provide more clarity on the process and also to set standards for models with greater interpretation value.

As stated in the IAIS guidance paper (IAIS.a, 2007:5) an internal model is created by a risk manager to determine the final risk position – all possible outcomes considered. The central idea of an internal model is to achieve better accordance between the risk and capital management procedures. The model realises this goal by quantifying risks and thereby providing a suggestion of the appropriate resource allocation for risk mitigation.

The paramount advancement which the IAIS has incorporated – with regard to the use of internal models – is the special consideration granted for these models tailored to the

modeller's and interpreter's needs. The IAIS even goes so far as to acknowledge varying levels of expertise and experience with the use of internal models. This not a perilous concession since the base rule is that all models must adhere to the requirements as prescribed by the Association. With specific reference to the use of internal models the IAIS' requirements can be summarised with ten key traits (IAIS.a, 2007:8-21).

5.4.2. Key Traits of Internal Models

The first trait concerns the dual goal of capital allocation to both economic capital and capital requirements of regulators. The model which is applied for ERM and the subsequent solvency assessment must form an integral part of the decision-making process in particular for business strategies. The motivation behind this is a course of action called ORSA – Own Risk and Solvency Assessment. In combination with an internal model the ORSA becomes a very effective instrument for capital management.

The second key trait states that the internal model must be standardised according to predefined criteria. These criteria may include references to the confidence levels, risk measures and the time horizon deemed suitable for the capital management and strategic plans. This standardised internal modelling approach now acknowledges risk tolerances as set out in the firm's risk profile along with the strategic actions of the business plan.

The third trait is the right of supervisors to determine the appropriate criteria for internal models. This trait is an essential feature since it develops consistency throughout the regulatory system. These criteria are designed so as not to be a compulsory set of policies to follow, but rather an underlying set of principles with generic objectives and standards. Due to this trait a higher level of comparability is achieved, and updating models becomes a simplified process.

Trait four is rather obvious; the modeller must keep track of the characteristics, range and intricacy of the risks that the organisation faces. The IAIS also condones that modellers make use of various methods to compile the organisation's risk profile. It is, however, the responsibility of the modeller to demonstrate the suitability the approach chosen. A method to prove the validity of the chosen approach is defined in the following three traits. These are tests the modeller can perform to verify that the optimal internal model and criteria is being used.

The fifth trait discusses the statistical quality test the modeller can perform. This test evaluates the quantitative methodology of the model. Many elements of the modelling process form a part of this test; the data input, parameter estimation and assumptions. All these elements must be tested for statistical quality as prescribed in Statistics literature. Naturally the data ought to be precise, complete and applicable to the model. Another facet of the model which can be tested with the statistical quality test is whether the model truthfully reflects the assets and liabilities including their associated risks.

The 'calibration test' is trait six. This test determines if the model is consistent in its output especially with reference to the model criteria established earlier. This test is a vital one when the internal model is used for the independent calculation of regulatory requirements. The result of the calibration might be a review of confidence levels or even the re-estimation of capital requirements.

Trait seven is the 'use test'. This test may perhaps be considered more in the light of an assessment. The modeller must establish whether the model, its methodologies and results are actually used in the strategy and operational practices of the organisation. The relevance of the test with specific reference to the senior management must be scrutinised. For an internal model to be worthwhile, senior management should use the outcome to make decisions for capital management and business activities. The methodology should also be checked to keep in line with the ERM framework.

The eighth trait is merely a formality in the application and use of the internal model. If it is the explicit desire to make use of the model to calculate the capital requirements the model must first undergo an inspection. A supervisory body will grant permission to the organisation to apply the model if it is not found lacking in the prescribed criteria. The process of this inspection could last several years if the scope of the embedded risks is complex and the validity of the model's output has to be dissected.

The nature of the supervisor's support is the base of trait nine. The onus is on the supervisor to ascertain whether the necessary expertise, dexterity and resources are at hand when a supervisory evaluation is conducted. The personnel involved with the assessment of an internal model should be equally, but preferably more, qualified than the modellers themselves. Their technical aptitude must cover all possible aspects of internal models and receive adequate compensation.

The final trait is centred on the responsibility of the modeller to disclose all the necessary related information of the internal model. These explanatory notes should clarify how the model is applied in the organisation's business operations and risk management.

From these notes the supervisor will determine which level of information is relevant and appropriate for public knowledge and then disclose these levels. The IAIS in fact expects that the regulated firm which makes use of internal models to have their model reports divided into the different levels before submitting the model.

These ten traits form the starting point from which supervisors approach the use of internal models. The subject which was only succinctly mentioned in this subsection is the use of models to determine capital levels. The regulation of capital levels is the theme of the following section. Some of the topics may seem repetitive of ideas presented here, but should be viewed with specific reference to the final phase of capital requirements after internal models have already been developed and applied.

5.5. Capital Regulation

5.5.1. Introduction

A second guidance paper of the IAIS provides a clear picture of the final state of the regulatory process (IAIS, 2007b:4). The assessment that a supervisory body carries out will concentrate on the required capital levels and the technical provisions used to attain this target level. Technical provisions refer to the amount that insurers need to cover all their commitments as insurers over the time span of the portfolio. The required capital level refers to an amount which is more than technical provisions and is an additional buffer to ensure solvency.

5.5.2. Capital Requirements in Essence

Feature one states that the capital held by the insurer should be adequate to guarantee that all commitments and obligations can be met even during adverse situations. This implies a dual task for an organisation's senior management. The involved personnel must maintain a satisfactory level of capital to support the loss exposure faced by the organisation but also decrease the probability of suffering losses in adverse situations. The greatest benefit derived from this trait is that the supervisory body induces more

safety and security within the financial system without loading unjustified costs on the premium payer.

The second feature calls for inspection of all interdependencies that may exist in the organisation's financial structure, i.e. the accounting components. Supervisors must have a clear idea which interactions are taking place between the assets, liabilities and equity of an organisation. The IAIS prescribes a method called the *total balance sheet approach* to determine the overall financial position of the regulated entity.

In the third feature the complex structure of the supervision is more apparent. This feature asserts that different trigger events in the capital management process must prompt different levels of intervention by the supervisory body. Naturally this intervention must be initiated early enough to allow ample time for corrective actions to take effect. The forms of intervention vary according to the gravity of the capital issues. On the one end a supervisory body may simply request a business plan of how the organisation intends to re-accumulate the lost capital while on the other end business operations may be severely restricted until the capital is restored.

The fourth feature once again mentions the concession of allowing internal approaches as discussed in section 5.4. The only additional condition for the use of internal models is that they be used consistently. This implies that the approach be standardised to some extent and the objectives and principles of internal models be the underlying source of model development.

Risk definition forms the core of the fifth feature. Unambiguous explanation and/or identification of the risks should be reported in the solvency regime. This also encompasses for the organisation to indicate how risks and their aggregation are translated into capital requirements. This feature is linked with the distinction between technical provisions and capital requirements. Part of the fifth feature is to clearly specify which level of the previous two capital sources is used for which type of risk. For the risks which are not successfully mitigated by holding capital, the organisation ought to consult with the regulatory body to find a more appropriate solution.

Feature six is a return to the criteria used (in the internal model) for calculating capital requirements. As expected, the criteria proposed by the supervisory body and those

actually used by the organisation need to correspond. There is also mention of determining time horizons in the guidance paper (IAIS, 2007b:14). These horizons can be categorised into two time spans where the 'shock period' refers to the time when a shock is directed to a risk and the 'effect period' refers to the time over which the same shock will impact on the insurer.

The seventh feature concerns the disclosure of the information regarding the organisation's capital requirements. The solvency regime which the organisation is following must be reported, along with capital objectives and the extent to which they are attained. Transparency is the key word for public disclosure, especially for reaching a point of generic understanding.

5.6. Standard & Poor's ERM Rating Procedure

5.6.1. Introduction

A large part of the rating procedure conducted by Standard & Poor's concerns the level of ERM that the regulated firm has implemented already. S&P especially emphasise in their ERM criteria (S&P, 2007) the consideration of risks when the firm intends to formulate strategic developments.

The quality of the ERM framework within the firm is determined by the efficiency of the firm's *loss tolerance*; how this tolerance level is defined and maintained. The evaluation used by S&P also recognises the balance preserved by the firm's management between the risks undertaken and the return yielded. It is clear that the ERM assessment process focuses heavily on management techniques and tendencies. According to the evaluation these management practices are exemplified in five areas.

5.6.2. Five Determinants of ERM Quality

Risk management culture is the first determinant of ERM quality. S&P attempts to assess the extent to which a risk culture is embedded in the firm's daily business operations. This includes the degree of involvement by senior management, but also the risk correspondence among different departments and corporate levels. The loss tolerance determined by senior management comes into play here and a clear development from the firm's original risk appetite must be indicated.

The second determinant is risk controls. This is an evaluation of the procedure described in section 4.2. The assessment determines whether the risk management personnel have performed the necessary and sufficient steps to mitigate the risks identified. This determinant requires very detailed information since it inspects processes for all the individual risks of the firm.

The third determinant relates to the anticipatory skills of the risk management team. The risk that mainly contributes to the failure of firms is operational risk. Operational risk is hardly ever apparent or clearly visible during risk identification. The risk management department need to cover every possible *and* improbable case of risk emergence. The ability to integrate risk anticipation with strategic development becomes an art in this sense and determines future survival and success.

Determinant four is a concept which should now be clear to the reader; the evaluation of internal models. The S&P assessment attempts to establish whether these models are worth their effort. Internal models should produce results which can be used for active decision-making. The criterion (S&P, 2007) warns that model input and in particular assumptions need to be updated on a continuous basis. Even though individuality is encouraged by the FSA and other regulatory bodies, S&P cautions that when prescribed models are used without modification the firm must be able to motivate that the original models satisfactorily depict their risk profile.

The fifth trait is perhaps better understood as an expansion of trait three. The S&P evaluation probes the intensity of *strategic risk management*. The risk management team must now prove that the concepts of risk, risk management, return on risk and strategic anticipation have been effectively added to the melting pot of ERM.

5.6.3. ERM within the Rating Procedure

S&P distinguishes between four levels of ERM quality: excellent, strong, adequate and weak. Each of these levels forms a part of the overall rating that S&P gives to an organisation. Here follows a brief summary of the four categories as defined by S&P in their online rating guide (S&P, 2007).

A 'weak' categorisation implies that the firm has strained capabilities in identifying, measuring and mitigating risks. A vague risk management framework exists, but is not applied consistently. Central personnel only ensure that the bare requirements are met.

An 'adequate' categorisation indicates that the firm has a serviceable ERM system. The risk management system may be silo-based, but is used often and correctly. The risk profile is not etched out to the full extent and risk tolerance remains a hesitant venture. Risk boundaries are generally set up independent of the prescribed indicators while models might lack robustness.

The 'strong' categorisation is merely the perfected form of the 'adequate' category. The risk management system has now developed to an enterprise-wide approach which is fully embedded in the business operations. The risk profile and tolerance are detailed while robust processes can adapt for the anticipated risk materialisation.

For an 'excellent' categorisation the firm must have an impeccable ERM system in place. Risk management is an underlying factor to all the corporate decisions. The ERM framework is similar to that of the 'strong' category, but more superior in the execution. Its risk management is highly refined and in tune with the prescribed methodologies.

These categorisations unmistakably point out the value of *strategic risk management*, especially in the case of S&P's assessments. This aspect is connected with an idea presented in chapter two: value creation. The rating guide also explicitly mentions that this is the single component of ERM that centres on augmenting 'upside', whereas the remainder of ERM focuses on reducing downside and its coupled risks.

A significant component of strategic risk management lies therein that the firm must optimise and preferably maximise the return on risk with quantitative approaches. For the life insurance industry this implies that the firm will use their short-term risk perspective to project long-term strategic trade-offs between products with credit, interest rate, equity and insurance risks. The case of non-life insurers primarily concentrates on the mitigation of long-term risks where their products are subject to credit and insurance risk.

The reader has now come to terms with the inherent complexity of maintaining the balance between ERM-encouragement and -regulation. It is clear that with the vaulting knowledge that regulatory bodies have over the risk management procedure and ERM they will logically have the expertise to tell which ERM strategies will be effective and which will not.

Regulatory bodies conduct assessments in meticulous detail; even the risk models are under scrutiny. This is not, however, where the assessment and recommendations stop. Regulatory bodies also have very transparent requirements concerning the employees who apply ERM. These requirements specify the roles played by risk management team members such as the actuary and the chief risk officer, their skills and cooperative approach that is necessary for an effective ERM procedure.

6. Exponents of ERM

6.1. Introduction

The exponents of ERM are the individuals who advocate the use of ERM. Throughout the dissertation there is mention of the ‘modeller’, ‘senior management’ or the ‘insurer’. These supporters of ERM may hold very different positions within the firm or serve dual purposes. The Financial Services Authority in the UK specifically identifies actuaries and auditors involved in the ERM venture. The roles these individuals fulfil along with that of a Chief Risk Officer are discussed in this chapter.

Looking at the duties and capabilities of these personnel within the firm does not imply that they are the only proponents of ERM. The keyword is generality – all the departments must be involved. The manager of the legal department is as much a part of ERM as an employee in the human resources department. The roles of actuary, auditor and CRO are only pointed out since ERM sets the tone for their daily activities.

6.2. The Role of the Actuary

6.2.1. Small Accounts

Davenport (1993:211) defines the role of the actuary by differentiating between the sizes of an account the prospective insurance client may undertake: small and large. This distinction mainly relates to the relationship that the actuary will have with the client.

When the client decides on a smaller account with the firm there will be less direct contact with the actuary and an insurance broker will serve as mediator. For these cases the actuary closely collaborates with the broker who communicates with the client to set up the input which the actuary will use. These input data is an important contributing factor to the actuary’s comprehension of the client’s business operations. The broker’s position is to construct a feasible insurance program for the client, but the analysis of the client’s data still lies with the actuary.

The first part of the actuary’s analysis starts with a loss projection for the client. The actuary must determine the scope of the client’s losses and whether there are adjustments

for loss expenses. The actuary has some predetermined idea of the loss distributions for the different clients and thus fits new data to these distributions. If the distribution fit is not favourable it may be an indication of lacking data, a shift in reserve policies or that the business operations of the client are not fully understood. During this phase prior analyses or simply the personal experience of the actuary come in useful. If neither of these options is viable the actuary can augment the client's data by using industry data or by calling on the opinion of an expert in the specific field.

The second part consists of the components one would expect from a statistical distribution; the mean and variation. The output gives a formalised idea of the expected losses the insurer can anticipate from the client along with the variation in these values. With this information the broker can then propose a suitable insurance program for the client according to their risk preference and the amount they want to spend.

Another function which specifically links with the actuary is the calculation of reserves required for an insurance policy. When the actuary has constructed the supposed payout examples, these are discounted to obtain estimates for the reserves needed to cover the possible losses.

The experience that actuaries acquire during these analysis functions is invaluable to both the broker and client. As the actuary picks up on trends in the business cycles and industries, this information is communicated to the broker and client. The discovery of a definite trend means that the broker can provide the client with a mitigating proposal. Naturally this will also help the client to save on the hidden costs of additional analyses.

6.2.2. Large Accounts

For larger accounts the actuary essentially performs the same functions as with smaller accounts, but now the actuary has much more personal and direct contact with the client. The analysis conducted by the actuary will not be focused on the account as a whole, but on its different components.

Davenport (1993:216) states that larger accounts and their divisionary nature imply that the actuary will be making less use of industry data. An additional benefit of the larger account is that the greater amount of claims that the client will be making guarantees that the actuary can experience client-specific trends in more detail.

The actuary's task is now centred on calculating the client's accruals over the different financial periods and then determining the appropriate reserves for the preceding periods. The task also connects with the client's business operations since the information compiled by the actuary may be applicable for further scrutiny by the client's auditors.

The assignments at hand for larger accounts may be much more actuary-intensive, but the broker has not disappeared from the insurance vending process. The fusion of the two parties could be a complicated undertaking with the broker and actuary more often than not being physically removed from one another. The actuary and broker ought to communicate any developments to each other to ensure that both parties are up to date on the client's decision regarding their analyses.

6.2.3. Communication Channels

It is the duty of the actuary to exchange findings and/or methodology with both the client and the broker. Davenport (1993:217) explicitly states that the broker must be acquainted with the methodology and especially the assumptions employed by the actuary. This makes sense since the broker is responsible for the design of an insurance package that is well-suited to the client. Communication skills of the actuary are not only restricted to the broker who might understand the technical terminology, but should also accommodate the client with no actuarial background. This will naturally lead to a better report if the client is more attentive to accumulating report information the actuary might require.

The actuary may be subject to some public relations scenarios with the client as well. If the analyses are thoroughly understood by the client along with the product packages designed by the broker, the client is more likely to keep the account at the current insurance firm. This might force the actuary to serve as a connection between the broker who cannot interpret all the information, and the client who cannot understand all the specialised information. The client will obviously be more sceptical of the technical quality of the analyses if the actuary does not perform well, than if the broker's performance leaves much to be desired for.

When the actuary is only involved in correspondence with the broker, the main topic should be the changes in the actuarial milieu. The correspondence can range from

informal contact with a single broker to formal contact with all the firm's brokers. The actuary could take a passive stance by habitually providing the brokers with information concerning the actuarial milieu. This could entail providing demonstration analyses to develop the broker's understanding, supplying commentary on analyses from external sources or partaking in colloquiums on themes proposed by the firm's brokers.

6.2.4. The Reserve Function

The reserve function forms an essential part of the insurer's business operations. This function naturally has implications on the financial reporting of the firm. Rech, Knott and Doodian (2008:6) specify that the IAIS uses the total balance sheet approach for their capital and solvency management. Under this approach both assets and liabilities are marked to market. Since most liabilities are not of a liquid nature, the firm needs reserves to act as collateral.

These reserves are calculated to account for the present value of the liabilities along with a risk margin. The risk margin is an accumulated representation of the risks which cannot be diversified. The difference that the actuary keeps in mind at this stage of the reserve function is the different business operations of the property/casualty and the life insurance industries. For the property/casualty industry the function now involves discounting the expected losses associated with the liabilities and then adding the risk margin. The life industry, however, already has this procedure incorporated in its functions. The alteration which will take place concerns the forecasting of expected losses which are taken from the management's projections and not the statutory expectations.

The statutory expectations refer to the reserve methodologies which were initially determined by state supervisors. With the principles-based approach as described by Rech *et al* (2008:6) each firm has more control over the formulas, parameters and assumptions which they apply for their reserve calculations. This calls for even more extensive involvement in the process by the actuary which must keep track of the appropriateness of the reserve levels that the firm maintain.

Given that the principles-based approaches provide more freedom to the firm, regulators require significantly more assessment of the methodologies by internal as well as external

parties. This means that the actuary must facilitate greater cross department cooperation whilst also acting as internal regulator.

6.2.5. The Actuary as Regulator

The Financial Services Authority identifies certain tasks that an actuary needs to fulfil (FSA.d, 2008). These tasks primarily utilise the actuary as regulator by expanding the actuary's role to that of internal regulator.

The first and foremost of these tasks is to inform the firm's management of the risks that the firm faces in its business operations and provide some kind of quantified analysis for the materialisations of the identified risks. This task is a preface to the second which asserts that the actuary must report any incidences of inability to comply with the long-term obligations that firm has made. Meeting these obligations also requires certain capital levels to be maintained and the financing contracts provide sufficient earnings. The instruments the actuary has at his disposal to perform the tasks vary from the well-known risk identification, quantification and monitoring to stress and scenario testing, or even financial forecasting for future business plans.

When the actuary is serving this regulatory role he must ascertain whether his disposition is free from partiality. The actuary must be remunerated as a normal employee with the same profit-enhancing incentives being valid for his performance as for other managerial employees. Severe cases of agency theory may exist in corporate structures where the actuary is also serving as the chairman or executive officer of the firm's executive committee. Logically it is the responsibility of the actuary to guarantee that no conflict of interest arises in his personal employee functions.

The actuary fills the role of the employee completing the core ERM responsibilities; quantification, forecasting and mitigation of risks. It is, however, the Chief Risk Officer that integrates the analyses and propositions of the actuary with the primary business operations of the firm. This is the great champion of the ERM mission that brings the entire venture together.

6.3. The Role of the Chief Risk Officer

6.3.1. Functions of the Chief Risk Officer

Lee and Shimpi (2005) emphasise the role of the Chief Risk Officer as the organiser of the firm's strategy. They confirm that the CRO initially only delivered some technical input to senior management's decision and policies, but now forms part of this body that determines the firm's future progress.

Two areas are identified by Lee and Shimpi (2005) where the CRO is an indispensable component. The first area is the duty that lies with the CRO to ensure that the firm has procedures in place which guarantee the firm will not only comply with regulatory standards and rules, but also exceed the expectations of shareholders of the firm. The second area is the development and implementation of an integrated risk management programme; an ERM programme.

This process of mitigating the risks identified or the preferred alternative of exploiting risks for value creation requires that the CRO make senior management aware of the correlation between the different risks. Along with this task the CRO must advocate the ERM culture throughout the firm. The CRO must therefore have a very clear idea of the firm's risk profile; the assessments, preferences and appetite.

The CRO should also allow the employee and other stakeholders of the firm to become acquainted with the ERM programme. Consistency is the key word here and the CRO must be unfailing with his implementation of the ERM programme.

The successful CRO will also pay special attention to the other departments within the firm: finance, accounting, legal and human resources. By making use of the expertise of employees of these divisions the CRO reduces his own duty of data collection and can focus on the ERM programme. Lee and Shimpi (2005) reveal that prolific CROs draw on the strengths of the internal auditing procedure as well as strategic planning.

6.3.2. Skills of the Chief Risk Officer

Many of the requisite skills have been hinted at in the previous subsection, but a few additional capabilities are important as well. One of these capabilities is the insight

which the CRO must have, to not only understand a great deal of information, but also to manipulate all this information and make it work for the firm. The CRO must have some actuarial knowledge; this might include an overview of statistical methods and modelling procedures.

The question of good communication skills is even more significant for the CRO than for his colleague the actuary. It is imperative that the CRO is a thriving communicator, since he will probably head the risk management team and integrate the team with the remaining departments. Seemingly insignificant aspects become a crucial day-to-day activity. These aspects include forming trusting relationships with the firm's staff and management as well as giving proper attention to public relations aspects such as language and interpersonal skills.

Lee and Shimpi (2005) view the CRO's job description as a parody when they portray the CRO as the "master technician of an arcane craft". Even though the CRO is not an esoteric mystic, the challenges that await him are vague and undefined and naturally an analytical mind is vital to provide structure for the ERM programme.

The CRO might be a candidate from the internal audit, strategic planning, finance, actuarial or risk management departments. Business operations are clear to the CRO and he can communicate fully with internal and external participants to the firm's functions. The difference between risk managers and CROs becomes obvious within the context of communication. According to Lee and Shimpi (2005) risk managers are the highly-skilled technicians of the risk management process but do not possess the skills of the CRO which serves as the project leader, the ERM champion and the integration communicator.

Lam (2000:4) – who coined the term 'Chief Risk Officer' and was the first true CRO – identified the leadership role that the CRO must fulfil as well as overseeing the integration process of the ERM programme. In addition to the communication skills a CRO must acquire, Lam (2000:4) proposes that training seminars be held (perhaps by the CRO himself) to ensure the firm's risk awareness. He also explicitly states the multiple risk functions which were implied in the paper by Lee and Shimpi (2005). In Lam's personal experience he was responsible for the entire risk profile of the firm along with various management responsibilities and even business and financial planning.

6.3.3. Empirical Results

Despite all the motivation and benefits given in the previous two subsections the popularity of the CRO was still somewhat feeble in past few years since its creation. Empirical findings presented by Pouliot (2004:4) at the CRO Forum indicated that the Chief Financial Officer still takes precedence. Even though many of the surveyed firms had appointed CROs, the CFO was indicated as the employee that oversees the ERM procedure. It was also found that the CRO reports to the CFO in 47% of the cases, but only in a quarter of the cases to the CEO.

The most interesting part of the survey was the great emphasis that was placed on the communication skills of the CRO by Canadian firms. The Canadian firms are also the leading employers of CROs. The remaining firms concentrated on CROs with excellent technical skills and therefore mainly recruited them from the actuarial departments.

6.4. The Role of the Internal Auditor

6.4.1. Introduction

The role that the internal auditor needs to fulfil is perhaps best described as that of an *advocatus diaboli*. The internal auditor must provide an external perspective to senior management on the efficiency of the ERM procedures as implemented by the risk management team. The efficiency of the ERM procedures can refer to the appropriate mitigation of risks and the quality of internal control exercised.

6.4.2. Functions of the Internal Auditor

The Institute of Internal Auditors (IIA, 2004:1-2) clearly specifies the functions that an internal auditor may fulfil and those which are not permitted. The two determinants of whether an auditing activity is permissible is the assurance that the auditing body remains independent and that the outcome of the activity will improve the firm's business operations. These distinctions should be kept in mind when internal auditing is taking place.

Permissible activities that internal auditors may perform include verification of the risk management processes as well as the accurate estimation of risks. Other core activities of the internal auditor are to assess the risk management process, the reporting of key risks, as well as how these risks are managed. The activities which are permissible, but verge on impermissible are providing assistance in the risk identification and evaluation process, coordinating ERM procedures, compiling risk reports and developing risks strategies. It is obvious from the latter activities that caution must be applied when performing these activities since they call for techniques and expertise which all internal auditors may not possess.

In the online guidebook (FSA.e, 2008) the FSA emphasises the independence that an auditor must maintain while performing their business functions. This naturally raises the question whether a total outsource venture is not the best route to take for the firm. This being said, the functions specified by the FSA agree with those of the IIA. The external viewpoint is accentuated much more, however, and this is with respect to the regulatory functions that the FSA expects auditors to perform and is thus not considered here.

Activities which are considered forbidden by the Institute of Internal Auditors for the internal auditing department are establishing the risk appetite, implementing risk management processes and then taking account for these or making decision on risk responses. The IIA (2004:2) explicitly states that internal auditors must always be aware that the actual risk management responsibility remains the task of senior management working alongside the risk management team. Internal auditors ought to act as critical observers to the risk management process.

The boundaries have been set within which ERM can be conducted and the risk management team members know what is expected from them; both in skills and coordinating operations. The next step is therefore to train the following generation of ERM-users in these techniques and practices which are employed. There is also a definite drive to promote future development of risk management employees which are already in the insurance industry and those which are about to enter it.

The education of industry entrants is an important factor in the training of risk managers and also that of actuaries. The next chapter indicates to what extent actuaries will be educated in the near future with respect to ERM in order to attain the high-level development of ERM practices.

7. Educating the Successors

7.1. Introduction

Several overseas actuarial societies have identified ERM as one of the key points to address in their basic training. Meetings concerning the matter have been held which were attended by the presidents of the respective actuarial committees of various countries. These meetings had ERM education and recognition of this education as their primary objectives.

As part of the ERM education a syllabus outline which is acceptable to both the educating party and the employing party was drawn up. The syllabus broadly covers many topics and it has been suggested to include a separate actuarial subject on ERM in the official actuarial training programme. This syllabus outline also served as muse for this dissertation and is therefore presented in greater detail in this chapter.

7.2. Setting the Scene: The Two Working Groups

7.2.1. Introduction

At the meeting of October, 2007 of the Presidents Forum (Panjer and Rowley, 2008a:1) it was deemed necessary to create two groups to either promulgate ERM education or apply it. With reference to the introduction of this chapter these two working groups were called the Syllabus Working Group (educating party) and the Recognition Working Group (employing party).

Panjer *et al* (2008a:1-19) compiled a report to finalise the group objectives and propose a syllabus outline with which a candidate would receive the global ERM designation. In this report findings concerning education shortcomings and developments are given as well as a detailed framework of the syllabus options.

7.2.2. The Syllabus Working Group

The Syllabus Working Group's members are mainly educators for the actuarial qualification, i.e. lecturers at some higher education institute providing training for

actuarial examinations or exemptions. This working group presented six parameters for the composition of the ERM syllabus. These parameters are naturally still subject to universal approval by the Syllabus Working Group members.

The first parameter states that the designation will only be awarded to candidates who:

- Meet the requirements of the International Actuarial Association (IAA)
- Meet the requirements of the global ERM designation
- Are members of their respective national actuarial societies

The second parameter asserts that the syllabus cover all the themes of the IAA, but encourages additional material to be added as needed. The third parameter is an elaboration on the second: the syllabus must explicitly be defined in terms of learning objectives. The fourth parameter incorporates the great versatility of the *global* ERM designation when it calls for no specific reference materials in order to accommodate all languages of the member countries who then compile reference lists internally. The fifth parameter gives the Syllabus Working Group greater control over the education process by not specifying the manner in which the knowledge is passed on or examined. The final parameter is merely a summary of the preceding parameters; the Syllabus Working Group is free to compile the ERM syllabus in whatever way they prefer.

7.2.3. The Recognition Working Group

The Recognition Working Group's members mainly consist of the presidents or representatives of individual actuarial associations. These members personify the employing part of the global ERM designation since they provide both national and international recognition of a candidate's ERM qualifications and therefore ensure their employment in appropriate positions. This working group proposes a treaty to be signed by the Recognition Working Group members when appropriate, to allow the presentation of the global ERM designation.

This treaty aims to ensure the quality of the qualification. The implications of the terms of this treaty are numerous. Firstly, the treaty permits the national actuarial association to award the ERM designation to candidates meeting the proposed requirements. Signing this treaty also implies that sporadic assessment will be exercised to certify the quality of the programme. The recognition arrangements state that member associations can award

the designation and recognise it when it was awarded externally or simply recognise the designation when awarded externally. This obviously necessitates greater cooperation between the IAA members, especially with regards to disclosing disciplinary information among members. This in turn leads to the facilitation of members moving among the associations – which includes when ERM designation candidates enter or leave associations – but also implies an obligation for full documentation for these movements.

7.2.4. Overall Objectives

As stated previously, the objectives structured the framework for this dissertation and are presented as such. The two Working Groups reached accordance concerning the following objectives which are summarised here and form an introduction to the subsequent section.

The objectives assert that a candidate with ERM designation must understand and be able to dynamically interpret the concept of ERM and its key drivers. The candidate should not only have a full passive knowledge of ERM methods, but also actively make use of them. The wide spectrum of risks and their quantification and mitigation methods must be part of the candidate's standard ERM understanding. The candidate ought to know why ERM is important for firms in terms of value creation and regulatory requirements.

7.3. The ERM Working Syllabus

7.3.1. Introduction

Several drafts of the syllabus have already been compiled and the revision of it remains a constant task of the two working groups. The syllabus outline discussed here is the final draft compiled by Panjer and Rowley (2008a:7-19) which was presented during the Presidents Forum of June, 2008.

Seven main areas were classified by group members and then these areas were dissected to provide the themes which ought to form the curriculum for the actuarial programme. The seven areas are examined separately.

7.3.2. Enterprise Risk Management Concept and Framework

A candidate receiving training on ERM topics must first of all be able to clearly define the concept of ERM in terms of various definitions. The candidate should also have an evident understanding of the drivers of ERM and all the applicable terminology whatever ERM topic is at hand.

After successful completion of this topic the candidate must become familiar with the external and internal structure of a firm's ERM framework. This also implies that the candidate has adequate knowledge about the process of constructing an ERM culture.

Certain topics were mentioned under this heading but received special attention in this dissertation. These topics include the candidate's awareness of regulatory requirements, supervisory compliance and insight into the value creation aspect of ERM.

Concerning regulatory requirements and supervisory compliance, it is imperative that the candidate has sufficient information and references on market conduct as well as audit and legal obligations. The candidate will find an excellent starting point for training in regulatory requirements in the Basel II framework along with the Solvency II (Panjer and Rowley, 2008b:6). Chapter three of this dissertation describes the candidate's responsibilities whatever role he may be fulfilling.

The question of value creation was discussed in chapter two. This is, however, a broad topic with many recent developments but also different application methods. The candidate should know how to create value in active and passive ways; either reducing costs or increasing returns.

7.3.3. ERM Process (Structure of the ERM Function and Best Practices)

As the title inherently implies, the ERM process will have several steps and considerations. The most important feature of the ERM framework is the creation of the firm's risk profile; i.e. the risk appetite, philosophy and goals. The candidate must be proficient in the use of risk filters and gauging the risk exposure.

Communication also features widely in the ERM endeavour. The actuary is no longer a mysterious employee providing equally mystifying written results. The candidate must be able to express himself and explain his findings to a diverse audience. Any entity

involved at any stage of the ERM process must have an ample grasp of the candidate's results. The candidate has consequently become the key player coordinating the risk correspondence which is so essential to ERM.

Furthermore, the candidate should be able to take a leading role in implementing a relevant risk management practice and determining how this practice influences the firm's operational strategy. This logically entails the candidate periodically applying risk control procedures to assess the risk management's efficiency.

7.3.4. Risk Categories and Identification

The magnitude of risk taxonomy cannot be emphasised enough. The candidate must consequently be adept in defining what is denoted by risk and the associated uncertainties. Not only should the candidate be able to recognise existing risks and their repercussions, but he should also be able to identify newly arising risks.

Knowledge of risk classification signifies that a candidate can completely distinguish between financial and non-financial risks. This section fundamentally only refers to the identification of risks since the concomitant mitigation thereof is treated as a different theme in the following section.

The risks a candidate can be expected to know include, but are not limited to: currency risk, credit risk, spread risk, interest rate risk, equity risk, hazard risk, operational risk, projected risk and strategic risk. Insurance-specific risks were discussed in chapter one and it is principally in this field where candidates must affirm their creative talents in pinpointing newly arising risks.

7.3.5. Risk Modelling and Aggregation of Risks

In order to fulfil the requirements pertaining to risk modelling and aggregation techniques, the candidate must be familiar with methods to make identified risks acquiescent to quantification methods and the resulting analyses. At this stage the candidate can easily utilise correlation methods and copulas for multivariate risk data.

Other methodologies which require the attention of the candidate are the employment of scenario analyses and stress testing as part of the risk measurement course of action. A natural development from this topic is that the candidate studies the topic of extreme

value theory and has a concrete perception of the significance of tail distributions and correlations.

A subject which is receiving more and more attention – and duly so – is the matter of model and parameter risk. The candidate should always be sentient of these risks and how they affect his modelling procedures and result reporting. Therefore, the candidate is obliged to deal with various risks and their modelling inferences in a suitable fashion.

7.3.6. Risk Measures

The recent developments in risk measures that the candidate should have knowledge of was illustrated in chapter two of this dissertation. The working syllabus as proposed Panjer and Rowley (2008a:7) further requires the candidate to define risk metrics and explain the characteristics of risk measures.

The related skills a candidate should possess are therefore the ability to perform quantitative analyses on financial and insurance data making use of all statistical methods available to him. It is also the responsibility of the candidate not to stagnate with the continued use of dated methodologies, but to educate himself on recent developments in these highly dynamic fields.

Understanding risk metrics, measures and measurements is an essential instrument for the candidate to use in his risk management techniques which is considered in the next subsection.

7.3.7. Risk Management Tools and Techniques

In the previous subsections the candidate has acquired a wealth of knowledge most of which might be deemed passive and unrelated. This subsection, however, addresses the integration of all these skills to transform the candidate into a fully-fledged enterprise-wide risk manager. The move from simple training to advanced application is now evident.

Completion of this higher-level syllabus theme will anticipate the candidate's ability to clarify the selected procedures for risk management. This implies a thorough justification of the method and degree of hedging the candidate will make use of. The candidate should be able to describe a method of risk optimisation and the effect it will have on the

firm's value. Parallel to this, the candidate should be capable of transferring risk to a third party when it is applicable.

In addition, the candidate can demonstrate the manner in which derivatives and financial securities can be exploited to favourably mitigate risk. This includes broad utilisation of the risk implication of derivatives; such as the relationship that exists between credit risk and derivatives or reinsurance.

The candidate's abilities should even stretch to the successful application of portfolio management to diminish equity and interest rate risk as well as asset-and-liability management to curb strategic risk and deploy investment stratagems.

7.3.8. Economic Value

The theme of economic value was covered in detail in chapter two of this dissertation. The prerequisites that the working syllabus includes on the topic are summarised here.

The candidate should be able explain the concept of economic value and how the risk measures mentioned earlier are once again drawn upon to provide an assessment of the firm's economic capital.

Economic value skills extend to the capability of applying techniques that facilitate the optimal allocation of economic resources with the intention of ameliorating the firm's performance.

7.4. New Developments: The CERA

7.4.1. Introduction

The Chartered Enterprise Risk Analyst (CERA) is perhaps the most significant step in actuarial training. According to Wolf, Klugman and Wong (2008:7) a CERA differentiates himself from the traditionally-qualified actuary by exploiting the opportunities associated with an ERM framework. The job description and training as prescribed by the SOA who award this designation is discussed here.

7.4.2. Fulfilling a Need

An introduction to the concept of the CERA is best described in terms of the various *types* of actuaries. D’Arcy (2005:745) briefly summarised the stages through which the actuary has gone to reach the current perspective. Actuaries *of the first kind* which were prevalent throughout the 17th century focused on insurance problems and made use of deterministic models. The early 20th century saw the rise of actuaries *of the second kind* to deal with worker compensation and insurance for automobiles and property whilst utilising probabilistic models. In the late 20th century actuaries *of the third kind* came into being and developed skills encompassing among other things stochastic models and contingent claims.

With the dawn of the 21st century and the quickened pace of risk management developments, D’Arcy (2005:746) calls for the improvement of the actuarial endeavour to transform the risk manager into an actuary *of the fourth kind*. This is the actuary who is making extensive use of ERM within his actuarial milieu. The most important statement D’Arcy (2005:750) makes, however, is the need to “move up or move out”. Caution is given that actuaries should move into the ERM field or risk ceding it to some other employee.

It is exactly this gap the actuary of the fourth kind, the CERA, is attempting to fill. The CERA embraces these new challenges by exploiting ERM prospects and by differentiating himself in the marketplace from the conventional actuary explain Wolf *et al* (2008:7-8). The CERA is thus still considered an actuary, but his training differs from the traditional approach. The training of a CERA is presented in the next subsection.

7.4.3. Training a CERA

The SOA indicates several fields that a candidate must pass before being awarded CERA designation. These fields are briefly featured by Wolf *et al* (2008:9).

The first exam the candidate writes is on basic micro and macro economics – VEE Economics. This is then followed by an exam on probability theory – Exam P. It covers topics on mathematical probability, probability distributions, statistical moments and their generating functions. Exam FP covers the principles of financial Mathematics and first tests the candidate’s knowledge on basic topics like annuities, present and future values

and rates of return before moving on to dynamic fields such as derivatives, securities and forward contracts. A paper on the models used in financial economics, forms Exam MFE which tackles inter alia the Black-Scholes pricing methodology, the Greeks, interest rate models and Ito's Lemma. The subsequent assessment is Exam C that determines the candidate's ability to construct models; this includes estimating parameters, using risk measures and model selection. Exam AFE justifies special attention.

In this AFE exam – advanced financial ERM – the candidate must demonstrate integrated ERM skills and techniques. The candidate is expected to identify risks of any nature, to measure and quantify these whilst also calculating interdependencies. The candidate must be accomplished in risk mitigation through risk transfer, the use of derivatives, financial management or any other acceptable methods. A complete understanding of ERM and its implementation to a highly transparent degree is a natural prerequisite and the candidate should be able to illustrate the positioning of an ERM culture and how it creates embedded value for the firm.

The CERA training concludes with a module on operational risk. This is the all the previous training of the candidate under magnification within the operational risk arena. The same skills of risk measurement and quantification, model building and risk mitigation apply here, but the theme is with specific reference to operational risk since it is the leading intricacy in risk management today, but the worst-demarcated.

Since the training of risk management team members is now accounted for, it is surely appropriate to ask why insurance firms and financial regulatory bodies are going to these great lengths to implement ERM. It is already a comprehensive undertaking to understand, use and study ERM, nevertheless it does not suffice. The greatest drive to implement ERM is the motivation behind it; i.e. why is efficient, why does it improve business operations?

These questions of motivation for ERM are discussed in the following chapter. In chapter six the benefits of implementing ERM are presented by means of two empirical studies.

8. Benefits of ERM

8.1. Introduction

The previous chapters have indicated what ERM is and how it should be applied. It is known that the subsequent question to be asked is why? Why should ERM actually be implemented? ERM requires significant time, resources and diligence in its implementation and yet the outcome and benefits seem vague and meaningless initially.

In this chapter the benefits are inspected by empirical studies. This includes a study of the American insurance industry which concludes pro-ERM results and a survey of market responses to the appointment of ERM overseers. Empirical evidence makes sense only in numerical terms, but it is the interpretation and analysis behind these figures that lift the veil of ERM's elusiveness.

8.2. Study of the U.S. Insurance Industry

8.2.1. Introduction

The greatest implication concerning the value of ERM hinted at in the preceding chapters is the manner in which ERM indirectly induces monetary benefits. This is done by lowering costs incurred with the realisation of risks or maximising the mechanisms of risk management. In contrast to this, the Hoyt and Liebenberg (2008:1) study of the U.S. insurance industry seeks to find determinants in its business operations which directly affect firm value.

8.2.2. Details of the Model

The study conducted by Hoyt and Liebenberg (2008:2) attempts to determine the correlation that exists between the implementation of ERM and the firm's value. Bias due to inherent factors of the decision to implement ERM and the actual results it achieves, is avoided by a model that jointly estimates the implementation and the implementation effects.

This model by Hoyt and Liebenberg (2008:8) consists of two steps. The first step involves letting ‘ERM implementation’ be the response variable. This is then equated to a function of four (possible) ERM implementation factors as determinant variables:

$$ERM\ Engagement = f(Size, Ownership, Diversification, Industry, Capital)$$

Size is considered an implementation factor since larger organisations will naturally have more resources in order to facilitate implementation. The ownership variable refers to the extent to which an organisation is owned by institutions or individual shareholders seeing as institutions can demand corporative actions more readily. The diversification variable is a binary variable that captures the complexity within the organisation. The variable used by Hoyt and Liebenberg (2008:8-9) for this purpose is split into three variables: one that takes into account whether the organisation has returns from non-insurance business operations, a second variable that indicates whether the organisation has geographical diversification such as business operations in foreign countries and a third that perceives the diversification over different business lines within the organisation. The industry variable merely shows if the organisation is operating in the life or non-life industry. The capital variable replicates the asset-liability position of the organisation.

In the second step which Hoyt and Liebenberg (2008:9) employ, the response variable of the first equation is now used as one of the determinant variables in the second equation which is given as:

$$Firm\ Value = f(ERM\ Engagement|other\ value\ determinants)$$

The study used *Tobin’s Q* as a proxy for firm value. The many advantages which are attributable to this measure include that it does not require risk-adjustment and that it reflects market expectations. Tobin’s Q is defined as the quotient of the sum of the market value of equity and the book value of liabilities with the book value of assets. The main purpose, however, of Tobin’s Q is that the perceivable effects of ERM will be subject to a time lag.

‘Other value determinants’ are not discussed here, but simply mentioned due to the fact that many of them either correspond with the determinant variable of the first equation or are instinctive additions. These value determinants could include extent of leverage which the organisation maintains, the profitability at which the organisation is trading,

the diversification strategy that is followed, growth opportunities, ownership composition and dividend policies.

8.2.3. Results of the Study

A correlation matrix of Tobin's Q, ERM Engagement and their determinants reveal low correlations among the elements. Calculating summary statistics disclose intuitive expectations the reader may have had already. The organisations which had high values for the measure Tobin's Q (therefore firm value) had a fully operational ERM framework. However, the organisations which do not incorporate an ERM framework were valued only 6% lower than their counterparts making full use of it.

Another important finding indicated by Hoyt and Liebenberg (2008:12) is the difference in the corporate setup between users and non-users of ERM. Organisations that employ ERM to a broad extent are usually large firms, with diversification in international and industrial terms along with a high degree of institutional ownership whilst they mainly operate in the life insurance industry. That being said, the result analysis becomes more complicated concerning the interpretation of inclusion of the binary variables.

The binary variables of international diversification, industrial diversification and life/non-life operations only provide significant results when the size of the organisation is excluded. On the other hand the same variables seem to be important in categorising the organisations as users and non-users. Hoyt and Liebenberg (2008:12-13) explain that this phenomenon is most probably due to the fact that a large firm will doubtless be more diversified in its operations and in most instances life insurers are much larger than non-life insurers.

Other remarks given on the analysis include the existence of a quadratic relationship between insider ownership and firm value as well as a positive relationship between dividend payments and firms value which can naturally be explained as a reduction of agency costs. However, the most noteworthy conclusion from this regression was that the coefficient of ERM was positive and tested to be statistically significant.

8.3. Unexpected Indicators of Benefits

8.3.1. Introduction

The study of Pagach, Beasley and Warr (2007:2) provides a remarkable perspective on the choice of response variable. The chief indicator used in this survey to determine the effects of ERM was the market responses to the appointment of senior personnel supervising ERM programmes at organisations. The study uses the announcements of employing a CRO as a signal of ERM implementation since it is almost never separately announced.

This study also keeps in mind the prickly matter that ERM can actually destroy firm value since shareholders are able to diversify idiosyncratic risks away in a costless approach. The third unique aspect is that the study was conducted on non-financial organisations to determine the robust effects of ERM as it is being implemented.

8.3.2. Methodology

Using the appointment of a CRO as indicator of ERM implementation is not unique. Previous studies (Pagach *et al*, 2007:1) on the same topic have made use of CRO appointment and this study was no exception. Pagach *et al* (2007:8) give three reasons why this indicator proves so useful yet again. The first reason is that the appointment could be the first CRO at the organisation and therefore show that the organisation is giving greater consideration to ERM practices.

Another reason is that a CRO is replacing his counterpart at the organisation to facilitate expansion of the ERM framework. The last reason is that the CRO appointment may simply be a change in job description to accommodate the higher ERM activity. Naturally the first reason is the most applicable since it is the only one accounting for the initial implementation of ERM.

The study also includes several firm-specific variables and their concomitant hypotheses. These variables incorporate information assignable to individual firms. For five of these firm-specific variables the hypotheses expect positive relationships between the market reaction of the announcements of the appointment of a CRO and the variable in question.

For only one variable a negative relationship is expected. The variables for which positive associations are expected are growth options, intangible assets, earnings volatility, financial leverage and organisation size. A negative relationship is expected for the variable cash ratio. Extensive reasoning for the use of either the pure variables or proxies of them along with the expected relationships are discussed by Pagach *et al* (2007:10) but not presented here, since the basic idea is clear already.

After defining the key indicator and compiling a list of co-indicator variables the study consisted of searching through business announcements which are affiliated in terminology with the indicators. With the different observations of appointments and the corresponding market reactions the study continues with a multivariate regression of the six variables mentioned previously on the dependent variable which is defined as the cumulative abnormal (excess) returns over the announcement period.

8.3.3. Results of the Study

Firm-specific variables which did not have statistical significance are those of market/book ratio (a proxy for growth options), intangible assets, earnings volatility and financial leverage. This concludes the overlapping hypotheses of direct relationship between the variables in question and the cumulative return to be void.

An important result presented mentioned by Pagach *et al* (2007:17) is that of the confirmation by statistical significance of the negative relationship between the cash ratio and the cumulative returns.

The remaining variable which also classifies as statistically significant is organisation size. This suggests that the beneficial outcome of ERM implementation is subject to the organisation's size and cash ratio and therefore is related to firm-specific conditions.

Further regressions in which the sample was divided into financial and non-financial subsamples only solidified the implication that the benefits of ERM implementation heavily adhere to the nature of the organisation's business operations. The most significant part of this conclusion was in agreement with that of Hoyt and Liebenberg (2008:12); organisations that experience the most benefits due to ERM are large and have relatively little cash reserves.

These two empirical studies also serve as a fitting introduction to the following chapter. In chapter seven the ERM position in South Africa is inspected whilst comparing it to that of the UK and attempting to obtain a clear perspective of the South African insurance industry compared to international ERM standards.

9. Trends in South Africa

9.1. Introduction

This chapter attempts to determine the ERM trends in the life insurance industry in South Africa. It follows the same principles as those of Bartlett *et al* (2005:1) of the Life Research Committee of the Faculty and Institute of Actuaries in the paper *Risk Management by UK Life Assurers: a Survey*, but with a South African application. The chapter consists of the results calculated from the data as provided by the respondents of an ERM questionnaire.

Throughout the chapter a comparison with the UK results is carried out. This is done to illustrate the ERM quality as set out by the FSA in their regulatory framework and thus to utilise the UK insurance industry as trendsetters.

9.2. Background to the Analysis

9.2.1. Introduction

This section consists of the way in which data was obtained and a discussion of the data set. The questionnaire⁶ is also briefly examined before an in-depth analysis of the individual questions in the questionnaire is presented.

The results explained and tabulated here were obtained from various insurance firms in the country. Some of these firms requested anonymity and therefore no company- or employee-specific information is given here. Appreciation is also expressed to all the participants for their efforts and insight.

9.2.2. The Data

The survey commenced by compiling a list of the insurance firms in South Africa that provide life insurance products. The appendix lists further details for the industry data.⁷ In total 32 firms were identified in the first collection of insurance companies. Out of the 32 firms five had merged with other companies and were not functioning separately or

⁶ See Appendix B

⁷ See Appendix A

had discontinued business operations completely. The remainder therefore was made up of 27 independent firms which were to be contacted.

Between April and August 2008, the various human resources departments were contacted via telephone and the respective departments supplied the contact details of the relevant employees. Contact with eight of the 27 firms failed over the three month period for various reasons; from refusal to give contact details of potential respondents to simply no answer at call centres. In this second elimination round nineteen firms were left.

The questionnaire was then sent to these nineteen respondents via personal e-mail correspondence. Naturally the job description of the respondents made it impossible to have personal interviews. The response control therefore consisted of telephonic confirmation of willingness to participate in this survey along with the responses received from personal email addresses. Quality control of these responses can also be assured by the commentary respondents indicated on their replies.

From May, 2008 the first responses to the questionnaire were received through to September, 2008. Over this period nine responses were collected from the nineteen. This means almost half of the respondents which were contacted completed the questionnaire and they make up a third of the 27 eligible firms.

Note that not all the respondents answered all the questions. This will be indicated accordingly. For these cases the probabilities might not add up to 100%; this is due to the fact that a rounding function was used. Furthermore, an interpretation problem arose with one of the questions, but the problem is addressed in subsection 9.3.10.

9.2.3. The Questionnaire & Respondents

The questionnaire was obtained personally by email from the co-author of the paper mentioned in section 9.2. Mr. D. Bartlett of the Life Research Committee. The layout and contents were determined by the Life Research Committee and are therefore not the individual design of the author of this dissertation.

This questionnaire was modified by the author to reflect the South African insurance environment. This modification only effected question 4 where the original questionnaire

had Pounds Sterling as monetary value. The values were not changed, simply the monetary to Rands.

26 questions make up the questionnaire, which are grouped under seven headings to reveal the different areas of the ERM manifestation. These seven distinct categories were perspectives on the firm, the risk management approach used, the risk organisation structure, the risk identification procedure, the manner of risk measurement, the actual risk management and an open category for two miscellaneous questions.

A 27th question is present at the beginning of the questionnaire where the respondent indicated the closest version of his own job description.

22 of the questions were multiple choice questions in which one (in a few cases more than one) option could be chosen. Three questions were concerned with a rating system according to the respondent's personal opinion and one question was a fill-in question.

The respondents consisted of inter alia two Chief Actuaries, two CRO's and one Finance Director. One respondent indicated that he served as both CRO and Finance Director whilst the two remaining respondents were classified as 'other'. One of these was a Director of the firm and the second was the Divisional Director for the 'Group Actuarial' in his firm.

9.3. The Analysis and Comparison

9.3.1. Question 1: The Firm

Question 1 asked the respondent to indicate the importance of the various classes of business. All the respondents completed the 'Annuity' class, two respondents did not complete the 'Property-linked' class and one respondent didn't complete the remaining classes. The average importance was thus calculated using the total of the respondents who *did* complete the class in question.

At first glance the 'With-profits' class does not seem as significant compared to the United Kingdom analysis. When the column 'Significant' is inspected, however, it is seen that 'With-profit' has in fact the highest percentage for business classes deemed *significant*.

Table 9.1. Business Classes

Classes of business	Minor	Modest	Significant	Principal
With-profits	25%	25%	38%	13%
Property-linked	57%	29%	14%	0%
Index-linked	25%	38%	13%	25%
Protection	25%	13%	25%	38%
Annuity	44%	11%	33%	11%

Source: Author

The results for the ‘Property-linked’ class disagree completely with the UK results. In the UK this is seen as a very significant business class or otherwise the principal class, whereas in SA few firms take real note of it and none have it as principal business source.

The ‘Index-linked’ class provides some interesting results. In SA the overall allocation of its application is fairly well-distributed. On the other hand, in the UK results it is considered a minor business class and very few firms used it as principal class.

In the SA industry the ‘Protection’ class has the highest percentage of all the business classes which are employed as the principal business division. This is not the exact same case in the UK, but this business class does receive the due attention.

The ‘Annuity’ class reflects the UK results very well. There is a high percentage of firms which consider it to have *minor* and *significant* importance and a lower percentage which consider it to have *modest* or *principal* importance. The strange combinations of *minor* and *significant* and *modest* and *principal* may probably be a reflection of the specialisation natures of the different firms.

9.3.2. Question 2: The Firm

Question 2 asked the respondent to indicate the type of ownership of the firm with the results of the three options given in the table 9.2.

Table 9.2. Firm Ownership

Listed	56%
Shareholder-owned but not listed	44%
Mutual	0%

Source: Author

Given that the total amount of firms was quite small, it can be concluded that more than half the firms are listed and the remaining firms owned by shareholders, are not listed. Zero *mutual* ownership was indicated by the South African respondents, but this made up a significant proportion of the respondents in the UK.

With the larger amount of firms inspected in the UK analysis similar results are obtained but of a magnified nature. There are more listed firms than unlisted firms which are owned by shareholders as well.

9.3.3. Question 3: The Firm

Question 3 asked the respondent to indicate whether the firm provides bancassurance.

Table 9.3. Bancassurance

Yes	25%
No	75%

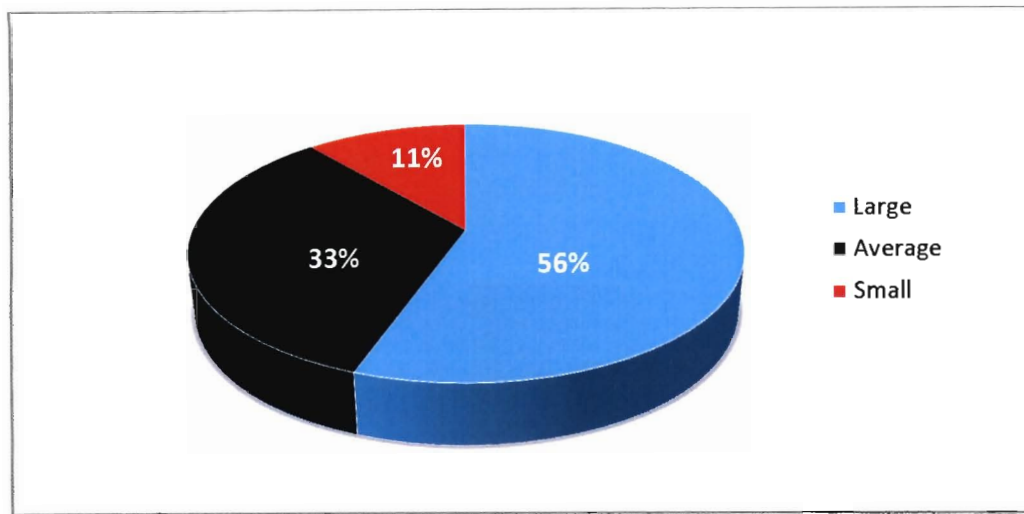
Source: Author

The results indicated an overwhelming ‘no’ for the prevalence of bancassurance in the South African insurance industry. The results of this question were never added to the UK report.

9.3.4. Question 4: The Firm

Question 4 requested an indication of the size of the respondent’s employing firm. Taking R1 billion and R10 billion as the boundaries for classifying a firm as either small, medium or large; the SA figures pointed out that there are more large firms than smaller ones as illustrated below. This was not the case in the UK; there is virtually the same amount of small and large firms, but there was twice the amount of medium-sized firms.

Figure 9.1. Firm Size



Source: Author

9.3.5. Question 5: The Firm

Question 5 was a simple question asking the respondent to indicate whether the firm was open to new business. The conclusion for the South African industry was a unanimous yes. The UK survey in contrast, reveals that almost a quarter of its firms are not open to new business.

Table 9.4. New Business Incentive

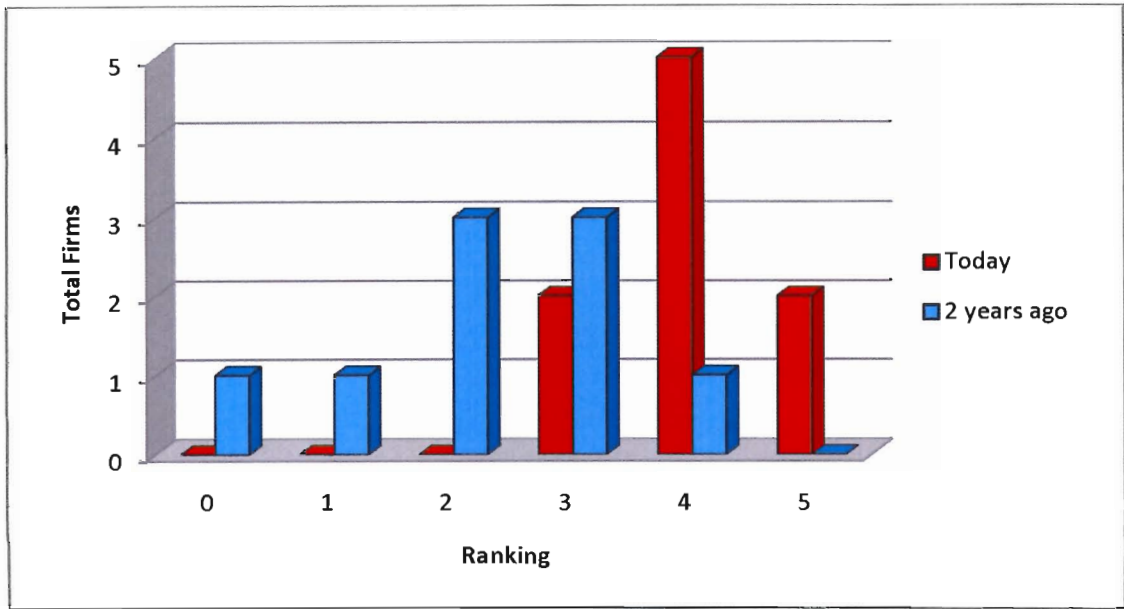
Yes	100%
No	0%

Source: Author

9.3.6. Question 6: Risk Management Approach

The goal of question 6 was to determine to what extent ERM has been implemented in the industry over the last few years. A period of 2 years was used along with a ranking system from 0 to 5. The ranking system serves as a measure for the degree to which an ERM framework is implemented in the firm where 0 implies 'no ERM framework present' and 5 implies a 'fully-operational ERM framework'. The totals for each of the different rankings at the respective instances are shown in the figure 9.2.

Figure 9.2. ERM Framework Development



Source: Author

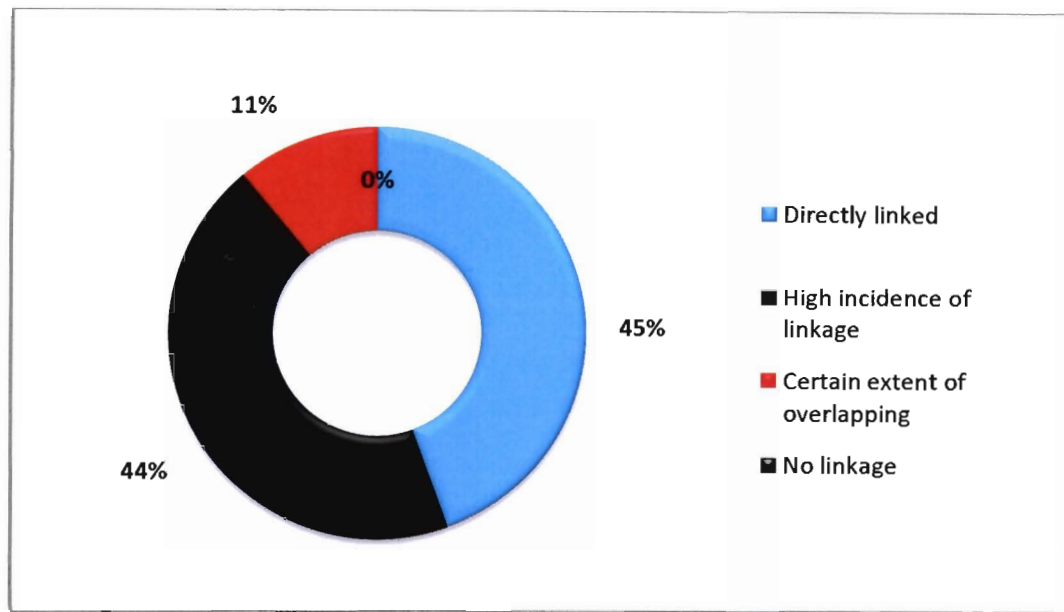
The graph illustrates that only one firm had no discernable ERM framework two years ago. In addition to this no firm had a fully-operational framework two years ago either. The results indicate good progression since the current situation shows that all the firms have some kind of ERM system in place.

Examination of the increase in the rankings provide further insight into the pace and extent of the development of ERM systems. The highest increase in ranking was three units and interestingly enough this was also for the firm which initially had no framework in place. The overall increase was two units. There was a zero increase as well which was for a firm that had already obtained an ERM framework with the high ranking of 4 at the start of the period and maintained it throughout the two years.

9.3.7. Question 7: Risk Management Approach

Question 7 functions as a representation of the incidence of linkage between the firm's general objectives and the risk management policy.

Figure 9.3. Linkage with Objectives



Source: Author

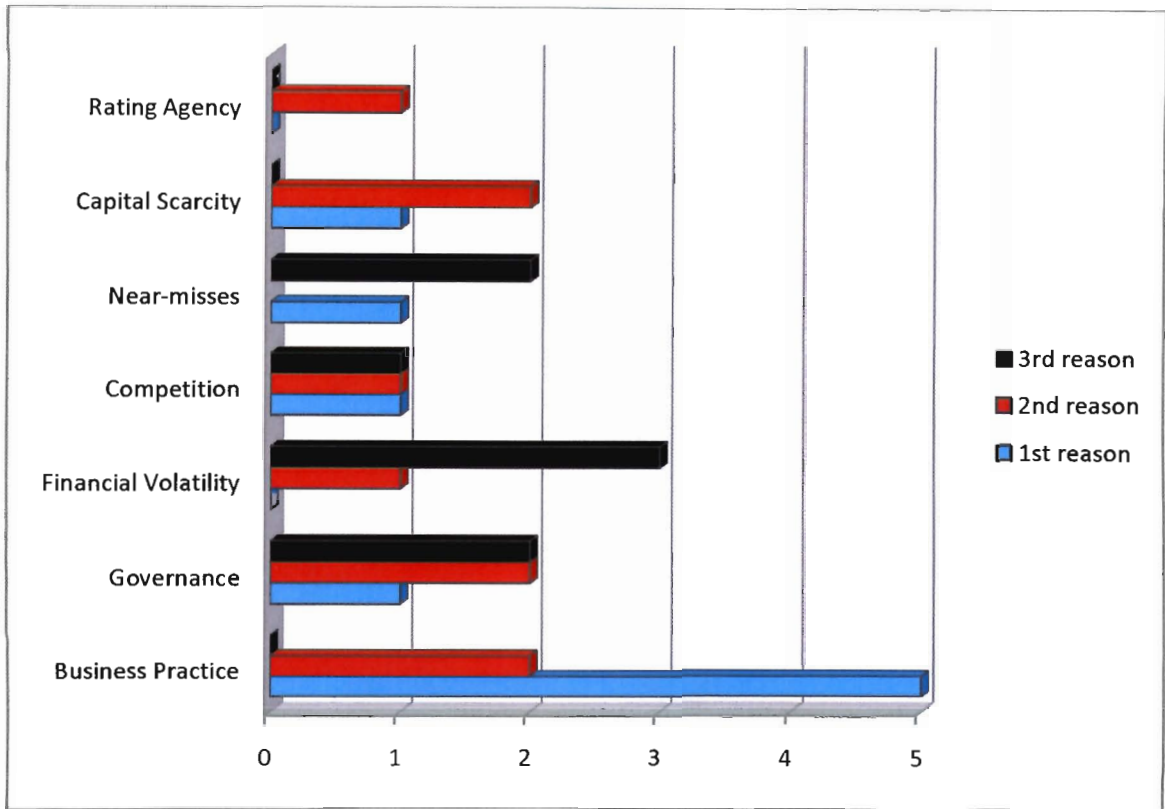
The South African results are closely tied with those of the UK. In SA the risk management policy was either a mirror image of the firm objectives or closely linked to them. It is worth mentioning that in the UK results there was actually one firm which did not have a risk management policy that was not coordinated with the overall firm objectives at all. The UK analysis also indicated that there are many firms with risk management *closely* linked to the firm objectives, but very few firms showed *directly* linked programmes.

9.3.8. Question 8: Risk Management Approach

Question 8 delved deeper into the reasons behind a risk management team's motivation to implement an ERM framework. The respondent could give three reasons in an ordinal ranking as to why ERM was introduced to the firm's risk management programme.

The results were centred on seven of a possible nine reasons for implementing ERM. The two reasons which were not indicated at any ranking by any firm were 'pressure from the investment community' and 'risk-related losses in the insurance industry'.

Figure 9.4. Reasons for ERM Implementation



Source: Author

The graph above shows the different reasons ranked from least to most votes received (irrespective of being indicated as 1st, 2nd or 3rd reason). The graph then clearly delineates good business practice as the most important reason for implementing ERM. This reason was either indicated as first or second reason by every respondent.

Governance was the second most mentioned reason. Many respondents indicated this as an important reason for applying ERM, however, not the most important. The third most important reason was using ERM to reduce the financial volatility the firm experiences.

A comparison with the UK results reveals that the reasons followed roughly the same ranking except that of compliance with rating agency regulations which was the most important reason above all. In the SA sector, however, it received only one vote.

9.3.9. Question 9: Risk Organisation Structure

Concerning the risk function in the UK the choice of a team leader was similar to the situation in SA. The leading role in the risk function was mostly headed by a CRO in both countries. Just like in the UK, SA saw several Finance Directors overseeing the risk functions.

Table 9.5. Risk Function Leader

Finance Director	22%
Chief Risk Officer	56%
Appointed Actuary/Chief Actuary	11%
Other	11%
No explicit risk management team	0%

Source: Author

The greatest difference is associated with 'Other' and 'No Explicit risk management team'. In the UK these were not rare occurrences. 'Other' was the second highest category in the UK responses whilst there was only one such response in SA; this position had the job title of *Head of Risk*. In SA there was no organisation which responded that it does not have any explicit risk function. This is a reassuring thought given that a significant proportion of the UK firms did indicate there was no definite risk management function in their business operations.

9.3.10. Question 10: Risk Organisation Structure

Question 10 introduced several problems in the SA analysis. It consisted of a table with nine important skills which a risk management team (or its individual members) should possess. The respondent then had to rank these skills on a scale from 0 to 5. Several respondents ranked each of the nine options on the scale whereas the remainder used each rank only once leaving four options void. Since this question was answered in this irreconcilable fashion, the two separate tables are given here.

The same problem occurred in the UK study. Since the sample size in the UK was much larger, the analyst excluded the incomplete entries and admitted that such incomplete rankings ought to have been treated as a ranking of zero.

Taking note of the UK approach the two distinct analyses are still presented here. The first analysis contains the data of four of the nine respondents who only made use of a rank once and therefore had five ranks in all. The second analysis contains the data of the five remaining respondents who ranked each option individually on the scale.

9.3.10.1. Ranking of nine separate options

Table 9.6. Risk Management Skills (1)

	Rating		Rating
Accounting/Financial	3	Operations	3
Actuarial	1	Statistical	2
Asset management	1	Strategic planning	3
Legal/Compliance	3	Tax	1
Marketing	1		

Source: Author

Table 9.6. contains the total amount of votes indicated for each individual option with a complete disregard for the actual ranking. The table was compiled in this manner since not a single option received the same ranking by any of the respondents. Hardly any conclusions can be made from this table. The least assumptive conclusion is that these respondents consider Financial, Legal, Operational and Strategic skills as the most significant. The UK analysis was in agreement concerning the impact of Operational and Legal aptitude of the risk management team.

9.3.10.2. Exclusive ranking of single options

For the analysis of the exclusive single rankings, the average of each skill was calculated for the five respondents. These rounded averages are indicated in the table 9.7. The most important skills are indentified to be Financial, Actuarial, Operational and Legal skills. Most of these skills also featured highly in the ranking system in the UK analysis with the

exception of Financial/Accounting skills which actually obtained the lowest score in the UK study. This might be due to the very high level of job diversification in the UK insurance industry. The lowest score in SA was Marketing skills with Statistical abilities scoring slightly higher.

Table 9.7. Risk Management Skills (2)

	Rating		Rating
Accounting/Financial	4	Operations	4
Actuarial	4	Statistical	2
Asset management	3	Strategic planning	3
Legal/Compliance	4	Tax	3
Marketing	1		

Source: Author

9.3.11. Question 11: Risk Organisation Structure

This question was merely posed to ascertain the average amount of personnel working in a risk management function (not with respect to the firm's overall size). Two respondents did not answer this question and one respondent gave a percentage of 25% instead of the pure number. It is difficult to make a proper conclusion on this question, since the highest number of personnel working in a risk department was 55 and the lowest 3.

9.3.12. Question 12: Risk Organisation Structure

Question 12 centred on the structure of the risk committee in terms of leadership. In other words: are the members equal in the committee or is a single person responsible for the direction of the risk function? The response to this question is a unanimous affirmative for employing a CRO, except for one respondent who did not answer the question with respect to the risk committee. It can therefore be concluded that even though a CRO is engaged in the risk function there is an entire support team for the risk management procedure.

Table 9.8. Risk Committee Leadership

	Yes	No
Chief Risk Officer	100%	0%
Risk Committee	89%	0%

Source: Author

9.3.13. Question 13: Risk Organisation Structure

This question is a further inspection of the composition of a risk function. One respondent did not complete this question and therefore eight was taken as the base figure. It is evident from table 9.9. that the CRO is the most important employee to serve on the risk committee in SA. This was not the case in the UK where the Finance Director fitted this description and the CRO was not such a significant feature for risk committees. Another interesting difference seen in the South African data is that Non-executive Directors almost always serve on this committee whereas in the UK their numbers were the lowest in reference to the risk function. A single respondent indicated a job description that was not featured in the table’s options; that of an IT Compliance Officer.

Table 9.9. Composition of Risk Function

Chief Executive Officer	88%	Chief Risk Officer	100%
Finance Director	88%	Appointed/Chief Actuary	63%
Head of Internal Audit	88%	Non-executive Director(s)	88%
Chief Investment Officer	13%	Other	13%
Chief Operations Officer	75%	Not Applicable	

Source : Author

9.3.14. Question 14: Risk Organisation Structure

This was the last question in relation to the structure of the risk organisation. It sketches the elements of an ideal world within which the respondent could establish whether the risk control structure ought to be more independent of or integrated with the specified operational activities.

Table 9.10. Risk Organisation Structure

	Business Unit	Internal Audit
More autonomous of ...	33%	33%
More incorporated with ...	78%	0%
No changes necessary	22%	22%

Source: Author

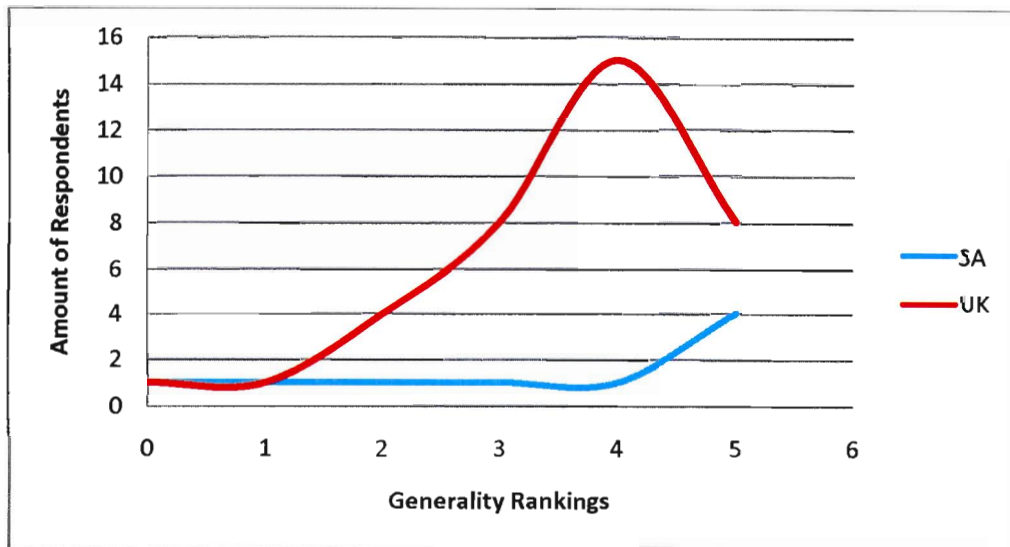
The information in table 9.10. naturally gives an introductory perspective on the success of risk control implementation. The results in SA differ greatly from those of the UK for ‘no changes necessary’. Most respondents in the UK indicated that no changes were necessary, whereas in SA only two respondents were of the same sentiment. Concerning greater autonomous function, the overall proportion in SA agrees with those in the UK. The focus in SA, however, fell on the heightened integration of the business units with the risk control structure.

9.3.15. Question 15: Risk Identification

Question 15 was asked to determine the extent to which a theme of commonality has been introduced in the task of risk identification. A scale from 0 to 5 was applied once again where 0 was indicative of no commonality and 5 denoted a fully generic approach over different departments within an organisation. The average score was 3. Four respondents specified a ranking of 5, whilst rankings 0 to 4 each received a single vote.

It might seem severe to assume that the SA results reflect the UK results in a scaled way, but the size of the UK data set was more than 4 times that of the SA data set. The similarity is apparent in the sense that the data are skewed to the. The difference is more pronounced in terms of the area in which the data are concentrated. For the UK results this was around a ranking 4 whilst for the SA results this was around the ranking of 5; indicating that a very high level of commonality in risk identification over an organisation’s various departments is not a rare occurrence in SA.

Figure 9.5. Risk Identification Approach



Source: Author

9.3.16. Question 16: Risk Identification

Question 16 posed the question of whether the organisation (risk committee) registers a central risk map. The conclusion is logically in the affirmative with a full 100% responding that such a risk map is compiled for risk identification purposes. The situation is similar in the UK where roughly 80% of the respondents made use of risk mapping.

9.3.17. Question 17: Risk Identification

This question required the respondent to indicate if the firm's board is notified of material risks as they manifest. In SA the answer was an undisputed yes. Of the UK's 38 respondents only two did not inform the board of such risks.

9.3.18. Question 18: Risk Identification

For question 18 the respondent had to indicate where the responsibility of risk identification is allocated. The respondents were allowed to mark more than one option in this question.

Table 9.11. Responsibility of Risk Identification

Business unit/Function managers	89%
Risk Function (Committee)	67%
Internal Audit	44%
Other	11%

Source: Author

The outcome of this question in the SA milieu was a reflection of the situation in the UK. The respective business units were responsible for identifying the risks, with a considerable amount of accountability also entrusted to the risk committees. The respondent which indicated that some 'other' source is entrusted with risk identification specified this entity as the board of the organisation.

9.3.19. Question 19: Risk Identification

Question 19 asked the respondent the average constancy of the implementation of risk identification procedures. The results in SA are an echo of the UK responses. The most common periods for applying risk identification processes in SA were those of 'quarterly' and 'continuous' implementation just like in the UK. The concentration of these results in the UK was, however, a bit more centred on the latter period, whereas in SA this distinction does not seem so apparent.

Table 9.12. Risk Identification Frequency

Annually	0%
Quarterly	44%
Monthly	22%
Other frequency	0%
Continuous process	33%
Never	0%

Source: Author

9.3.20. Question 20: Risk Measurement

Question 20 presented several risk measures for which the respondent had to indicate if the measure in question was calculated and/or reported to the board of the organisation.

Overall far more measures are reported to the board in the UK than in SA, but the values for the actual calculation of the measures were approximately the same in the two countries. In the UK only the measures indicated in table 9.13. were calculated, whereas in SA two respondents indicated that two additional measures are calculated; one of which is also reported to the board. These two measures are *Economic Capital* and *Business Risk*, which is reported to the board as well.

Table 9.13. Risk Measurement Calculated

	Calculated	Reported to Board
Stress test losses	56%	33%
Probability of solvency level less than a specified level	56%	56%
Value-at-Risk	56%	22%
Other	11%	22%

Source: Author

9.3.21. Question 21: Risk Measurement

This question gave the respondents an opportunity to indicate in which manner the linked risks are calculated. Methods which were not used for the specific risk were left empty and not indicated as 0% for reason of legibility. Note that not all the respondents commented on every risk.

The methods used for the specific risks in SA are fairly comparable with the UK practices. In both countries *Deterministic scenarios* is the leading method for calculating the risk measures. In the UK *Ad Hoc calculations* took second place and *Subjective assessment* was third. In SA these two methods were ranked the other way around. The *traffic light system* showed the worst performance.

Table 9.14. Applied Risk Measure

	Ad hoc calculation	Subjective assessment	Traffic light system	Deterministic scenarios	Stochastic Models
Equity Market	33%	33%			33%
Equity Portfolio	17%	50%			33%
Interest rate	14%	43%		14%	29%
Property markets	25%	25%			50%
Property portfolio	67%				33%
Implied volatility: equity	25%			50%	25%
Implied volatility: interest rates	20%	20%		40%	20%
Credit spreads	17%	33%		50%	
Corporate bond default	40%			60%	
Reinsurance counterparty	14%	29%	14%	43%	
Liquidity	50%	17%		17%	17%
Mortality assurance	13%	13%		63%	13%
Mortality longevity	14%	14%		57%	14%
Morbidity	14%			71%	14%
Persistency	14%	14%		57%	14%
Expense	25%	13%		63%	
Tax	33%	50%		17%	
Legal/Litigation	29%	57%	14%		
Regulatory	17%	67%	17%		
Mis-selling	17%	50%	33%		
Other operational	14%	29%	14%	29%	

Source: Author

As table 9.14. indicates, no single measure was calculated with a single method. The associated risks are calculated differently by the various organisations with the risks for *Property portfolio* making use of the least methods; namely two. The UK results showed even greater variation in applied methodologies where four methods were the least used for any given risk.

9.3.22. Question 22: Risk Measurement

Question 22 follows as subsequent step in the risk identification procedure. This question determines what the risk management team does with the information they have compiled. Table 9.15. lists the various possibilities.

Table 9.15. Implementation of Risk Information

Management information	100%
Limit/Risk appetite setting	56%
Calculating business performance	44%
Allocating capital	33%
Calculating remuneration	11%
Communicating with rating agencies	33%

Source: Author

In SA – as in the UK – *Management Information* was the most important purpose of the risk measurement procedure. The order of importance in use was virtually parallel for SA and the UK with both countries seeing *Calculating remuneration* as the weakest use of risk management information.

9.3.23. Question 23: Risk Measurement

Question 23 provided a chance for respondents to signify where there is allowance for diversification benefits for various risk pairs. The two-way table with the corresponding proportions is given here. (Table 9.16.)

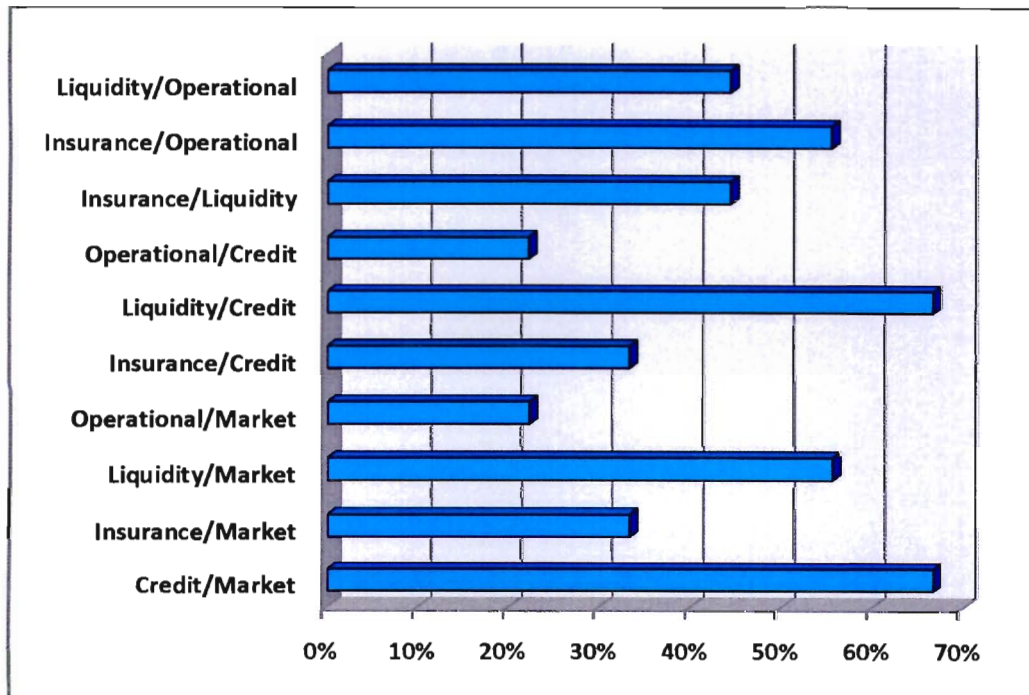
Table 9.16. Allowance for Diversification Benefits

	Market	Credit	Insurance	Liquidity	Operational
Market		67%	33%	56%	22%
Credit			33%	67%	22%
Insurance				44%	56%
Liquidity					44%

Source: Author

The risk pairs in SA receive comparable attention in the UK with Market*Credit indicated as a very significant risk pair. Risk pairs which have *Market* as one of the elements receive the greatest amount of allowance for diversification benefits, both in SA and the UK. In SA the remaining allowance dispersion is relatively uniform and in the UK the uniformity is even more apparent with the proportional values varying between 20% and 60%. The margin in SA is somewhat wider; varying between 20% and 70%.

Figure 9.6. Diversification Benefits



Source: Author

9.3.24. Question 24: Risk Management

Question 24 is a summary of the business operations for which risk measurement information might be used directly. Unsurprisingly the main direct use of this information is the same for SA and the UK; specifically that of setting risk policies. The remarkable difference is that the second most important direct use in SA is to assess strategic options for the firm compared to the case of strategic asset allocation for the UK. In the UK all the respondents ticked one or more of the options excluding 'other'. In SA there was one respondent which indicated another use of the risk measurement information. This supplementary use was stipulated as *compliance with mandates*.

Table 9.17. Uses of Risk Measurement Information

Setting risk policies	100%
Assessing strategic options	78%
Investigating possible hedges	67%
Determining the strategic asset allocation	56%
Determining insurance risk retention levels	44%
Determining the tactical asset allocation	44%
Weighing up expenditure on risk controls	44%
New product pricing	44%
Other	11%

Source: Author

9.3.25. Question 25: Miscellaneous

The question was added to provide the respondent with a means to articulate the problems with ERM which were personally experienced. A few obstacles were tabulated from which the respondents could choose as many as applicable to their situation.

Table 9.18. Obstacles to ERM Implementation

Cost	33%	Lack of senior management support	22%
Insufficient data	56%	Diversity of risks	33%
Insufficient resource	67%	ERM an impractical goal	0%
No suitable systems	33%	Other	11%
Low priority	11%	No significant obstacles	0%

Source: Author

The greatest obstacle for successful ERM implementation and use is the insufficient resources allocated for the purpose. This was also the case in the UK along with insufficient data being available for the risk management team to exploit.

In SA all the respondents indicated that some kind of obstacle was present in their ERM framework. The UK results, however, saw almost 18% of the respondents indicating that they did not experience any difficulties with ERM support throughout the organisation.

One respondent in SA specified an obstacle that was not taken up in the table and that was the obstacle of IT implications for an ERM framework implementation.

9.3.26. Question 26: Miscellaneous

Question 26 listed four basic components of risk management and requested the respondent to indicate the degree of expenditure over the next three years on these different aspects. A table with the proportional assessments is presented here (Table 9.19.). In SA the most respondents indicated that expenditure will mostly be either moderate or significant with only one respondent indicating expenditure on any risk management component to be zero or extensive. An analogous reaction was present in the UK results.

Table 9.19. Risk Management Expenditure

	No expenditure	Modest	Significant	Extensive
Risk organisation structure	11%	78%	11%	0%
Risk identification	0%	78%	11%	11%
Risk measurement	0%	44%	44%	11%
Risk management	11%	44%	33%	11%

Source: Author

9.4. Comments on Results

9.4.1. Introduction

These comments are added with the purpose of tying together the separate questions in this chapter in order to provide a top-down perspective. The general perspectives are grouped under the same seven headings as mentioned in section 9.2.3. The UK survey carried out a similar approach of overall conclusions, but this was performed throughout their result analysis. The South African data set was too small to re-categorise the firms and therefore the same approach was not followed here.

9.4.2. The Firm

Unlike the UK industry, the ‘Property-linked’ business class showed poor performance in South Africa. This might be explained by the fact the UK property market has reached greater stability than its South African counterpart. Another fact that should be mentioned as explanation is the extreme ebb and flow of the property market in SA in the last 5 to 8 years; this was not so harsh in the UK – not in the year of analysis at least. A third explanation associated with the second is the year of analysis: the UK survey was already conducted in 2005, the SA survey only in 2008.

Another puzzling fact was the prevalence of large firms in SA. The UK insurance sector favoured medium-sized firms with small and large firms being the exception. The development stage of the insurance industry in SA as a whole is most probably the cause of this phenomenon. It is natural for monopolies to control industries in the early stages.

9.4.3. Risk Management Approach

There is no reason to fret about the place of ERM in the South African insurance industry. Even though the actual name of Enterprise Risk Management might still be unknown to some, the intuitive practice of ERM is firmly-rooted in the risk management system. This can be seen in the direct (and close) linkage which exists between the firms' objectives and their risk policies.

A worrying aspect, however, is the reasons for which ERM is being implemented. In the UK with its FSA-watchdog, compliance with supervisory bodies was the first reason for applying ERM. This very reason received little attention in SA.

The main reason in SA – ERM is a good business practice – is a plausible reason, but the slight hint of disregard for financial supervision is perturbing. Why is the South African equivalent – the Financial Services Board – not an overwhelming power in the national insurance industry?

9.4.4. Risk Organisation Structure

As stated in section 3.2.2., the CRO has a fixed foothold in South Africa. Virtually all the organisations involved in the survey had a post designated as such. With respect to the organisation of the risk management team, the CRO took the lead in almost every case with the 'democratic' Risk Committee taking a definite backseat.

It appears that these Risk Committees mainly include the cooperation of the CRO, the CFO, the CEO, the Head of Internal Audit and a non-executive director.

A disheartening fact that was noted in the data was the lack of interest in Statistical capabilities of employees. This dissertation alone relies heavily on Statistics and its advanced associated techniques. It is difficult to say from outside the actual workplace whether this preference is a true reflection of the risk management proceedings. Do the respondents perhaps not realise how much Statistics they are using every day and therefore take it for granted?

The unexpected interest in Legal/Compliance capabilities is in opposition to the indifference shown for Statistics. This seems a bit contradictory with the ignorance shown for supervision in section 9.4.3. Nevertheless, this capability scored high among

the respondents. Concerning purely legal matters, it makes sense to have sufficient knowledge about commercial and company law to improve business operations. Perhaps the future Enterprise Risk Manager should be learning a bit less of the prescribed advanced Statistics and know a bit more about the laws and legislation of his work environment.

9.4.5. Risk Identification

The results concerning risk identification were comforting, given the generic nature of ERM. All the companies indicated the utilisation of generic identification processes and have improved on these as well. That being said, the firms make thorough use of risk maps as part of their generic approaches.

In all cases the Board was notified of relevant risks, however, the responsibility of the actual identification remained with the function managers. This makes perfect sense that an employee, who is actively involved in a specific business aspect, is accountable for identifying risks since these risks might only be discovered simply because of the employee's specialisation.

9.4.6. Risk Measurement

It is no surprise that deterministic scenarios are the leading form of risk measurement, since they allow a great amount of flexibility, freedom and speed in calculation. The problem with the other leading risk measurements is that firms prefer *ad hoc*-calculations and subjective assessment. This is naturally completely acceptable in an operational point of view, but it becomes problematic when students and/or new employees enter the risk management team. These measures usually remain vague and unknown to outsiders which obviously will encumber operations of a risk management team.

The analysis in this chapter indicated that the results of all the measurements are reported to the firm's management, but only half of the respondents actually used them for setting a risk appetite. This is a distressing issue since the calculation of the measurement requires time and expertise – which imply costs – and then the results are not even practically applied.

9.4.7. Risk Management

The concern from the previous section is perhaps explained by the results of the questions related to risk management. Though the firm's management does use the risks measurements for setting risk *appetites*, risk management – and therefore risk measurements – is used to set risk *policy*.

This conclusion summarises the theme in South Africa which is the same as that of ERM – generality. The focus is on obtaining an overall impression of the situation. Yes, individuals are burdened with calculating the details, but the goal is to obtain a transparent expression of the risk situation. This is clearly the case in South Africa.

9.4.8. Miscellaneous

Given the optimism expressed in section 9.4.7., it is still not clear why so few resources are available to the enterprise-wide risk management team. Many respondents indicated this as the major problem for the expansion of ERM practices. Unfortunately the lack of resources has consequences: data accumulation becomes impossible and operational system adaptations remain forgotten.

The light at the end of the tunnel is revealed in the last question when it becomes evident that the expenditure topic is starting to manifest in the business goals. Expenditure for risk management practices is still modest, but a few firms have realised its importance and are opening their wallets.

10. Conclusion

10.1. Introduction

In this conclusion a retrospective look is taken at each of the chapters and the concepts, techniques and methodologies presented in them. It serves as a thorough summary of the ideas illustrated in this dissertation, whilst simultaneously determining whether the hypotheses and problem statements given in the introduction have been addressed and a solution found.

10.2. Consolidating a Final Impression

Chapter one confirmed what Wang and Faber (2006:4) suspected: ERM means different things to different people. From its conception in the banking industry to its wide-spread use and alteration taking place in the insurance industry, ERM is a risk management approach with many faces and facets.

The first notion that ERM brings with it, is that of eradicating the silo approach which risk and line managers have become accustomed to. These employees are responsible for reporting on their personal experiences of ERM implementation in order to create a framework which is extremely generic and applicable to all their colleagues' departments. A second and very important idea which is inherent to ERM is not simply removing risk, but also to exploit it to the firm's benefit by using it as a tool for value creation. The third integral idea is scrupulous communication; both horizontally and vertically. It does not matter which type of risk communication canals are followed, the CEO should still have a firm understanding what the lowest-ranking employee is busy with and this employee should at least have an idea of the framework within which he is working.

These ERM practices have proliferated to such an extent that its examination is now forming an essential part of the rating procedures regulatory bodies conduct on organisations. These supervisors are not testing whether ERM is actually being implemented – they expect it to be applied already. Their examination at this stage in time consists of determining to what extent the ERM framework is rooted in a firm.

When defining ERM it should be duly noted that there are several risk dynamics and separate risks involved in making the process successful. The separate risks which are perceived are grouped under four headings: hazard risks, operational risks, financial risks and strategic risks. The way in which these risks interact and affect each other provide the risk dynamics.

Taking all of the preceding defining information into account, ERM can be delineated as follows: “ERM is a holistic and consistent approach to an organisation’s risk management at all levels of the organisation for all the stakeholders of the organisation (including employees, management, shareholders and clients) to reduce risks to predetermined levels and create new value.”

In Chapter two it is clear that the first step to consign an ERM framework is by laying an ERM culture among the employees. In chapter seven the grave result was apparent that very few ERM implementers have due support from either management or their colleagues. It is a significant success that a firm at least realises the value of ERM and then appoints an ERM controller, but this validation process should continue by incorporating a firm-wide ERM culture. Gorvett and Nambiar (2006:2) proposed to set up a Project Management Office for the time being to make the transition to full ERM practice a gradual one.

The next step in ERM implementation is to form a system of risk taxonomy. Even though risks are categorised under the four simple groups, there are many unknown and unexpected risks and of course risks which only apply to the insurance industry itself. After these risks have been classified they will be quantified and estimated with techniques such as copulas which have seen many advances in recent years.

The complement to the previous step is the clarification of the risk metrics, measures and measurements. The measures which have common everyday use were not presented here, whereas the new developments – especially by Wang (2002:52, 2006:1) – include the Wang and Esscher Transforms as well as Exponential Tilting. These methodologies were given a full description in this dissertation to present them in a more practical situation for the reader. Naturally risk measures can be created by an actuarial-related employee according to the need of a specific department and problem; however, any risk measure must always be subject to the four prerequisites set out by Artzner *et al* (1998:20).

Once the risks have been identified and valued; the organisation will naturally wish to alleviate them through risk mitigation. There are many methodologies for risk mitigation since the mitigation process is orientated towards the type of risk. The methodologies investigated here were those for achieving optimal debt and equity values, catastrophe bonds and how the ERM implementer can re-allocate risk.

The following step of risk modelling is actually still fused with risk taxonomy and mitigation. Risk modelling provides a method with which the risk management team can forecast the occurrence and nature of future problems. The greatest fear in risk management is infrequent, severe risks – i.e. losses. Since these risks (losses) rarely occur they are usually disregarded, but when they do occur their impact is profound and can bankrupt a firm instantly. For this problem the field of extreme value theory and tail behaviour of loss distributions provide many solutions which can be easily implemented.

A vital determinant of the methods and practices for risk management is economic capital. This capital which protects the firm from the financial problems is now also a balance sheet attribute requirement which supervisory bodies inspect meticulously. A long illustration is given for the impact of frictional cost on a firm's capital which is then followed by a clarification of the benefits of diversification in terms of capital.

The section on value creation is probably one of the most important aspects of ERM. Even though this is such a vital facet of ERM the literature is quite scarce. The clever derivation of Gold (2006:4) where systemic risk in the CAPM is eliminated was cited with permission from an improved paper by Gold (2006:1-7). The improved paper was obtained personally by the author of this dissertation. The notion of actually reducing the risk in this way seems completely plausible in mathematical sense, whereas real-world implementation differs a bit. This being said, it opens up new ideas for further investigation into complete mitigation of certain risks.

A completely separate section on operational risk was added to chapter two since it is the risk which causes the most corporate failures and yet it is the least studied. This type of risk is discussed along with its identification method and the actuarial modelling procedure of convolutions.

Chapter three provides a framework for the ERM user. It describes the areas such as retained capital levels and modelling practices which regulatory bodies will inspect and reveals allowances for the varying organisations. The guidebook of the Financial Services Authority provides much material for this purpose. The framework was then completed with the extensive discussion papers of the International Association of Insurance Supervisors.

The section of capital regulation links with the section on economic capital in chapter two. The treatment of capital is now, however, from the supervisors' point of view. This supplies an introduction to the rating procedure, as performed by Standard & Poor's.

Chapter four answered the problem statement of who actually implements ERM. Who will be the ERM champion and controller, which employee will take responsibility for carrying out the ERM tasks at hand? In this chapter three key employees were identified, namely the actuary, the CRO and the internal auditor. Sometimes these employees are not permanently employed by the firm, but simply outsourced. Luckily with the regulatory practices as described in chapter three their duties and actions are becoming much more defined and their role in the ERM framework is clear.

The actuary in this role should especially have detailed skills. The actuary is being transformed into a multi-faceted profession where the person filling the job should be able to act as an internal regulator, chief communicator and confidante of the firm's reserve function.

The investigation in chapter five of ERM education is a presentation of the pre-emptive strike that an ERM framework and its implementers should take in order to affirm its future success. ERM should naturally be taught at tertiary level to students studying actuarial sciences, financing and risk management or related courses. South Africa is participating fully in this endeavour of making ERM education an accessible part of tertiary education. Concerning the two working groups which are compiling the ERM syllabus, South Africa is represented by Riaan de Jongh of the North-West University's Business, Mathematics and Informatics department on the Syllabus working group while Janina Slawski – President of ASSA – is the South African envoy to the Recognition working group.

In chapter five the syllabus is presented as briefly as possible whilst still giving a full description of the expectations which the recognition working group has of potential candidates. The chapter then concludes with a section on the training of a Chartered Enterprise Risk Analyst.

Chapter six inspects the benefits in empirical terms of implementing an ERM framework. The results of two studies are presented, along with their models and conclusions which in a universal sense might not seem very conclusive at all, but the model implications provide a proper introduction for the study in chapter seven which asserts the situation in the South African industry.

The questionnaire and data set used in chapter seven are fully explained in the chapter itself. The analysis inspected every question separately and then compared the South African results with those of the United Kingdom. Overall it can be concluded the South African industry is on track; there were even some areas in which South Africa outperformed the UK. There are fewer firms in SA and they are more often than not much smaller than UK firms – e.g. the same scaling factor was used in the UK where 1 billion and 10 billion served as the classification boundaries, however, pounds sterling was the applied currency and thus implies much greater values than the South Africa classification system.

10.3. Closing Remarks

Many of the authors cited and quoted for this dissertation lamented that the literature on ERM is grossly lacking. Luckily with all the working groups, the CRO conferences, and the workshops conducted by the ERM-II the progression rate is increasing exponentially. Two authors stand out in this respect: Shaun Wang and Gary Venter. Their specialisation and proliferation know no bounds and they are certainly the leading world experts on ERM.

That being said, even in their work it is apparent that ERM is complex, far-ranging and a vague subject. Specialisation is important and improves future development, but the basics are found lacking in the most instances. These basics include training in quantification techniques and modelling experience but also hindrances such as deficient corporate support.

It was clear in the study of the trends in the South African industry that small companies are highly organised as opposed to poor system coordination in the large dominating entities. Employees in small companies were fully-informed and provided accurate data promptly, whereas many larger organisations were lethargic in their methods which also proved to be conducted quite surreptitiously.

The best way to solidify ERM in the South African insurance industry is to dispense with the traditional silo disaggregation-regime, and push with the new generic ERM framework.

Appendix A

3.3. Risk Taxonomy

3.3.2. Copulas

With $T = C(U)$, the marginal distribution function for copula T is given as:

$$F_T = \frac{1}{(n-1)!} \times \int_0^t \varphi^{-1(n)}(w) [\varphi(w)]^{n-1} \varphi'(w) dw$$

With repeated partial integration the cumulative distribution function has the representation:

$$F_T = t + \sum_{k=1}^{n-1} \frac{1}{k!} \times (-1)^k \varphi^{-1(k)}(\varphi(t)) [\varphi(t)]^k \quad .$$

3.3.2. Copulas

Sklar's Theorem

Let H be a two-dimensional distribution function with marginal distribution functions F and G . Then there exists a copula C such that

$$H(x, y) = C(F(x), G(y))$$

Conversely, for any univariate distribution functions F and G and any copula C , the function H is a two-dimensional distribution function with marginals F and G .

Furthermore, if F and G are continuous, then C is unique.

Weisstein, Eric W. "Sklar's Theorem."

<http://mathworld.wolfram.com/SklarsTheorem.html>

4.2. Risk Mitigation

4.2.3. Optimal Debt and Equity Values: Modelling Implications

The Dirac delta function was added to the equation to ensure the term it multiplies will have a non-negligible contribution to the integral. The function is defined as follows:

$$\delta^{\mathcal{D}}(x - x_0) = 0 \text{ if } x \neq x_0$$

$$\text{And } \int \delta^{\mathcal{D}}(x - x_0)f(x)dx = f(x_0)$$

4.2.4. Catastrophe Bonds

The Wang Transform is defined by the following equation in Wang (2006:91):

$$F_X(x) = g(F(x)) = \Phi[\Phi^{-1}(F(x)) - \lambda]$$

When the X-variable here is assumed to be a continuous variable, the Wang Transform corresponds to the following Radon-Nikodym derivative:

$$RN_g(x) = g'(F_X(x)) = \exp\left(\lambda \cdot \Phi^{-1}(F_X(x))\right) \cdot \exp\left(\frac{-\lambda^2}{2}\right)$$

This function was implemented by the author himself to obtain the graph presented in the corresponding section of the dissertation.

4.3. Risk Modelling

4.3.4. Mixture Models

$S_i(t)^w$ must be a function that satisfies

$$S_i(t)^w = e^{-\int_0^t \lambda_i(u) du}$$

for some hazard function $\lambda_i(u)$.



9.3. The Analysis and Comparison

9.2.2. The Data

Basic details for the South African insurance industry were obtained from:

<http://www.insurance.za.org/insurance-directory.htm>

(Date of Access: 14 March 2008)



Appendix B

9.3. The Analysis and Comparison

The full questionnaire is given here in the form that it was sent out to the respondents.

Your firm

Question 1

In the first column of the following table certain classes of business for life insurance are given. Determine the importance of each of these by indication one option on each line.

Classes of business	Minor	Modest	Significant	Principal
With-profits				
Property-linked				
Index-linked				
Protection				
Annuity				

Question 2

Choose which of the following best describes the ownership structure of the ultimate parent organisation.

Listed	
Shareholder-owned but not listed	
Mutual	

Question 3

Does your firm provide bancassurance?

Yes	
No	

Question 4

Indicate the size of the firm – with respect to assets – by choosing one of the following.

More than R10 billion	
R1-10 billion	
Less than R1 billion	

Question 5

Does the firm in question actively writing new life insurance business?

Yes	
No	

Risk Management Approach

Question 6

To which degree in there a form ERM present in the firm's operations? Use a rank from 0 to 5 where:

0 – no distinguishable risk management system

5 – fully functioning ERM system

Today	
2 years ago	

Question 7

To what level does the risk management policy relate to the firm's overall business goals? Choose one description.

Directly linked	
High incidence of linkage	
Certain extent of overlapping	
No linkage	
Not applicable	

Question 8

Indicate the top three reasons for the expansion of your firm's risk management practices. Use the indicators:

- 1 – top reason
- 2 – second reason
- 3 – third reason

Leave the other options unmarked.

	Rating		Rating
Good business practice		Risk-related losses (near misses) in the industry	
Competitive advantage		Risk-related losses (near misses) in your firm	
Rating agency's approval		Reduce volatility of financial results	
Investment community pressure		Scarcity of capital	
Corporate governance guidelines		Other (Specify):	

Risk Organisation Structure

Question 9

Which of the following heads up the risk management? Indicate only one.

Finance Director	
Chief Risk Officer	
Appointed Actuary/Chief Actuary	
Other (Specify)	
No explicit risk management team	

Question 10

Once again using a ranking from 0 to 5, where 0 is not important and 5 is utmost important, rank the skills as you deem fit for a risk management team.

	Rating		Rating
Accounting/Financial		Operations	
Actuarial		Statistical	
Asset management		Strategic planning	
Legal/Compliance		Tax	
Marketing			

Question 11

What amount of personnel work in the risk management department?

Question 12

Are any of the following employees present in your firm? Tick one box on each line.

	Yes	No
Chief Risk Officer		
Risk Committee		

Question 13

Indicate all the personnel who serve on the risk committee, denoting the chair person with a "C".

Chief Executive		Chief Risk Officer	
Finance Director		Appointed/Chief Actuary	
Head of Internal Audit		Non-executive Director(s)	
Chief Investment Officer		Other (Specify)	
Chief Operations Officer		Not Applicable	

Question 14

Given a perfect situation, which of the options mentioned below would you consider being the optimal attribute of the risk control structure? Mark one box in each column.

	Business Unit	Internal Audit
More autonomous of ...		
More incorporated with ...		
No changes necessary		
Other (Specify)		

Risk Identification

Question 15

To which degree is a generic approach used concerning risk identification *across* the firm? Rank on a scale from 0 to 5 where:

0 – no commonality

5 – complete generic approach

--

Question 16

Does the firm sustain one central risk register/map?

Yes	
No	

Question 17

When any material risks arise, is the board notified?

Yes	
No	

Question 18

To whom is the risk identification entrusted? Mark one or more boxes.

Business unit/Function managers	
Risk Function (Committee)	
Internal Audit	
Other (Specify)	

Question 19

How often is the risk identification process (re-)implemented? Mark only a single box.

Annually	
Quarterly	
Monthly	
Other frequency (Specify)	
Continuous process	
Never	

Risk Measurement

Question 20

Which of the measures given below are calculated and are reported to the Board of Directors once results have been obtained? Mark as applicable.

	Calculated	Reported to Board
Stress test losses		
Probability of solvency level less than a specified level		
Value-at-Risk		
Other (Specify)		

Question 21

In the table on the following page various methods are listed with which the risks could be calculated. Please note that for the risks marked with an asterisk (*), the firm's specific portfolio is implied (as opposed to the market portfolio).

How are the following risks assessed? Mark one box for each row.

	Ad hoc calculation	Subjective assessment	Traffic light system	Deterministic scenarios	Stochastic Models
Equity Market					
Equity Portfolio*					
Interest rate					
Property markets					
Property portfolio*					
Implied volatility: equity					
Implied volatility: interest rates					
Credit spreads					
Corporate bond default					
Reinsurance counterparty					
Liquidity					
Mortality assurance					
Mortality longevity					
Morbidity					
Persistency					
Expense					
Tax					
Legal/Litigation					
Regulatory					
Mis-selling					
Other operational					

Question 22

In what way are the risk measures utilised? Mark as applicable.

Management information	
Limit/Risk appetite setting	
Calculating business performance	
Allocating capital	
Calculating remuneration	
Communicating with rating agencies	
Other (Specify)	

Question 23

Taking the following pairs of risk into account, do you allow for diversification benefits? Indicate a yes with a “Y” and a no with “N” in the boxes which are not shaded.

	Market	Credit	Insurance	Liquidity	Operational
Market					
Credit					
Insurance					
Liquidity					
Operational					

Risk Management

Question 24

Indicate whether the listed risk measurement processes are used directly.

Determining insurance risk retention levels	
Determining the strategic asset allocation	
Determining the tactical asset allocation	
Investigating possible hedges	
Weighing up expenditure on risk controls	
Assessing strategic options	
Setting risk policies	
New product design	
New product pricing	
Other (Specify)	

Miscellaneous

Question 25

According to the following table, which would you consider the most significant obstacles to effective ERM? Mark as applicable.

Cost		Lack of senior management support	
Insufficient data		Diversity of risks	
Insufficient resource		ERM an impractical goal	
No suitable systems		Other (Specify)	
Low priority		No significant obstacles	

Question 26

What will the expenditure be in the coming three years for the various components of risk management? Mark one box on each line.

	No expenditure	Modest	Significant	Very significant
Risk organisation structure				
Risk identification				
Risk measurement				
Risk management				



Acknowledgements

The questionnaire used for the ERM implementation analysis in South Africa, which is a slightly modified version of the original, was obtained from Mr. David Bartlett to whom the utmost gratitude is expressed. He is co-author of the paper 'Risk Management by UK Life Assurers – A Survey' which is also used as special reference in chapter nine.

The research for this dissertation was extensively supported by a grant from the National Research Foundation – internal NWU reference number: DNN 308.

Bibliography

ACHARYYA M. 2006 An abstract of the PhD thesis titled Exploring the understanding, motivation, design, challenges and performance of Enterprise Risk Management in the insurance industry: an empirical study on four major European Re/insurers http://www.ermii.org/News/Abstract_Mahdu.pdf 2p.

ANON. InsuranceZA <http://www.insurance.za.org/insurance-directory.htm> Date of Access: 14 March 2008

ARTZNER, P., DELBAEN, F., EBER, J-M. & HEATH, D. 1998. Coherent Measures of Risk. <http://www.math.ethz.ch/~delbaen/ftp/preprints/CoherentMF.pdf> 24p.

BARRIEU, P. 2007. On Pareto optimal allocations for multi-period risks. <http://isfaserveur.univ-lyon1.fr/ermii-research-workshop/Ermii-ISFA-Barrieu.pdf> 26p.

BARTLETT, D., CHAPLIN, M., DOWD, K., KELLIHER, P. & O'BRIEN, C. (Life Research Committee) 2005. Risk Management by UK Life Assurers: A Survey. www.actuaries.org.uk/___data/assets/pdf_file/0007/27574/risksurvey.pdf 14p.

BASEL COMMITTEE (ON BANKING SUPERVISION) 2006. International Convergence of Capital Measurement and Capital Standards. <http://www.bis.org/publ/bcbs128.pdf> 347p.

BÖCKER, K. & HILLEBRAND, M. 2007. Interaction of Market and Credit Risk: An Analysis of Inter-risk Correlation and Risk Aggregation. www.ermisymposium.org/pdf/papers/Bocker.pdf 29p.

BROADIE, M., CHERNOV, M. & SUNDARESAN, S. 2006. Optimal Debt and Equity Values in the Presence of Chapter 7 and Chapter 11.

www.ermii.org/Research/bcs_2006.pdf 55p.

CALANDRO, J., FÜSSLER, W. & SANSONE, R. 2008. Enterprise Risk Management – an insurance perspective and overview.

www.capco.com/files/pdf/62/PART%202/Opinion_Enterprise%20risk%20management%20an%20insurance%20perspective%20and%20overview.pdf 6p. (p.117-122)

CHANDRA, V. & SHERRIS, M. 2005. Capital Management and Frictional Costs in Insurance. www.ermii.org/Research/downloads/chandrasherris2005.pdf 33p.

COMITÉ EUROPÉEN DES ASSURANCES & MERCER OLIVER WYMAN LTD. 2005. Solvency Assessments Models Compared.

www.cea.eu/uploads/DocumentsLibrary/documents/CEA%20-%20Mercer%20Oliver%20Wyman%20-%20Solvency%20II%20-%20Final.pdf 57p.

D'ARCY, S.P. 2005. On Becoming an Actuary of the Fourth Kind.

www.casact.org/pubs/proceed/proceed05/05755.pdf 10p. (p.745-754)

DAVENPORT, E.W. 1993. The role of the actuary in an insurance brokerage firm

www.casact.org/pubs/dpp/dpp93/93dpp209.pdf 14p. (p.209-222)

ESTRELLA, A. 2003. The Cyclical Behavior of Optimal Bank Capital.

www.ny.frb.org/research/economists/estrella/Cyc_mar2003wp.pdf 54p.

FDIC – FEDERAL DEPOSIT INSURANCE CORPORATION. 2003. Supervisory Guidance on Operational Risk Advanced Measurement Approaches for Regulatory Capital.

www.fdic.gov/regulations/laws/publiccomments/basel/oprisk.pdf 41p.

FELDBLUM, S. 2007. Enterprise Risk and Management Incentives.

http://www.soa.org/library/journals/actuarial-practice-forum/2007/january/APF0701_3.pdf 32p.

FSA – FINANCIAL SERVICES AUTHORITY. 2008a. Online Handbook.

<http://www.fsa.gov.uk/Pages/About/Aims/index.shtml> (Date of Access: 18 July 2008)

FSA – FINANCIAL SERVICES AUTHORITY. 2008b. Online Handbook.

<http://www.fsa.gov.uk/Pages/About/Aims/Principles/index.shtml> (Date of Access: 18 July 2008)

FSA – FINANCIAL SERVICES AUTHORITY. 2008c. Online Handbook.

<http://fsahandbook.info/FSA/html/handbook/SUP/1> (Date of Access: 18 July 2008)

FSA – FINANCIAL SERVICES AUTHORITY. 2008d. Online Handbook.

<http://fsahandbook.info/FSA/html/handbook/SUP/4> (Date of Access: 4 August 2008)

FSA – FINANCIAL SERVICES AUTHORITY. 2008e. Online Handbook.

<http://fsahandbook.info/FSA/html/handbook/SUP/3> (Date of Access: 4 August 2008)

GIESECKE, K. & WEBER, S. 2003. Cyclical correlations, credit contagion and portfolio.

www.stanford.edu/dept/MSandE/people/faculty/giesecke/paper_sk_voter5.pdf 28p.
(p.3009-3036)

GOLD, J. 2006. Bye Bye β , Bye Bye.

[www.ermsymposium.org/2006/pdf/papers/Gold paper 4-21-06.pdf](http://www.ermsymposium.org/2006/pdf/papers/Gold%20paper%204-21-06.pdf) 7p.

GOLDSTEIN, R., JU, N. & LELAND, H. 2001. An EBIT-Based Model of Dynamic Capital Structure. www.haas.berkeley.edu/groups/finance/WP/Goldstein-Ju-Leland.pdf 30p. (p.483-512)

GORGE, G. 2007. Economic Capital & Diversification: a practical experience. <http://isfaserveur.univ-lyon1.fr/ermii-research-workshop/Ermii-ISFA-Gorge.pdf> 10p.

GORVETT, R. & NAMBIAR, V. 2006. Setting up the Enterprise Risk Management Office. www.ermssymposium.org/2006/pdf/papers/Gorvett%20and%20Nambiar%20paper.pdf 11p.

GRONDIN, T., SINGH, R., KEAN, S., ROBINET, F., BOLLER, P., HENRARD, L., CAPREZ, P., HELE, J., SHAMIEH, C., CROSSLEY, A., MUMENTHALER, C., OECHSLIN, J. & FISHER, W. (Chief Risk Officer Forum) 2005. A framework for incorporating diversification in the solvency assessment on insurers. www.soa.org/files/pdf/research-framework-inc-div.pdf 59p.

GUPTA, B. & CHATIRAS, M. 2003. The Interdependence of Managed Future Risk Measures. <http://cisdm.som.umass.edu/research/pdffiles/Interdependance%20of%20Risk%20Measurments.pdf> 34p.

HEYDE, C.C., KOU, S.G. & PENG, X.H. 2007. What is a good risk measure: bridging the gaps between robustness, subadditivity, prospect theory and insurance risk measures. www.fdic.gov/bank/analytical/cfr/2007/apr/KOU_hkpv1.pdf 31p.

HIEMSTRA, S.W. 2007. An Enterprise Risk Management View of Financial Supervision.

http://www.ermii.org/Research/downloads/ERM_Hiemstra_10172007_sml.pdf 34p.

HOLTON, G. 2002. Risk Measure and Risk Metric.

http://www.riskglossary.com/link/risk_metric_and_risk_measure.htm Date of Access:
5 June 2008

HOYT, R.E. & LIEBENBERG, A.P. 2008. The Value of Enterprise Risk Management: Evidence from the U.S. Insurance Industry.

www.ermssymposium.org/pdf/papers/Hoyt.pdf 27p.

IAIS – International Association of Insurance Supervisors 2007a. Guidance paper on Internal Models.

http://www.naic.org/documents/committees_e_isawg_071201_guidance_paper_internal_models.pdf 21p.

IAIS – International Association of Insurance Supervisors 2007b. Guidance Paper on Capital Requirements.

http://www.naic.org/documents/committees_e_isawg_071201_guidance_paper_capital_requirements.pdf 17p.

IIA – Institute of Internal Auditors 2004. The Role of Internal Auditing in Enterprise-wide Risk Management. www.theiia.org/iia/download.cfm?file=283 8p.

KUNREUTHER, H., DEODATIS, G. & SMYTH, A. 2003. Integrating mitigation with risk transfer instruments. <http://opim.wharton.upenn.edu/risk/downloads/03-13-HK.pdf> 18p..

LAM, J. 2000. Enterprise-wide risk management and the role of the chief risk officer. www.erisk.com/Learning/Research/011_lamriskoff.pdf 5p.

LEBARON, B. & SAMANTA, R. 2004. Extreme Value Theory and Fat Tails in Equity Markets. <http://people.brandeis.edu/~blebaron/wps/tails.pdf> 32p.

LEE, P.R. & SHIMPI, P. 2005. The Chief Risk Officer: What does it look like and how do you get there?

<http://www.rmmag.com/Magazine/PrintTemplate.cfm?AID=2855> Date of Access: 29July 2008

LEWIN, C. 2005. Enterprise Risk Management: a structure for managing risks. 6p. Original document is in possession of author.

MANGO, D. 2006. Applying Actuarial Techniques in Operational Risk Modelling. <http://www.soa.org/library/monographs/other-monographs/2006/july/Mango-abstract.pdf> 21p.

McGRATH, M.P. 2007. A Group Cognitive Approach to Operational Risk Identification and Evaluation.

www.ermssymposium.org/2007/pdf/handouts/A1/A14_combo.pdf 28p.

McNEIL, A.J. 2007. Mixture Models of Dependent Risks. <http://isfaserveur.univ-lyon1.fr/ermii-research-workshop/Ermii-ISFA-McNeil.pdf> 25p.

MEDINA, P.K. 2007. When is diversification a benefit?

<http://isfaserveur.univ-lyon1.fr/ermii-research-workshop/Ermii-ISFA-Koch.pdf> 10p.

MICCOLIS, J., BREHM, P., DICKSON, K., FRANKLIN, B., KIRSCHNER, G., KOLLAR, J., MANGO, D., MORIN, F., NELSON, C. & ZUBULAKE T. (CAS Committee) 2003. Overview of Enterprise Risk Management. www.casact.org/research/erm/overview.pdf 64p. (p.100-164)

PAGACH, D., BEASLEY, M. & WARR, R. 2007. Information Conveyed in Hiring Announcements of Senior Executives Overseeing Enterprise-Wide Risk Management Processes. [www.aerf.org/pdf/Beasley-Pagach-Warr winning paper 2007.pdf](http://www.aerf.org/pdf/Beasley-Pagach-Warr%20winning%20paper%202007.pdf) 34p.

PANJER, H. & ROWLEY, F. 2008a. Report to Presidents Forum. 19p.

PANJER, H. & ROWLEY, F. 2008b. A Global Enterprise Risk Management Qualification. 24p. (Both of the Panjer and Rowley documents obtained via Prof. DCJ de Jongh from Prof. PJ de Jongh – Representative of ASSA on Syllabus Working Group for Global Enterprise Risk Management Designation Initiative)

POULIOT, H. 2004. New York - Chief Risk Officer (CRO) Forum. www.soa.org/files/pdf/091_bk-ny04.pdf 20p. (p.1-6)

RECH, J.E., KNOTT, J. & DOODIAN, J.J. 2008. ERM and other Considerations related to a Principles-based Approach. www.erm-symposium.org/pdf/papers/Rech.pdf 18p.

SCHACHERMAYER, W., JOUINI, E. & TOUZI, N. 2007. Optimal risk sharing for law invariant monetary utility functions. www.fam.tuwien.ac.at/~wschach/pubs/preprnts/prpr0122.pdf 28p.

SCOTT, J. s.a. Economic Capital: At the heart of managing risk and value in insurance operations. [www.iisonline.org/pdf/Scott - Economic Capital.pdf](http://www.iisonline.org/pdf/Scott%20-%20Economic%20Capital.pdf) 10p.

S & P – STANDARD & POOR'S 2007. Criteria: Summary Of Standard & Poor's Enterprise Risk Management Evaluation Process For Insurers.

<http://www2.standardandpoors.com/portal/site/sp/en/us/page.article/2,1,6,4,1148449517749.html> Date of Access: 29 July 2008

VENTER, G. 2006. Adapting Banking Models to Insurer ERM.

http://www.ermii.org/Research/Adapting_Banking_Models_to_Insurer_ERM.pdf 23p.

WANG, S. 1998. Aggregation of Correlated Risk Portfolios: Models and Algorithms.

www.casact.org/pubs/proceed/proceed98/980848.pdf 92p. (p.848-939)

WANG, S. 2002. A Set of Methods and Tools for Enterprise Risk Capital Management and Portfolio Optimization.

www.casact.org/pubs/forum/02sforum/02sf043.pdf 36p. (p.43-78)

WANG, S. 2004. Cat Bond Pricing Using Probability Transforms.

<http://www.ermii.org/Research/catbondpaperbywang.pdf> 11p. (p.19-29)

WANG, S. 2006. Normalized Exponential Tilting: Pricing and Measuring Multivariate Risks. [www.soa.org/library/journals/north-american-actuarial-](http://www.soa.org/library/journals/north-american-actuarial-journal/2007/july/naaj0703-5.pdf)

[journal/2007/july/naaj0703-5.pdf](http://www.soa.org/library/journals/north-american-actuarial-journal/2007/july/naaj0703-5.pdf) 20p.

WANG, S. 2007. Economic Capital and Diversification at Group Level.

<http://isfaserveur.univ-lyon1.fr/ermii-research-workshop/Ermii-ISFA-Wang.pdf> 39p.

WANG, S. & FABER, R. 2006. ERM-II: Enterprise Risk Management for Property-Casualty Insurance Companies.

www.ermii.org/Research/downloads/erm_paper080106.pdf 64p.

WEISSTEIN, E.W. Sklar's Theorem.

<http://mathworld.wolfram.com/SklarsTheorem.html>

WOLF, R., KLUGMAN, S. & WONG, K. 2008. CERA – The New Actuarial Opportunity: Earning the Designation.

<http://www.casact.org/education/spring/2008/handouts/wolf.pdf> 25p.

WU, F., VALDEZ, E. & SHERRIS, M. 2006. Simulating Exchangeable Multivariate Archimedean Copulas and its Applications.

<http://wwwdocs.fce.unsw.edu.au/actuarial/research/papers/2006/SimulatingArchimedeanCopulas.pdf> 18p.