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1. Introduction

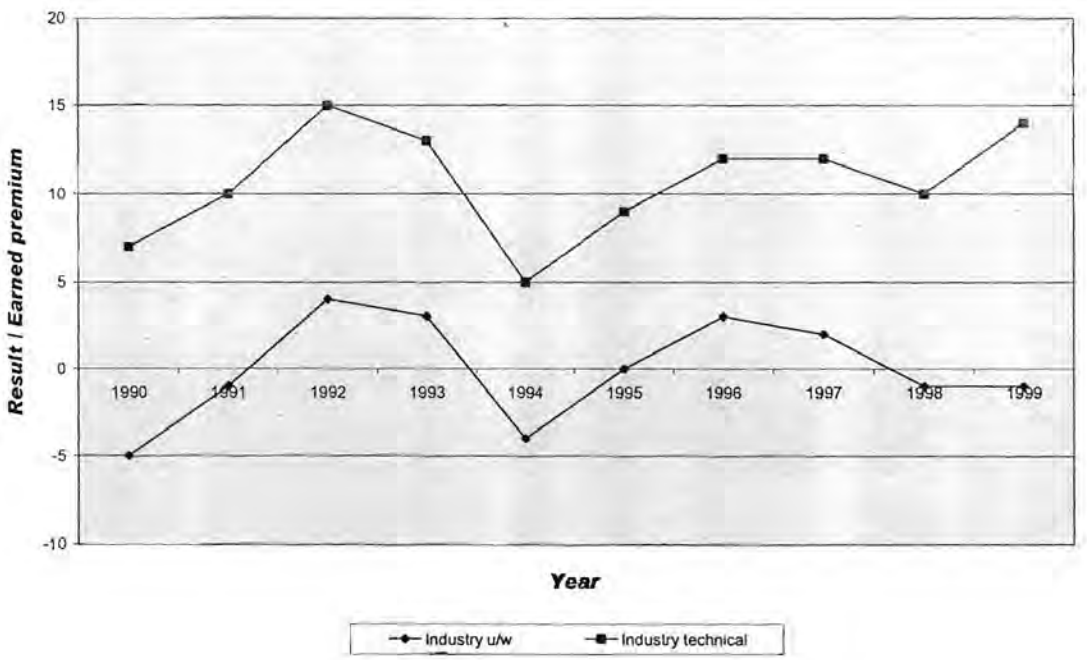
1.1 The reasons for this study

In recent years the general insurance industry has been exposed to a variety of events which have adversely affected the entire industry in one way or another. Lloyds of London has been exposed to an aggregation of exposure leading to a spiral of claims. This, combined with adverse underwriting results, has led to the total restructuring of that industry. In South Africa the short-term insurance company IGI has been placed under curatorship due to insolvency. Cycles of underwriting results, namely periods of losses followed by periods of profits[1] have become more pronounced. However, it is getting all the more difficult to adequately increase premium rates to cover past losses in the face of growing competition.

These reasons have led to the realisation that a better assessment of the risks to which a company is exposed is of paramount importance. To use the analogy of a production company: In a normal production company the company first incurs its outgo and then receives its income on the product. For the insurance industry the reverse is true as the company first receives premiums and subsequently pays claims. As a result some managers have, in the past, been relaxed about

[1] Information provided by the Financial Services Board, the regulating authority of insurance companies within South Africa, shows the following graph. The graph clearly shows the results of the entire short-term insurance industry over time from 1990 to 1999. A cycle is apparent in the underwriting results.

Underwriting cycle comparison



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the assessment of the expected claims cost of a policy as the problem could be solved by writing more policies. It is clear however, that this approach of cash-flow underwriting is neither equitable nor durable. These managers soon realised the problems in this approach as competition for business increased and margins were reduced. The end result was that the necessity for proper risk management, in particular proper and pro-active evaluation of risks, was confirmed.

The field of information technology has also seen tremendous development in recent years. This development has placed very complex modelling techniques within the grasp of many analysts (BRIGHAM 1985). Complex structures can now be modelled using numerical techniques. This approach only recently came to the fore due to the increased computing capability which is now available.

This study has originated from the above two factors namely the need for better analytical[2] risk evaluation and information technology capacity. The aim of the study is to provide a guide for the analytical based methodology as part of risk management to be used in a general insurance environment. This methodology will enable management to obtain a better understanding of the business procedures to the extent that management will be able to gauge the expected variability in the business. Consequently proper risk management principles can then be applied to reduce the cost of risk and optimise the return to the insurer's shareholders.

1.2 A structured approach to risk management

Webster's dictionary provides the following definition of risk:

"a hazard; a peril; exposure to injury; the possibility of suffering a loss"

In this dissertation risk will be considered in accordance with the benchmark used to measure risk. When not stated explicitly, risk is assumed to be the possibility of suffering a loss.

Risk can broadly be categorised as follows:

[2] Analytical risk evaluation refers to the process of quantifying risk rather than describing risk in a qualitative manner. Details of such techniques are widely available. DAYKIN, PENTIKAINEN and PESONEN 1994 provide a solid framework.

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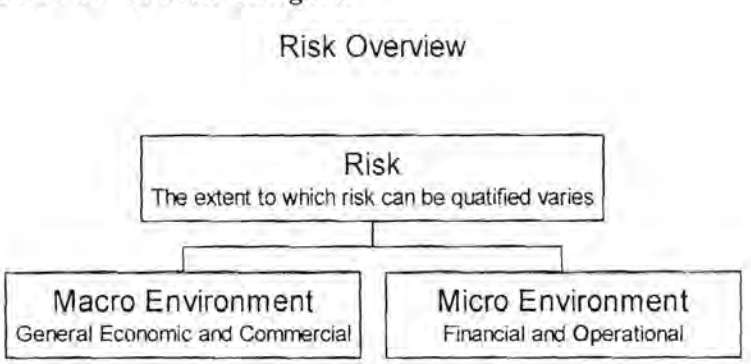
Figure 1: An Overview of Risk Categories



There is definite overlap between the macro and micro environment as any micro environment is a subset of the macro environment.

Risk management involves the following (CARNEGIE MELLON SOFTWARE ENGINEERING INSTITUTE 2000):

1. Identification: Search for and locate risks.
2. Analysis: Transform risk data into decision-making information.
3. Evaluation: Consider the impact, probability and time frame of the risks identified.
4. Plan: Translate risk information into decisions and mitigating strategies.
5. Implementation of the strategies.
6. Tracking: Monitor and evaluate the strategies. This involves the comparison of actual versus expected experience.
7. Control: Correct deviations from the risk mitigating strategies.

MICCOLIS[3] (2000) considers the assessment of risk to be the first step in the process of enterprise risk management. He states that risk should be described as fully as possible, taking the following into account:

1. Casual factors and consequences.
2. Timing of risk. For example short term or long term or seasonal effects.
3. Correlation with other risks[4], including whether a given risk could trigger or be triggered by other risks and whether certain risks are negatively correlated and therefore present natural hedges against each other.
4. Current risk mitigation strategies and their effectiveness to date.

[3] MICCOLIS is a contributor to the expert commentary published by the International Risk Management Institute www.irmi.com and works for Tellinghast-Towers Perrin. He has published a series of articles on Enterprise risk management which can be obtained from this web site.

[4] Correlation of risks can be regarded as an item that should be treated with extreme caution. EMBRECHTS (2000) shows empirically that correlation matrices cannot be assumed to be fixed over time.

In particular he considers the extreme case of stock market crashes and finds that normal correlation structures change completely. As a result collective modelling approaches cannot be used on a stand alone basis but should rather be considered on a scenario basis in the extreme.

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5. Either historical data on or expert assessment of a given risk's impact on financial performance.

This dissertation will consider the application of risk management in a general insurance environment. The approach consists of
1. An appraisal of areas of risk and uncertainty.
2. Identification and specification of the problem.
3. Developing and implementing the solution.
4. Monitoring and control of the solution.

The first component is the same as the first proposed by CMSEI. The second provides a consolidation of components 2 to 4 proposed by CMSEI. The third component is the same as the fifth proposed by CMSEI and the fourth consolidates the sixth and the seventh components proposed by CMSEI.

INSTITUTE OF ACTUARIES AND FACULTY OF ACTUARIES core reading on study material (1995 to 1998) for subject 403 also provide this approach as the basis for its syllabus.

1.3 Appraisal of areas of risk and uncertainty.

As indicated in Figure 1: An Overview of Risk Categories, risk is identifiable on a macro and a micro level. Setting all the risk factors without a detailed analysis into a specific insurance operation is not possible as risk on a micro level is dependent on the business operation under investigation. Some of the areas of risk and uncertainty are listed below. This dissertation also includes areas of risk and uncertainty identified by other institutions. These are mentioned in later chapters.

1.3.1 Macro risks: The general economic and commercial environment

Before setting the problem specification of this study, the general economic and commercial environment in which a general insurer operates must be considered and understood. A variety of different risks may arise from this environment. A list of some of the factors in the environment that may have an impact on business operations is provided below. This list is not exhaustive.

1.3.1.1 Statutory and regulatory requirements

The state of the country of domicile of the insurance company may impose certain constraints on insurance companies in order to protect the public interest. In particular the state will be concerned that all companies are run by fit and proper persons and that all companies are sufficiently capitalised in order to protect policyholders' interests. Possible capital requirements will ensure that the company is able to pay claims in adverse circumstances.

A change in statutory and regulatory requirements can have a serious impact on business operations. For example a change in capital requirements might lead to the liquidation of an insurance company. For example, in the instance of

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increasing capital requirements, some companies with low levels of solvency may subsequently find that they are unable to meet the new requirements. As a result the regulator may require that the company be put in liquidation.

1.3.1.2 Legal or legislative requirements

Legal requirements may be imposed on the insurer. This can range from compulsory insurance to employment policy for staff. The impact of such requirements can enhance or constrain business procedures.

1.3.1.3 Reporting requirements

One aspect that has a tremendous impact on shareholders' appreciation of return is the manner in which results are presented. In a general insurance environment, results may be more difficult to assess due to uncertainties in the business. As a result any changes in reporting requirements may change shareholders' perception of return and the most appropriate manner in which to maximise this return[5].

1.3.1.4 Tax

The fiscal policy of the state will have a direct impact on the return to shareholders. Any change in tax structure can have a direct impact on return. Where tax is not applied consistently to all classes of business, this will lead to changes in business profiles in order to enhance return by paying lower levels of tax.

1.3.1.5 Demographic environment

Changes in the demographic profile of a country and also of the policyholders of an insurer can have an important impact on the results. For example, the current trend in the ageing of populations worldwide is expected to lead to higher costs of medical expenses.

1.3.1.6 Social environment

Social changes, though often unforeseen, can have a devastating effect on the return of shareholders. Recent court action as a result of increased knowledge relating to latent claims, for example asbestosis claims, has lead to the demise of many insurance companies and names in the Lloyds market. In addition increased consumer awareness also leads to increasing numbers of legal actions brought against insurers. This also has a direct impact on shareholders' return.

[5] For some readers this may not be intuitively obvious. Due to the inefficiency of markets and the lack of proper information pertaining to business, estimates are often required in order to present results. The lower the level of information or the more variable the business the less exact the results presented will be.

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1.3.1.7 Political environment

Changes in the political dispensation of the country of domicile can impact on the operation of an insurer. In addition political risk will affect the availability of capital in a country of domicile and will therefore affect shareholders' requirements. Changes in the political paradigm may even lead to the closure of an insurer.

1.3.1.8 Economy

The state of the economy will impact on the investment strategy and also the return on investments achieved by the insurer. This has a direct impact on return on capital. Changes can pertain to investment returns, levels of inflation, economic activity, currency rates, cost of labour, borrowing requirements or levels of investment, to name a few. Shareholders' requirements cannot be set without regard for the level of risk inherent in the economy.

1.3.1.9 Technology

Advances in technology have made it possible to present an insurer as a collective risk model. In addition technology also allows insurers to manage their risks quicker through regular reporting. Advances in technology have also made the application of the methodology set out in this dissertation possible.

1.3.2 Micro risks: The financial and operational environment of the insurer

MICCOLIS provides the following list for which business strategies can be developed in order to mitigate risk. Some of these items will be considered in detail later in this study. The first five factors are financial risks while the remainder are operational risks.

1.3.2.1 Pricing

Most insurance companies are in the business of accepting premium in return for the indemnification of insureds in the event of a loss for any or all insureds. Setting a price on the insurance provided is of critical importance for the future existence of the company. If business is written at inadequate rates the company will eventually fail. A proper appraisal of future risks as well as risk inherent in business already sold is important and is the topic of a future chapter.

1.3.2.2 Investment strategy[6]

Investment return is used to enhance premium rates as well as shareholders' returns. A proper understanding of investment opportunities and threats as well as the interaction with liabilities is as important as the appraisal of liabilities themselves. The graph on the first page of this chapter also shows the relative importance of investment returns. They are critical for the future existence of any short-term insurance company.

[6] GOLDMAN, SACHS & Co. and SWISS BANK CORPORATION 1998 provide a thorough non-technical overview of risk management in investment strategy.

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Investment risk can be investigated according to the risk inherent in income generated. The expected variability as well as the likelihood of default has to be considered. Similarly assets' capital values need to be considered. A sudden plunge in the value of assets may affect the solvency of the company.

The third aspect pertaining to investment strategy is the extent to which asset cash flows match those of liabilities. Any correlations between these cash flows also need to be considered at this stage.

Asset risk and the models appropriate to quantify this are also covered separately in a future chapter.

1.3.2.3 Capital structure

The most important problem specification considered later is that of optimal capital utilisation. This involves the consideration of the entire business portfolio and subsequently optimising the business process. MICCOLIS (2000) states that the optimisation of return on capital consists of three components:

1. Optimisation of growth of business
2. Optimisation of return on capital
3. Stability of earnings

1.3.2.4 Product mix and marketing strategy

The product structure and distribution channel is arguably one of the most important areas of risk and uncertainty. Furthermore the elasticity of demand for products need to be considered in order to allow for growth expectations relating to business volume as well as earnings. Marketing information for both accepted and declined contracts is required to properly manage this risk.

1.3.2.5 Reinsurance[7]

Reinsurance can function as a substitute for capital. As a result strategies pertaining to reinsurance are important in the optimisation of shareholders' return. Examples of reinsurance strategies will be addressed later in this study.

1.3.2.6 Human resource risks

These risks pertain to the recruitment, training and incentive schemes provided for staff. Human capital is of critical importance but the mitigation of these risks often lie in managerial strategies.

MICCOLIS (2000) differentiates between manageable and strategic risk mitigation. Manageable risks are those that the organisation can address with existing capabilities. These risks might include such things as weak contingency planning in critical facilities or midlevel employees dissatisfied with opportunities for advancement. The proper response to manageable risks is simply to use the

[7] COUTTS and THOMAS 1997 provide further insight in their paper "Modelling the impact of reinsurance on financial strength" This paper is highly recommended.

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existing organisational capabilities in mitigating them by assigning them to the appropriate managerial level.

Strategic risk factors are those that have to be addressed with substantial expenditures and / or a change in strategic direction. These can arise when an organisation enters unfamiliar business territory because of a major acquisition, or when a new competitor emerges, or when customers change their buying preferences.

1.3.2.7 Internal controls

These pertain to manageable risks. For an insurance company two areas of internal control that are extremely important are those of credit control and claims control.

Credit control refers to the collection of premium. For a direct insurance company this is less of a burden as the premium will be provided through direct debit order via a bank. For companies using brokers this is, however, not the situation. Broker balances can be substantial and if proper details are not kept then the insurer may very well be on risk for more or less policies than for which premiums are received. Policy records therefore have to be properly audited.

Claim control is also critical. Many insurance claims are fraudulent. The extent of the problem varies but is often cited by market players (R OTTO of OUTSURANCE Insurance Company). As a result it is of the utmost importance that claims that do not appear to be in line with general trends be investigated further and that the number of claims per policy also be investigated. Furthermore companies achieve great savings through incentives to service providers. Some of these strategies will be discussed again in later chapters.

1.3.2.8 Mergers and acquisitions

Mergers and acquisitions require integration of systems and change management. Often the cultures of companies or the operating systems are incompatible. This may render sub optimal returns if it is not managed properly.

1.3.2.9 Technology

Technology has also been identified in the macro risk environment. Technology is extremely important as it has a direct or indirect impact on almost all aspects of the business. A proper appraisal of technology is therefore critical.

1.3.2.10 Customer service

As with technology, customer service is advancing rapidly. Such changes in business processes need to be identified and managed. They do, however, not present risks which should be modelled. These risks are less quantifiable and their mitigation is conducted through proper management.

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1.4 Identification and specification of the problem

The problem specification of this study is two-fold:

1. A framework or model structure is required to test business practices.
2. The methodology on the assessment and quantification of the different types of risks inherent in this model is required.

A framework is required whereby risk managers can evaluate the risks to which a general insurance enterprise is exposed. This framework must enable managers to quantify the impact of different risks and test different business strategies. Following the tests, managers must be able to optimise their objectives.

Once the problem specified has been discussed, a methodology will be available to test and solve the problems faced by management. Management have to meet their objectives set by shareholders. For this dissertation the primary set of objectives of management is to optimise the level of return on shareholders' capital, optimise the level of growth and ensure a stable return of earnings over time.

The framework will also allow for other objectives and subsets of these objectives. This dissertation will consider the framework on the primary set of objectives specified above but the reader should bear in mind that this is not the sole purpose of the methodology laid out in this study.

The problem specification will be considered further below with reference to the required framework and the optimisation of shareholders' returns.

1.4.1 Setting the correct framework

This study deals primarily with the appropriate framework required to test and implement appropriate business strategies to optimise shareholders' returns. This framework will consider the following:

1.4.1.1 The structure of an insurance company[8]

The business framework of an insurance company must be set up on a simulation basis. This requires that all operational and financial processes be identified and modelled collectively. An evaluation of the financial statements and the areas of risk and uncertainty are required. Through these evaluations the financial model can be determined as well as those risks that are of primary importance.

[8] This dissertation originally started from the work conducted by CHRISTOFIDES et.al. on GISMO (General Insurance Stochastic Model Office) – Short-term modelling for management decisions. This paper was presented at the General Insurance Convention at Stratford-upon-Avon, October 1996.

The paper considers the modelling of all business processes of a general insurance company thereby enabling managers to adopt more appropriate decisions. The paper is based on asset liability modelling techniques and provides excellent reading material for this subject.

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The structure is set as follows (and explained in detail in the next chapter):

1. The balance sheet is first considered. This will render the embedded value of the company.
2. The financial statement is then considered. The consolidated movement on the income statement for a certain specified period of time will render the retained earnings available to shareholders after the period of projection.
3. These retained earnings can then be compared to the objectives set and different business strategies can be tested on the same criteria thereby identifying the most appropriate strategies.

1.4.1.2 The structure of the collective risk model

Once the structure of the insurance company has been determined the extent to which different elements of risk and uncertainty will be modelled on a collective basis must be determined. A balance will be required between the cost of such development and the possible return that management can obtain from additional development.

This structure will consider areas such as

1. Liability risk
2. Asset risk
3. Expense risk
4. Capital risk

These items are considered in depth in later chapters.

1.4.1.3 The quality of information

A model of an insurance operation has certain shortcomings as it is never possible to accurately predict the future. It is important to realise that the methodology developed in this study relies on the following:

1. As detailed information as possible on past experience as well as existing and future business structures.
2. Detailed knowledge of business procedures.

These items are combined to form the best estimate of future expected experience. It is important to note that these estimates may be wrong and as a result continual monitoring of expected experience versus actual experience is important to ensure that possible problem areas can be identified and resolved as soon as possible.

BERNSTEIN (1996) warns against applying the techniques of risk management blindly. It is important that the framework be tested regularly and that management is aware of the possible pitfalls inherent in a defective framework.

Once the appropriate framework has been set an objective can be tested in the framework.

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1.4.2 Evaluation of the primary objective: Optimising business strategies

In order to maximise the return, a benchmark of risk versus return is required. Even though the methodology set out in this study will allow for the investigation into a variety of definitions of risk, the same information might not be available in the market. As a result it may be difficult to set an appropriate benchmark.

For example risk might be defined as the possibility of not paying a dividend in a year. Though quantifiable for the insurer, it may not be quantifiable for other investment opportunities. As a result, risk will initially be considered to be variability in return even though better than expected experience would not normally be considered as risky.]

BRIGHAM (1985) describes three methods to set market benchmarks for the cost of capital.

1.4.2.1 The Capital Asset Pricing Model

The first method makes use of the capital asset pricing model. This model relies on the efficient frontier[9]. The efficient frontier is the curve presenting the highest yielding portfolio of assets at different levels of risk. The risk is calculated as the standard deviations of returns over a specified period of time. Depending on the level of risk in a certain investment, it is then possible to determine the required return on capital.

[9] A computational procedure for determining the efficient set of portfolios was developed by MARKOWITZ and first reported in his article "Portfolio selection" in the Journal of Finance March 1952, 27 – 91. In this article MARKOWITZ develops the basic concepts of portfolio theory.

The essence of portfolio theory is based on the following ideas:
If an investor were to invest in a single company, the investor would find that by investing in another company with returns independent of the first company, the investor would be able to reduce the variability of return on the portfolio but yet maintain the same level of risk.

As all investors are rational and want to optimise their return at the lowest level of risk, there will exist in the market a range of fully diversified investments with different levels of risk and return where the return will increase with the risk. The range will exist because not all investors have the same view of risk and some may be more risk averse than others.

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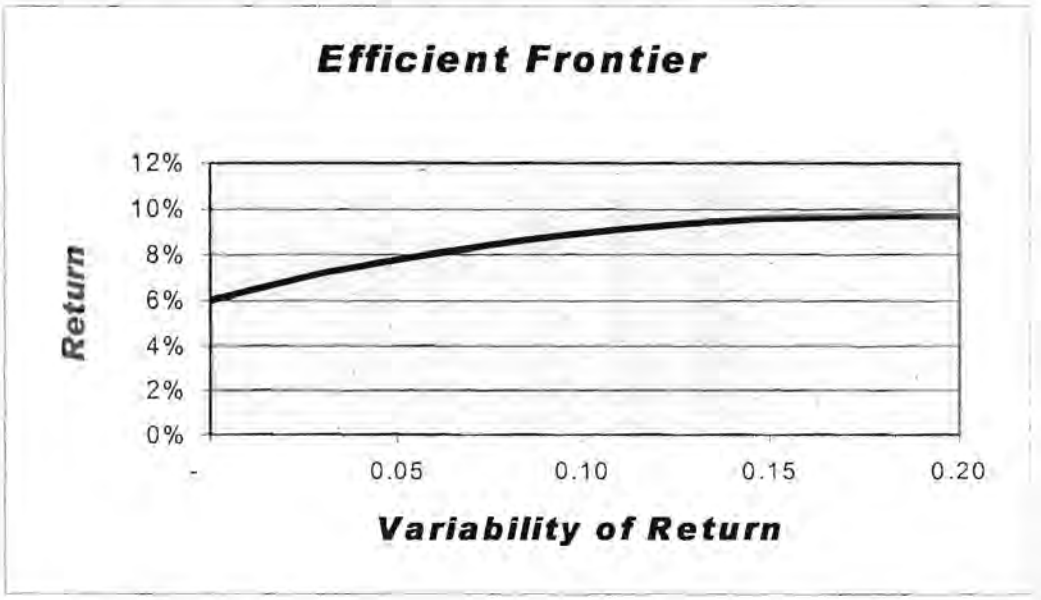
Figure 2: An example of the efficient frontier



For example assume Figure 2 above represents the efficient frontier for the real levels of return[10] in a certain market. Given the expected level and variability of return for a certain investment, it will be possible to determine whether or not that investment is better or worse than an investment in the assets backing the efficient frontier. Clearly, shareholders would only be prepared to invest in a certain investment if it can yield the same or better return than the assets backing the efficient frontier.

Economic theory further holds that the market will quickly eradicate such arbitrage opportunities, where one company has a competitive advantage enabling it to perform better than other investments. It is hence unlikely that any one insurer will be able to perform above the efficient frontier for a significant duration of time.

The problem set is therefore to adjust the business operation in such a fashion to be in line or better than the efficient frontier.

Note that the efficient frontier according to the Capital Asset Pricing Model is given by a straight line. As this model assumes that money can be borrowed and invested at the same rate of interest, the efficient frontier has been adjusted to allow for this incorrect assumption.

It is important to bear in mind that the efficient frontier is not necessarily appropriate as it is based on past returns that may not be achievable in future

[10] Real rate of returns are net of inflation.

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again. An allowance for the changes in the general economic and commercial environment will be critical in order to ensure that an appropriate analysis is conducted.

1.4.2.2 Discounted cash flow methods

The second method involves the use of discounted cash flow. Given the price and expected returns expected on a similar investment, a suitable rate of return required for such an investment can be obtained. Shareholders of the company may then require a similar return. Therefore the rate of return required is given by the internal rate of return on similar types of investment.

The internal rate of return is the rate at which the present value of future profits is equal to the market price of the investment at the date of calculation.

$$NPV = \sum_{t=0}^{\infty} Cashflow_t v^t \qquad (1.1)$$

NPV is the net present value of the future cash flows and will take the market value.
t is the time of the possible cash flows from the date of calculation to infinity.
v is the discount factor evaluated at the internal rate of return at time t.

The internal rate of return is obtained through an iterative process until the present value of the cash flows equals the market value.

1.4.2.3 Determine an appropriate risk premium

The third method involves the setting of a risk premium. According to this method the rate of return required will consist of a risk free rate of return plus additional charges for different elements of risk.

Required rate of return = risk free + inflation + risk premium (1.2)

The risk free rate of return does not exist in any market but is approximated by the real returns on long term sovereign debt[11].

Inflation is the long term expectation for future inflation. Note that the first two elements on equation (1.2) are given by the redemption yields of long term sovereign debt issued by the country of domicile.

The risk premium consists of the risk premium applicable to an investment in the particular company. This risk premium consists of a risk component for the relevant industry as well as the relevant company. In order to obtain these risk premiums reference is again required to the second method explained above.

[11] Sovereign debt is debt issued by the government of the country of domicile.

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1.4.2.4 Rating agencies

Rating agencies have over time distinguished themselves in identifying the risks inherent in an enterprise. Their risk grades have been quantified and as such managers may be able to use these ratings as a benchmark instead of one of the three methods mentioned above. Given the high value shareholders put on the opinion of rating agencies, this is a very likely scenario.

A comparison of rating agency ratings to the expected probability of insolvency in 10 years is given below (MAHER 2001):

Table 1: Quantification of Rating Agencies' Rates

Moody's	S & P	Expected Probability of ruin in 10 years
Aaa	AAA	0.00%
Aa1	AA+	0.10%
Aa2	AA	0.10%
Aa3	AA-	0.20%
A1	A+	0.40%
A2	A	0.70%
A3	A-	1.00%
Baa1	BBB+	1.40%
Baa2	BBB	2.00%
Baa3	BBB-	3.40%
Ba1	BB+	5.20%
Ba2	BB	7.40%
Ba3	BB-	9.70%
B1	B+	12.20%
B2	B	15.00%
B3	B-	19.20%
Caa	CCC+	35.80%

Using one of the approaches above, the requirement for optimising the business process can be set.

1.5 Developing and implementing the solution

This dissertation considers a methodology that can be applied to quantify both the expected return and variability of return of an entire business operation. As a result it will be possible to determine whether or not the business strategies can achieve the results required. In addition the methodology can also be applied to test a variety of business ventures and, based on the results, to set an appropriate course of action for the company to optimise shareholders' return.

The solution revolves around the establishment of a model office. This is similar to a simulation of the entire office given a specified business plan. It is not possible to model all aspects affecting a business operation. The model office will, however, facilitate in the identification of problem areas and aspects which clearly inhibit shareholders' return.

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1.5.1 Business strategies

Once the framework of the model office has been established, strategies of business excellence have to be tested. Due to resource limitations, it is not possible to model each and every eventuality. Instead business strategies based on financial and operational issues have to be developed and tested against the requirements of optimal returns, growth and stability.

These strategies will apply to one or more of the following:

1.5.1.1 Business mix strategy

The volume of business by type of business must be considered. Every type of business will have a different risk profile and will have different correlation to the existing business. As a result the impact of writing more business in certain classes will have a different impact to other classes even when their individual risk profiles are similar. This impact can only be determined through a collective model.

Furthermore, the marketing risk must also be considered. Depending on the level of competition in the market and the type of product, the elasticity of demand will vary and as a result business acquisition will come at a varying range of prices for different types of products.

For every type of business the claims management procedures and market custom differ. Often companies will not be able to implement their strategies due to market reluctance to implement the strategies.

1.5.1.2 Managerial strategies

Credit control and claim management are two important aspects to proper insurance governance. By implementing arrangements with assessors or salvage companies or premium collectors, management might be able to enhance the business operation considerably. These strategies will depend on the class of business. Some of the following provide an indication of possible strategies:

1. Scrutinise claims for fraud.
2. Assess claims independently and audit all payments made.
3. Maintain detailed inventories of items on risk in order to check claims at the time of claim.
4. Where necessary require a police investigation.
5. Promote recoveries through salvage.
6. Make use of subrogation rights to sue third parties.
7. Maintain independent record of cover provided and do not pay claims in the event of premium not paid.
8. Ensure that accounting information pertaining to premium conforms to exposure information.
9. Minimise management expenses.

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1.5.1.3 Distribution channel strategy

The distribution of business has a critical impact on the success of insurance business. For every type of distribution, the cost of distribution compared to the sale of products needs to be considered. Furthermore, clients' needs are critical. When a distribution channel does not meet the needs of clients, take up following a marketing exercise will be very low.

ROOS (2001) presented a case study to the General Insurance Mini Convention presented by the Actuarial Society of South Africa on the appropriateness of different media for a direct insurance company. This is similar to testing different distribution channels as the take up and the cost of take up is considered in both instances.

Following the advances made in information technology, the number of distribution channels has increased. Also, clients are demanding better service. These developments have led to the necessity for well designed and speedy information systems. Data requirements are discussed in a later chapter.

1.5.1.4 Capital allocation strategy

CLARK[12] (2000) traces the origins of capital allocation back to the banking sector. The essence of such allocation is to ensure that riskier opportunities are allocated more capital to compensate for the higher levels of risk. Such higher allocation also leads to a higher capital charge. This is similar to a risk premium idea but instead of changing the risk premium, the amount of capital allocated to a line of business is changed.

An important idea surfaces from this discussion. The capital requirement is set on a certain specified business structure. This capital requirement is then allocated to the different types of business according to some capital allocation measure. But were the business volumes or business structure to change the capital requirement might also change and as a result new requirements would be set. It is important to note this iterative process.

Capital allocation is critical to ensure that internal management procedures recognise the variability inherent in different classes of business. This ensures that the correct charge is given to the different lines of business. This issue is considered in detail in a later chapter.

1.5.1.5 Investment strategy

The matching of investment income with claims and expense outgo is an important issue that has received extensive coverage in financial papers. CLARK

[12] CLARK is a contributor to the expert commentary published by the International Risk Management Institute www.irmi.com and works for Winterthur International ART & Financial Lines. He has published a series of articles on Enterprise risk management which can be obtained from this web site.

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(2000) cites the Savings and Loan crises in the United States in the nineteen eighties as an example of incorrect matching of assets to liabilities.

EMBRECHTS (2000) cites the Long Term Capital Management bankruptcy as an example of incorrect asset liability management. Though not an insurance company, LTCM was also a manager of risks.

Proper asset management is therefore critical and cannot be conducted without a comprehensive understanding of all possible items of outgo. This is a requirement that will only be met through collective risk modelling.

1.5.1.6 Reinsurance strategy

COUTTS and THOMAS (1997) provide a detailed structure for setting the most appropriate reinsurance strategies. As reinsurance mitigates excessive risk it can be considered to be a substitute for capital. As a result reinsurance has a very important part to play in maximising the return on shareholders capital.

The managers will need to consider the cost of reinsurance as compared to the expected cost of claims to the reinsurer as well as the cost of capital required to support the business considered.

Using a collective model it will also be possible to investigate reinsurance structures for individual lines of business as well as the entire business operation.

1.5.2 Evaluate business strategies

The business strategies that have been developed then need to be checked against the requirements specified. On the one hand the requirements for return on capital, stability of returns and levels of growth need to be considered and on the other hand the probability of ruin given the outcomes generated need to be considered. This is no easy matter.

This evaluation will be done by generating financial statements for all classes of business culminating in a collective set of financial statements over time. Given the results generated, it will be possible to evaluate the requirements set and compare different business strategies to the requirements set.

Note that all business strategies need to be considered. During the testing new strategies may also come to light. As a result these would also need to be tested to the criteria specified.

As a collective risk model will require extensive computing power, MICCOLS (2000) suggests that for certain strategies where variables do not affect the strategy, the probability distribution of those variables be replaced by their expected values to speed up the process. Also by maintaining all other variables

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fixed and only altering isolated strategies will indicate the relative impact of such a change in strategy.

A matrix of strategies can be set up and tested in this fashion to ensure that an optimal set of strategies is employed.

The results of the different combinations of business strategies are then tested to the benchmark in order to identify the optimal set of business strategies.

1.6 Monitor the experience

Any model is only as strong as the data, assumptions and methodology supporting it. As a result it is important that these elements will be regularly tested to actual experience and updated as and when discrepancies are identified.

The structure developed in setting the solution should be used to monitor the experience.

The information gleaned from such exercises will indicate possible ways in which strategies can be changed and also ways in which the collective model office can be updated.

The cost of implementing different strategies should also be reflected in the model as any subsequent changes might be very costly and therefore the risk of incorrect implementation should be minimised.

The importance of systems was mentioned. It is critical that all the necessary information required to yield the results is captured on a regular basis. Without such structure, the monitoring described here will also not be possible. Risk data has traditionally not been captured as it was not considered important from a financial point of view. This is no longer the case. Details pertaining to data structures and requirements are discussed later in this study.

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1.7 Summary

This concludes the introduction to this dissertation. In this introduction the following aspects were considered:

1. This dissertation is a complement to risk evaluation in the general insurance industry. All business strategies operate in a structure of risk and uncertainty.
2. The aim of this study is to discuss a framework and methodologies appropriate to quantify the appropriateness of business strategies for meeting objectives such as the optimisation of shareholders' return on capital.
3. The methodology aims to identify risks and opportunities in a general insurance environment through the development of a model office.
4. The control cycle of this risk evaluation was discussed by considering the general economic environment, specifying the problem, providing the solution and monitoring the results.

MICCOLIS (2000) cites the following advantages to applying this framework:

1. Allows a determination of the necessary capital level for the enterprise, and provides a means to efficiently deploy and improve return on capital.
2. Permits the proper allocation of capital to business segments, thereby improving the performance tracking of those segments.
3. Helps executives evaluate alternative capital structures that leverage returns.
4. Provides a method to ensure that enterprise owners receive proper compensation for the risks they assume.
5. Helps stabilise earnings by identifying and addressing the risks that create the most volatility.
6. Guides the development of an optimal risk financing strategy.
7. Provides better information, which increases negotiating leverage with the enterprises' stakeholders, from shareholders to analysts to regulators to capital markets to merger and acquisition targets.

The next chapter will consider the model insurer. The model insurer is the framework for an insurance company. The model insurer is considered from the basis understandable to shareholders: the financial statements. The financial statements are also used to report the return on capital and are therefore particularly important.

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2. The model insurer

2.1 Introduction

This chapter considers information pertaining to the framework required to evaluate business strategies. This framework is based on a structure that is familiar: The departmental structure of the company is considered. These departments give rise to income and outgo which can be consolidated in an income statement. The result of the income statements over time is reflected in the balance sheet of the company which is subsequently considered. An algorithm suggested by other practitioners is also mentioned. The synthesis of an appropriate algorithm to apply to the framework is considered in the next chapter after the relative importance of the different areas of risk and uncertainty has been considered.

Consider the use of flight simulators in the training of pilots. Flight simulators are very useful, as the trainee is able to experience a variety of circumstances without actually being in a plane. It is therefore possible to simulate the take-off, landing and a variety of situations. Great pains need to be taken, however, to ensure that the simulator will generate the situation as realistically as possible. This normally leads to enormous investment in time and knowledge to ensure that the simulator "flies properly".

The importance of an accurate simulator cannot be over estimated. In the air travel industry people's lives are at stake. Consequently operators of aircraft must take the utmost care to ensure that pilots are properly trained and prepared for any eventuality. The room for error in many situations encountered by a pilot is very small.

The simulator is at the end of the day still just that, a simulator. If the designers of the simulator had failed to foresee certain eventualities or correlations between such eventualities, the pilot may experience such a situation for the first time under real circumstances. This is far from ideal but it has to be borne in mind that a simulator is never perfect.

This example can be used profitably in the context of a general insurance company.

The aim of setting up such a simulator is important. As explained in the introduction, a better appraisal of the risks a company is exposed to is required. Furthermore this appraisal can assist the company in optimising its return on capital.

As the value that will be unlocked using this approach is not always apparent at the outset, care is required to first consider the entire company's framework and

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subsequently to consider which areas can be modelled and which have to be managed through proper corporate governance. In this study, areas that lend themselves to modelling are considered.

A simulator or a "model insurer" can represent the entire company's operation. The current structure of the company will first be investigated. This can be compared to building the simulator. This process involves identifying all factors affecting the operation of the business and the economic environment in which the business operates. The problem areas are identified and the simulator is constructed to solve the problems identified. Following this, the way the company will "fly" is tested. The next stage would be to test different scenarios i.e. the business strategies mentioned in the introduction. This can be compared to the trainee pilot being subjected to certain conditions and scenarios and monitoring his reactions in such situations. The results seen are then tested to actual experience. This forms part of the monitoring process that is then used to revise the structure of the simulator to provide a better model in future.

As mentioned, room for error in the air travel industry is very limited, hence the quality of the simulator has to be perfect. In the general insurance environment room for error has generally tended to be significant. For instance, market players could change their premiums in the event of poor experience. In recent years these margins have, however, been decreasing. More and more companies are entering the market with new ideas to cut back on expenses, improve service and provide lower rates. The introduction of direct insurance companies in recent years is testimony to this. As a result the companies who are leading the race are those who are able to accurately assess their entire business operation. These are the companies who are willing to invest in the ideas and methodologies described in this study.

As with the simulator, the management of the company will only be able to obtain quality information if the simulator or model insurer is of a high standard. Substantial investment in terms of human resources, time and money in proper data systems and model design is therefore required.

2.2 The basic working of a model insurer

2.2.1 The aim of implementing a model insurer

The aim is to develop a stochastic[13] model of the entire business operation to ensure that management can investigate the current business structure as well as the impact of risk management actions on the entire business structure.

[13] Stochastic is often used instead of the word probabilistic to describe a variable or process that has a distribution of possible outcomes each with a possibly different probability of occurring.

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2.2.2 *The basic operation*[14]

In order to develop a stochastic model of the entire business operation all items affecting cash flows must be investigated. The following considerations should be taken into account:

1. The data available to model expected experience. Data requirements will be considered in a next chapter.
2. The main areas in which optimisation is required. The cost of implementing this exercise can be substantial and therefore the Pareto principle of focusing on 80% of the problems and only incurring 20% of the total cost is relevant.
3. Each and every asset and liability (or obligation) on the books of the insurer must be identified. This is reflected in the balance sheet of the insurance company but due recognition is required for the manner in which the assets and liabilities have been valued. A variety of accounting bases are currently in existence. The important factor here is to realise that a realistic basis is required as the model will be used for internal management purposes[15]. The valuation basis will be discussed further below.
4. Model the expected future cash flows on each asset and liability as well as the expected cash flows on existing and new business for the period of projection. The period of projection can be structured into sub sections as well. The main idea is to set the balance sheet, model the cash flows that occur during the first sub section of the projection period and then set up the new balance sheet at the end of this period. Subsequently, the process will be repeated for the next period and so forth until the company's financial situation has been projected for the entire period of projection.
5. For large companies and for companies with many of the same kind of assets and liabilities, it is not practical to project each and every cash flow. As a result, model points will be chosen to model the expected cash flows. Model points are fictitious assets and liabilities closely representing the actual assets and liabilities by nature of cash flow[16]. One model point can represent several similar assets or liabilities that are actually on the books of the company. The same model point is then used to project the experience of a number of assets, liabilities or policies of the company.

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[14] COUTTS and DEVITT (1997) also provide an algorithm that is given in section 2.4.1.

[15] Companies often include margins in the basis used to value assets and liabilities. In a general insurance environment this is done to ensure that the solvency position of the company is not over estimated and also that the profits are not over estimated.

When evaluating the future income streams, the results will be affected by any over or under estimation of assets and liabilities that would become apparent in the evaluation of actual versus expected experience but the reasons for such discrepancies might not be clear.

[16] The nature of cash flows refers to the timing, amount, currency and volatility of cash flows. Model points are also further explained in the glossary.

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6. It is important to realise that both assets and liabilities need to be modelled consistently to ensure that the interaction between these can be allowed for. For example, high interest rates will be correlated with higher claims experience in mortgage protection business. High levels of interest rates should also be correlated to higher levels of inflation.
7. Once the model points have been set up, the expected cash flow for each such point can be modelled. Determining the models whereby this can be done will be discussed extensively in other chapters of this dissertation.
8. The cash flows at different durations can then be determined.
9. By simulating this process through the use of Monte Carlo Simulations[17], probability distribution functions can be obtained for a variety of items of cash flow. In this manner a probability distribution function can be determined for the solvency position of the company at each sub period of projection. Similarly a probability distribution function can be determined for the retained earnings in each year. Therefore it is possible to determine a probability distribution function for the return on capital in each sub period as well.

2.3 A possible company structure

A structure is required whereby the future cash flows can be modelled. The departmental structure of the company as well as the financial statements of the company will provide a guide for the most appropriate structure. Furthermore, it is important to identify which cash flows can be modelled and which not. Where a stochastic approach is not possible the average expected cash flow will be used.

2.3.1 Departmental structure

The model insurer's structure can be represented as follows:

[17] Monte Carlo Simulations refer to the resampling process whereby different possible outcomes, given a specified hypothesis of the distribution of these outcomes, are generated. Each sample is assumed to be independent of any other sample. Simulation techniques are discussed further in later chapters.

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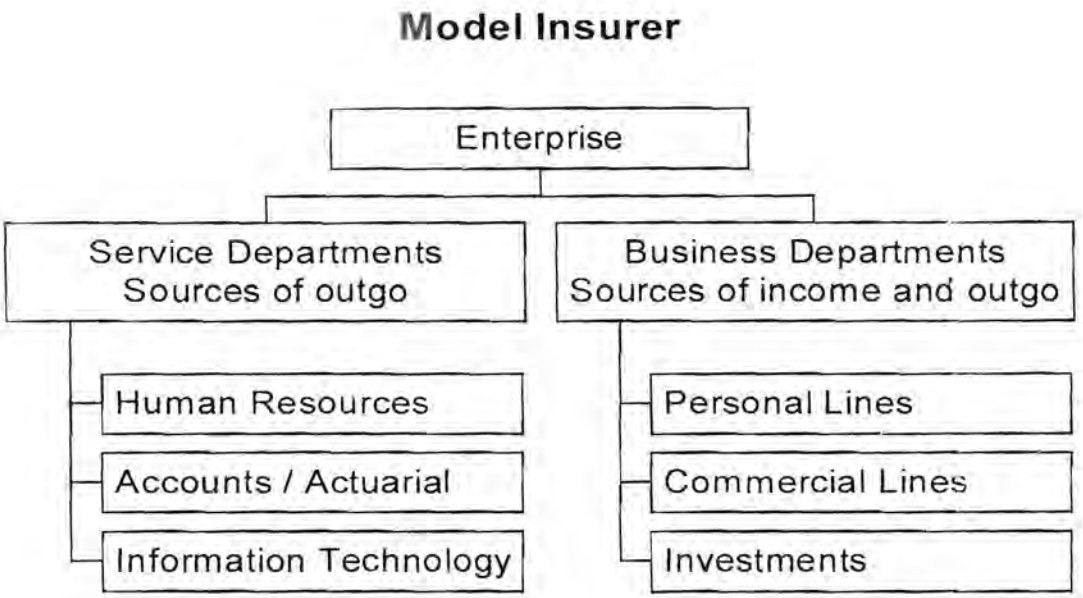
Figure 3: Possible Departmental Structure for a General Insurance Company



Arguably a variety of different structures may exist. For the purpose of this dissertation it is essential that consideration be given to the structure of the company. This will help the model builder to identify different model points as well as areas of risk and uncertainty affecting these model points. Figure 3 represents a possible layout of a company structure. Each one of these departments will incur expenses and the business departments will receive premium income while the investment department will receive investment income.

The structure of the items of income and expenditure must be scrutinised to determine where these items originate. This is required in order to identify and manage risk areas. In particular the risks associated with the business and investment department are considered in more detail in later chapters of this dissertation.

Accounting information provides a solid framework to combine all cash flows. In particular, the income statement and balance statement must be considered.

In this dissertation consideration is given to accounting information based on a best estimate. Full detail is provided in the Accounting Guide on Short-Term Insurance, THE SOUTH AFRICAN INSTITUTE OF CHARTERED ACCOUNTANTS (2001).

2.3.2 Income structure

The departmental structure outlined above will generate income and outgo during a period of time. This is reflected in the income statement of the company.

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Income statement of a general insurance company

2.3.2.1 Evaluation of earned premium[18]

Unearned Risk Reserve[19] at the start of the financial period

less Deferred Acquisition Costs[20] at the start of the financial period

less Unearned Risk Reserve ceded to reinsurers at the start of the financial period

plus Deferred Acquisition Costs ceded to reinsurers at the start of the financial period

Written Premium[21]

less Acquisition Expenses

less Reinsurance Premium ceded

plus Reinsurance Commission

less Unearned Risk Reserve at the end of the financial period

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[18] The constituents of earned premium can be presented in a variety of circumstances. The structure below considers each item separately.

[19] The unearned risk reserve consists of the unearned premium reserve and the additional unexpired risk reserve. Paragraph 27 of the accounting guide reads: "Earned premium is that that relates to the risks covered during the accounting period. Some policies incepting in the previous (or prior) accounting period will not have expired and the proportion of the written premium relating to the unexpired period of these policies is carried forward as unearned premium to be treated as earned premium of the next accounting period or, where appropriate, future accounting periods. Written premium of the current accounting period is treated as earned premium except to the extent that it relates to unexpired periods of risk at the balance sheet date."

[20] Paragraph 83 and 84 of the accounting guide reads: "A proportion of the acquisition expenses and reinsurance commission revenue is deferred commensurate with the deferral of the related premium revenue and outwards reinsurance premium expense.
Acquisition expenses generally consist of commission paid to intermediaries only."

[21] Paragraph 15 of the accounting guide reads: "Written premiums in an accounting period comprise all premiums relating to policies incepting in the accounting period. They include the premiums for the whole of the period of risk covered by the policies regardless of whether or not these are wholly due for payment in the accounting period. Written premiums also include adjustments to the written premiums of prior accounting periods."
Paragraph 19 reads: "Written premium includes an estimate of pipeline premium"
Paragraph 80 reads: "Portfolio premiums payable are included within premiums for reinsurance outwards in the financial statements of the transferor insurer, but deferred to subsequent accounting periods as appropriate in respect of any unexpired period of risk at the balance sheet date. In the financial statements of the transferee insurer they are included with written premiums with any amount unearned at the balance sheet date being carried forward in the unearned premiums provision.

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plus	Deferred Acquisition Costs at the end of the financial period
plus	Unearned Risk Reserve at the end of the financial period
less	Deferred Acquisition Costs ceded to reinsurers at the end of the financial period
	Earned Premium for the financial period

2.3.2.2 Evaluation of incurred claims

	Outstanding Claims Reserve[22] at the end of the financial period
plus	Incurred But Not Reported Claims Reserve at the end of the financial period
less	Reserves ceded to Reinsurers at the end of the financial period
	plus Claims Paid[23] during the financial period
	less Subrogation Recoveries and Reinsurance Recoveries
less	Outstanding Claims Reserve at the start of the financial period
less	Incurred But Not Reported Claims Reserves at the start of the financial period
plus	Reserves ceded to Reinsurers at the start of the financial period
	Incurred claims for the financial period

[22] Paragraph 34 of the accounting guide reads: "Provision is made at the balance sheet date for the expected ultimate cost of settlement of all claims incurred in respect of events up to that date, whether reported or not, together with related claims handling expenses, less amounts already paid. If liability exists but there is uncertainty as to its eventual amount, a provision is nevertheless made."
The guide also refers to the necessity of distinguishing between outstanding claim reserves and incurred but not reported claims reserves.
Paragraph 38 reads: "The level of claims provisions is set such that no adverse run-off experience is envisaged" Note: This may not be a best estimate approach and hence the valuation basis used is of critical importance when evaluating the results.

[23] Paragraph 81 reads: "Portfolio claims transfers are accounted for in the financial statements of the transferor insurer as payments in settlement of the claims transferred. For the same reason, the consideration receivable by the transferee insurer is credited to claims payable in the balance sheet.

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2.3.2.3 Income statement

	Earned premium for the financial period
less	Incurred claims for the financial period
	Underwriting result
less	Expenses[24]
plus	Investment Income[25]
	Technical Result
Less	Tax
Less	Dividends
	Retained income

The revenue account and income statement provide a good background to understanding the different areas' activities and therefore the different areas of risk and uncertainty. Given a certain model point for a specific type of policy some of the issues that may be identified are:

1. The premium can be inadequate to meet the future claim payments and expenses.
2. The reserves set aside now may be inadequate to meet the future outgo for which they have been constituted.

[24] Expenses refer to all management expenses that have not been included in the claim-incurred amount. Expenses allocated to claims include allocated and unallocated loss adjustment expenses. These are expenses incurred by the claims department while processing claims.
Paragraph 43 of the accounting guide reads: "Provisions are made at the end of the accounting period for all claims handling expenses to cover the anticipated future costs of negotiating and settling claims that have been incurred, whether reported or not, up to the balance sheet date. Separate provisions are assessed for each category of business.

[25] The allocation of investment income is one of considerable debate: The main line of thinking is that business units have no control over investment performance and therefore investments should be allocated to business units based on a tracking fund that matches the liabilities of the business units. It should be noted also that investment income can only be allocated on cash flow generated and not reserves booked because reserves may be raised without the funds actually being available for investment. This is done in order to assess the profitability of each policy written on an individual or specific class of business grouping basis. No such allocation has been shown in the income statement set out above.

All remaining investment income would be attributed to better than expected investment activity as well as returns on shareholders' capital, both of which should accrue directly to shareholders.

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3. The profitable classes of business can be distinguished from the unprofitable classes of business.
4. The impact on the company's experience of reinsurance structures failing can be assessed.
5. Patterns in claim recoveries.
6. Investment income may be inadequate.

This list is not exhaustive.

A company's reserving policy plays a very important role when it comes to the amount of money recognised as profit in a year. This is because reserves are recognised as incurred claims and therefore a conservative policy will lead to a delay in the recognition of profit and an optimistic policy will lead to an acceleration of the recognition of profit but with the greater possibility of recognising unforeseen losses at later durations. Due to this uncertainty, the business needs to be monitored on a regular basis to ensure that estimates remain as accurate as possible.

2.3.3 Capital structure

The balance sheet represents the layout of the value of the company to a certain extent. All factors affecting each of the components of the balance sheet can be modelled in order to project the value of the company in future.

The result of the projection of the income statement will affect the balance sheet. In particular, the retained earnings generated will be transferred to the equity base of the company.

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Balance sheet of a general insurance company

Ordinary Share Capital[26]

plus Share Premium Account[6]

plus Revaluation Reserve[27]

plus Contingency Reserve[28]

plus Retained Earnings[29]

Capital and Reserves

This is the net asset value of the company. Assuming all items are provided at best estimate the net asset value provides the total investment by shareholders to date into the company. As a result this would then be the amount that needs to service shareholders' requirements. That is shareholders expect a return on their capital invested.

The net asset value is represented by the difference between the assets and the liabilities of the company.

2.3.3.1 Evaluation of the assets of the company

Fixed Assets

Property, plant and equipment[30]

Subsidiaries

Investments[31]

[26] Reference will be made to the authorised share capital as well as the issued share capital. The share premium will be calculated on the issued shares.

[27] The revaluation reserve reflects unrealised positions in the assets held by the company. Furthermore, differences in exchange can be reflected in this reserve.

[28] The Contingency Reserve is required in terms of the Short-Term Insurance Act (1998). This constitutes 10% of written premium net of admissible reinsurance.

[29] The build up of retained earnings is reflected in the income statement for a specified period of time. This is discussed further in 2.3.2 below.

[30] In the notes to the financial statements reference will be made to the book value (cost), exchange differences, additions, disposals, depreciation charge, accumulated depreciation and the net book value.

[31] All investments are shown at a best estimate value. That is the value at which the investment can be sold based on market prices.

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Current Assets

Receivables and prepayments

Current investments

Bank and cash balances

Technical Assets

Reinsurers' share of technical provisions[32]

Deferred Acquisition Costs

Total Assets

The investment strategy might change depending on the results obtained during the year. This will be discussed further in 2.4.1 below. The assets need to be of such a nature that they secure a return and are liquid enough to meet liability outgo as and when required.

2.3.3.2 Evaluation of the liabilities of the company

Technical Liabilities

Unearned Premium Reserves

Outstanding Claims Reserves

Additional Unexpired Risk Reserve

Deferred Acquisition Costs ceded to Reinsurers.

Current Liabilities

Borrowings

Deferred income tax[33]

Total Liabilities

[32] Reinsurers will share in the Outstanding Claims Reserve, the Incurred But Not Reported Claims Reserve, the Unearned Premium Reserve as well as other technical reserves that might be set up from time to time. It may well be that no reserve is shown for non-proportional covers and that these are calculated at the outset net of reinsurance.

[33] Note that assessed losses give rise to deferred income tax assets as these losses have to be off-set against future profits.

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The balance sheet shown is very condensed and should be expanded upon if a true and fair representation of the company's financial soundness is required. This is done through the notes appended to the financial statements.

An important aspect regarding the risks to which the company is exposed is highlighted in the balance sheet. This is because the company's capital depends on the value of its assets as well as the value of its liabilities. Hence the relationship between these two must be investigated extensively. It is therefore important not only to assess the risks associated with the liabilities (i.e. claims) on the one hand and those with the assets on the other hand, but also the interaction between the assets and the liabilities.

Once the capital base has been determined, the business processes used to secure a return on the capital structure must be evaluated. This is best done by evaluating the returns secured on the different lines of business. These returns are consolidated in the income statement of the company.

Below a generic algorithm is provided, this algorithm can be compiled for any subsection of the business and therefore provides a very powerful base to assess the financial health of the existing business operation.

2.4 Combining ideas

Once the model points[34] and the areas of risk have been identified, the next step will be to try to model those areas of risk relevant to the different model points as accurately as possible. This will form a substantial part of the investigation. Once this has been completed the cash flows on each model point can be projected.

This process will be considered in further detail in the next chapter. The following provides an algorithm provided by other practitioners as an example of a possible algorithm suitable for this approach.

2.4.1 An algorithm for the business process

S.M. COUTTS and E.R. DEVITT have suggested the following algorithm for the simulation of the business process of a reinsurance company. The ideas are, however, directly applicable to direct short-term insurers as well:

Step 1

Determine the cash inflows for the year in respect of premiums for each line of business. This will relate both to business on the books and to new business and will involve modelling payment patterns which make due allowance for variability and the impact of factors such as commission and reinsurance.

[34] Refer to the glassary of terms for a definition on a model point.

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Step 2
For each line of business, generate total gross claim payments for the year using assumed probability distributions to generate losses by time and amount for that line of business. This will be obtained from the model points used to represent the liabilities.

Step 3
Determine the aggregate cash flows in respect of the insurer's reinsurance programme, making due allowance for bad debts.

Step 4
Generate cash inflows in respect of investment income by applying the models for investment yields to the assumed opening asset portfolio. Once again, the model points representing the asset structures are extremely important.

Step 5
Aggregate the results of steps 1 to 4 and determine whether cash flow for the year is positive or negative.

Step 6
If cash flow is positive the assumed reinvestment strategy is applied. This will lead to a new set of assets at the end of the year. Proceed to step 10.

Step 7
If cash flow is negative determine whether there are assets of sufficient value remaining to meet the payments. If there are, proceed to step 8. If there are not, proceed to step 9.

Step 8
Apply assumed disinvestment strategy to arrive at a new set of assets at the end of the year. Proceed to step 10.

Step 9
Assume sufficient cash is borrowed at some appropriate rate of interest to cover payments for the year. Proceed to step 10.

Step 10
Determine whether further claim payments are to be made. If yes, return to step 1 and repeat a further year. If no, proceed to step 11.

Step 11
Record the value of the remaining assets. This can be positive or negative.

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Step 12
Repeat the process 1,000 times (say) from the start, to build up a distribution of possible values of the strength of the company.

This method shows what requirement is placed on capital at different durations. No indication is given as to a possible allocation of capital and the result this will have on the simulated experience. The capital required would, however, be an important consideration for pricing purposes. The proper approach is to set the capital allocated in advance as an item of input. Given the results of the investigation, it would be possible to test different levels of capital allocation.

This algorithm can be adjusted to represent the structure of the general insurance company. The principles underlying the process are analogous.

The modelling of the different structures is a complex matter. This is compounded by the fact that the different cash flows are sometimes correlated. These issues are discussed in further detail in later sections of this study.

The advantages of the algorithm proposed by COUTS and DEVITT according to COUTTS and DEVITT are:

1. It places an obligation on the management to make explicit assumptions about key financial variables.

2. It gives management a better grasp of the essential financial dynamics of their business.

3. It provides a method of looking at capital strength not only in terms of expected results but also in terms of probability.

4. It lets the sensitivity of financial results to various parameters be assessed.

5. It facilitates meaningful investigation into such issues as changes in business mix, different reinsurance protection arrangements and different investment strategies.

6. It enables management to investigate different growth strategies and their associated capital requirements.

7. It allows management to investigate fluctuations in the market in advance so that an assessment of the impact can be made.

8. It permits the effect of investment income on profitability to be appreciated.

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2.5 Summary

In this chapter the framework required to model different business strategies was touched upon. It was indicated that the structure of the enterprise would need to be considered in terms of the income and outgo generated by every department.

This income and outgo can be represented as an income statement which is subsequently consolidated in the balance sheet. This dissertation will consider further how these items of income and outgo can be projected and which items should be considered the most important. These items will also differ depending on the business strategy that is being applied.

The chapter then continues with an example of an algorithm proposed by COUTTS and DEVITT (not dated).

In the next chapter the different areas of risk and uncertainty will be reconsidered and the most important areas identified. A methodology will be proposed whereby the items of income and outgo can be projected in the framework as discussed above.

Once this framework is in place, the modelling of these cash flows will be considered and subsequently the testing of business strategies and the optimisation of the business process will be considered.

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3. Setting a framework for the model insurer

3.1 Introduction

This study has already covered a variety of aspects required to set appropriate risk evaluation techniques in a general insurance environment.

In the introduction the idea of the control cycle was introduced:

1. Appraise the areas of risk and uncertainty. A structured approach to risk management was introduced and a wide range of risks was introduced. In this chapter the areas of risk will be finalised by considering what other sources have suggested on this topic.
2. Specify the problem. Two problems were identified:
    a. A framework or model structure is required to evaluate business practices. This framework will be finalised in this chapter.
    b. A methodology on the assessment and quantification of the different types of risk inherent in this model is required. This methodology will be discussed in later chapters, starting with an evaluation of data requirements and moving on to the main areas of quantifiable risk.
3. Develop the solution. This requires an investigation into a variety of business strategies and testing these strategies against objectives that have been clearly defined. A number of objectives can be set:
    a. The efficient frontier of returns can be specified.
    b. The minimum level of solvency at any point in time can be specified.
    c. The stability of returns over a specified time horizon can be specified.
4. Once an optimal set has been identified, the experience will need to be monitored to test whether or not the actual experience represents that assumed in the model. As changes become evident the strategy will need to be revisited.

3.2 Synthesis of the framework

GOLDMAN, SACHS & Co and SWISS BANK CORPORATION WARBURG DILLON READ (1998) suggest the framework requires the following prerequisites before its implementation can be considered:

1. Commitment from senior management
2. Carefully designed policies and procedures
3. Properly staffed risk analysis and monitoring functions
4. Access to reliable technology
5. High integrity data
6. Validated models
7. Experience and judgement

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The framework can be presented as follows:

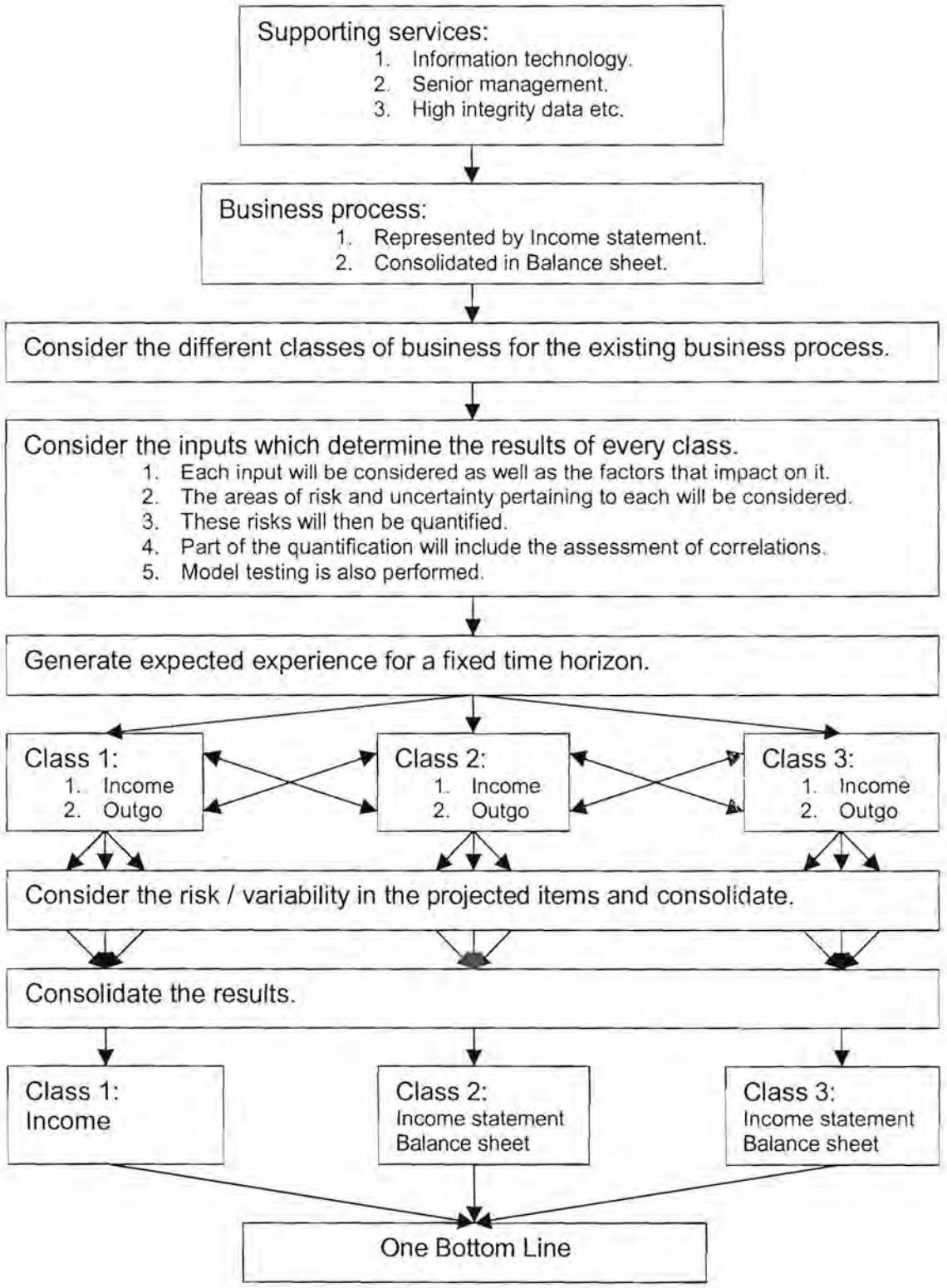

Figure 4: Framework overview

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This framework is the combination of ideas set out thus far. The commercial environment within the enterprise is considered by evaluating the service and business units. The different classes of business are identified for every business unit.

Recalling the control cycle, the different areas of risk and uncertainty inherent in the business environment must be identified and quantified. This will be done in relation to the existing business strategies.

Proper testing of the model will be required and subsequently the projection will be performed.

This projection is a function of a specified set of business strategies. The starting point will be the existing set of business strategies.

The projection is then considered for each class of business where the income is generated from the business in the department as well as investment income and the outgo is generated based on the business as well as the service departments outgo identified. For each element the risk inherent in the element will be considered and included in the projection. Furthermore the correlations (the cross arrows) will be considered to ensure consistency in the projection.

The projections are then consolidated into revenue accounts and income statements per class of business. These consolidations will include an evaluation of the risk or variability inherent in the projection.

The individual projections will then be consolidated for the entire business enterprise into an income sheet and balance sheet for the entire enterprise.

Both the projections for individual classes of business as well as the projection of the entire enterprise are useful to evaluate business strategies. This evaluation will entail the same control cycle i.e. the identification of problem areas and the testing of solutions to find an optimal solution and the subsequent monitoring of those solutions.

3.2.1 A framework or model structure

In the previous chapter the different structures of the general insurance company were considered i.e. the operation structure, the capital structure and the income structure.

The framework that will be suitable is one that is based on each individual contract and can be consolidated into the different structures as explained previously and illustrated in Figure 4. above

A problem frequently mentioned is that some classes of business are more volatile than others, one such an example being liability business as opposed to

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private motor business. In such cases, the one class of business may obscure the end result of the other class if the company is viewed on a holistic basis. A dual approach is thus required:

1. The underlying risk structure on each individual line of business must be assessed.
2. The combination of these individual lines of business must be investigated as this will reflect the potential experience of the company.

3.2.1.1 The holistic basis

The holistic basis refers to the fact that the model insurer must include model points of all items in the company giving rise to cash flows. It will not suffice to ignore certain classes as their experience will have an impact on the overall situation. A bottom up approach is therefore required. In particular:

1. For each class of business homogeneous groups of policies must be identified for which the expected experience is similar and for which the assumption can be made that each policy in the group will be identically, independently distributed.
2. Such homogeneous groups will form the model points for the investigation. The risk factors applicable to each model point will be investigated to determine how they influence the expected experience. This will require investigating the risk factors that are expected to have an influence on the frequency and severity distributions of the model points.
3. For assets, the model points will be determined according to the actual investment portfolio. The important aspects to consider will be the expected income stream generated by the asset portfolio as well as the expected level of realised and unrealised asset appreciation or depreciation.
4. When the modelling approach, as discussed in the previous chapter (COUTTS and DEVITT), is implemented, all the model points will be used simultaneously. This approach will assume that each item of cash flow is independent. Where this is not the case, the correlations between the different classes will need to be assessed as well as possible.
5. One aspect that COUTTS and DEVITT failed to address was that the model point structure will change over time. Arguably they did mention that the investments will change. A similar argument holds for the liabilities. The change in exposure over time is a critical requirement to ensure that the future experience is modelled correctly. When setting model points it is important to first evaluate the changes in model points over time. Such changes can be a result of changes in business source or market circumstances.

Before applying the algorithm proposed by COUTTS and DEVITT it is important to project the expected exposure for the period of projection. As COUTTS and

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DEVITT rightly pointed out, this change in exposure can also be a result of the actual experience. That is to say the exposure is correlated to the actual experience as is the case with the investment spread.

3.2.1.2 A consolidated algorithm for the proposed framework

Given the ideas set out thus far in this dissertation the consolidated algorithm for the proposed framework can be set out as follows:

3.2.1.2.1 Step 1: Planning

Plan the framework relevant to the business operation. Note that this framework is required to support a variety of investigations from solvency verification to the optimisation of return on capital. The framework is wider than any one objective. In this planning stage the following is required:

1. An understanding of the business process and a realisation that the business result is a reflection of the entire business process. This is critical as optimisation will only be possible when the required changes in business processes can be identified
2. Identification of all the items contributing to the business process.
    a. The actual business on the books or the exposure of business is very important in this regard.
    b. The expected experience on the exposure will determine the business result.
    c. The constraints imposed by management for every type of exposure.
3. Identification of all the areas of risk and uncertainty.
4. Identification of the information requirements necessary to evaluate both the exposure as well as the actual experience on a regular basis.

3.2.1.2.2 Step 2: Understand the needs

Obtain buy-in from all the relevant parties, the most important of which is senior management. Without the active support of senior management, the results identified will not be implemented and as a result the value added will be substantially less. As the framework is holistic, it has to be embraced holistically.

Set up a risk evaluation department with suitably trained personnel to manage the proposed framework.

The framework will be able to support a variety of needs in the company. The interaction with different parties within the organisation needs to be considered:

1. The risk committee who needs to be informed of accumulations of risk and the possible impact thereof.
2. The business units who need to understand the profitability for the different lines of business and the reasons for possible deviations.
3. The finance department who need to produce profit and loss accounts.

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4. The regulators who may wish to investigate the model structure and require solvency reports.
5. The auditors.
6. Rating agencies.

Ensure that the necessary information technology structures are in place to provide timely and accurate data. Furthermore the workflow process needs to be audited to ensure that possible sources of data error are eliminated.

3.2.1.2.3 Step 3: Prior investigations

Identify the different sources of risk and uncertainty. Identify those areas that have the greatest probable impact on the business result. This has been discussed in 3.3 above.

Consider how these risks can be modelled and where this is not appropriate how procedures can be put into place to mitigate this risk. This will be discussed further when corporate governance is considered.

For those risks that are quantifiable set up appropriate models and test the models for reasonability. Also conduct sensitivity testing to ensure that the models are robust. It they are not then the constraints on models should be noted and documented. In later chapters this will be discussed at length.

Consider the correlations that exist. Some of these will be correlations between asset classes, correlations between liability classes, correlations between assets and liabilities and correlations between these items and the exposure at any point in time.

3.2.1.2.4 Step 4: Build and document the framework

The exposure structure represented by the model points will be considered first. The starting point will be the existing exposure. On these model points the expected experience will be generated as discussed by COUTTS and DEVITT.

Once one period of experience has been generated the impact of this on the exposure will be considered. This is the change in investment or borrowing that COUTTS and DEVITT referred to but it will also include other independent changes in exposure expected such as a change in policyholder profile.

The framework must be built in such a fashion that full details of all expected model points at different durations as well as expected experience at different durations are recorded.

3.2.1.2.4.1 Step 4.1

Set up the framework with sufficient flexibility to investigate different time horizons as well as frequency of projections in this time horizon. That is the total

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duration for which future experience will be projected as well as the number of changes in projections that will be made within this period of projection.

3.2.1.2.4.2 Step 4.2

Start with the current exposure. If a different exposure structure needs to be considered, then the manner in which the current structure will change to the proposed needs to be considered. This may be as a result of a marketing drive or change in distribution channel etc.

3.2.1.2.4.3 Step 4.3

Based on the models which have been fitted, tested and correlations established, project the expected experience for the first period of projection. This will include the projection of expected claims on the existing exposure, allowance for reinsurance and bad debt, projection of investment income and allowance for all other expenses as noted in the revenue account and income statement. Consolidate the projected experience.

The consolidated experience can be presented by the income and balance sheets discussed previously. All transactions supporting this should also be considered.

Note that the running time can become very slow and therefore an optimisation of the programming structure should also be considered. This will, however, not be discussed further in this dissertation.

3.2.1.2.4.4 Step 4.4

Consider the impact of the projected consolidated experience on the exposure of the company. Consider any other expected influences on the exposure as well as the models, if considered necessary. Change the exposure accordingly.

For example, if following the projection, borrowing is required allow for the introduction of a borrowing component in the model points. Or if a change in investment structure is required, allow for this change. Also allow for any other independent expected changes in exposure, for example following the change in distribution channel.

Set up model points for the new set of exposure.

3.2.1.2.4.5 Step 4.5

Project the experience for the new set of exposure relevant to the next period of projection and repeat steps 4.3 and 4.4 set out above.

3.2.1.2.4.6 Step 4.6

Repeat the process for all periods of projection for the duration of projection initially specified.

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3.2.1.2.4.7 Step 4.7

Repeat the process a number of times to establish a distribution of possible outcomes for the purpose of the investigation.

Note that for a sufficiently flexible system, it should be possible to limit the capturing of information to only the relevant items necessary for the purpose of the investigation which will accelerate the running time.

3.2.1.2.4.8 Step 4.8

Evaluate the results and provide feedback to the party requesting the results.

This process must be documented for every step of the workflow to ensure proper maintenance and robustness following possible staff movements.

3.2.1.2.5 Step 5: Testing

It is useful to conduct back testing exercises whereby the model is run for previous periods of time and the actual experience compared to the expected.

In similar fashion, the monitoring process will be to compare the future experience as and when it occurs to that projected using the framework and thereby improving the framework. Due to changing business environments, model error is quite likely. The ability to allow for changes in the model is critical as the model is required to be a projection of future expected experience. This is discussed further in subsequent chapters.

The framework can then be used to test business strategies to optimise goals set by shareholders.

3.2.1.3 A note on correlations

This approach is extremely useful as the individual classes can be investigated in detail while the combined influence of all classes together can also be investigated. An area of concern, however, is the level of correlation between the different model points. These correlations will be more pronounced under extreme[35] conditions.

Where correlations are expected, these will be modelled by investigating the sample correlations from investigations and applying the results to the model.

[35] Empirical evidence, such as the fact that all share prices fall in the event of a market crash, is proof that model points, which would normally be considered as independent, are in fact correlated, at least in extreme circumstances.

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An analysis of the areas of risk and uncertainty now follows together with an identification of the most important areas of risk and uncertainty. Although the importance will vary from one enterprise to the next, this analysis considers the importance for the general insurance industry as a whole.

3.3 Analysis of areas of risk and uncertainty

In the introduction macro and micro risks were identified. The reader is referred back to the introduction for a detailed discussion.

A number of institutions have investigated the areas of risk and uncertainty relevant to general insurance operations. Some of the results of these investigations are given below. It is important to note that such results are not all-inclusive. Furthermore, note that not all these risks can necessarily be quantified.

3.3.1 The National Association of Insurance Commissioners (NAIC) in the USA

The NAIC has established a set of rules whereby a minimum statutory requirement of Risk Based Capital (RBC) can be determined for property and casualty insurance companies in the USA. These rules are applied according to perceived levels of risk in various areas. Different action levels are set upon which the company will face different types of intervention from the regulatory authorities. The aim of this dissertation is not to suggest a statutory basis for calculating a minimum capital requirement or to explain the USA Risk Based Capital system. It is necessary, however, to identify the relevant areas of risk and uncertainty which may be practically used in an internal investigation, can be modelled and which have been highlighted by the NAIC.

1. *Asset Risk.*

   It has been identified that the assets held by the company contribute to the level of risk in the business process. The extent to which asset fluctuations match or differ from liability fluctuations must be investigated. Assets will need to match liabilities by amount, term, nature and currency. This issue is investigated further later in this dissertation.

2. *Credit Risk.*

   Credit risk refers to the possibility of broker insolvency and broker balances being lost or that a reinsurer fails to meet its commitments to the direct writer. In effect, credit risk refers to the possibility of default of any third party insofar as that default has an impact on the financial solvency of the company. Brokers and reinsurers are arguably more important credit risks and should therefore be investigated first.

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Assessing credit risk can be difficult. The ideal is that the methods described in this dissertation should be applied to the individual brokers and reinsurers in order to determine their possibility of default.

3. *Growth Risk.*

   In their paper to the Casualty Actuarial Society, REDMAN & SCUDELLARI (1992) examined a number of reports concerning the causes of insolvency in the USA. Rate of growth proved to be a significant factor associated with insolvencies. It is debatable whether this may have been due to inadequate pricing but it should still be borne in mind.

   Solvency is often measured as a percentage of written premium and for a company expanding at a rapid rate the solvency situation will consequently deteriorate. It is therefore a logical consequence that rapid growth has proved to be a significant factor associated with insolvencies. Given that business written will normally expand free reserves[36] by a ratio smaller than the solvency ratio[37] it follows that the rate at which a company can grow is limited by the following:

   1. Its current free reserves.
   2. Its minimum solvency requirement.
   3. The additional expected contribution to free reserves from the additional business sold.
   4. The return achieved on reserves held.

4. *Reserve Risk.*

   This is the risk that reserves will prove to be inadequate to meet future outgo on liabilities. Due to the varying nature, term and currency of business sold the office needs to assess the reserve risk per line of business *and* keep in mind that the experience on different lines of business is not necessarily independent. For this reason it is also important to investigate the office holistically.

5. *Underwriting Risk.*

   Where the reserve risk stated in 4 above refers to business that has already been sold, this risk refers to business to be sold in future. It is of prime importance to ensure that the premium received for future business will be sufficient to meet the future liability outgo on the business sold unless there is

[36] The free reserves are the assets less liabilities less any non-distributable reserves.
[37] The solvency ratio is defined to be the ratio of free reserves to written premium.

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a justified strategy to loss-lead with an associated monitoring system to ensure that the losses do not exceed a pre-determined budget.

The NAIC has suggested certain percentages to be applied to premiums and statutory reserves held by companies in order to determine the company's RBC requirement[38]. These percentages,[39] which reflect the deemed level of risk of each of the items given above, are FINNIS (95):

1. Asset Risk 23%
2. Credit Risk 10%
3. Growth Risk 1%
4. Reserve Risk 43%
5. Underwriting Risk 23%

As the purpose of RBC in the USA is that of a regulatory tool, the calculation of the required capital has had to be restricted to robust methods and hence the split of risk given. The reader will appreciate that other areas of risk also confront the insurance company. Such risks include natural catastrophes and asset liability mismatching[40].

3.3.2 The General Insurance Study Group (GISG) in the UK

A working party was set up by the GISG on Capital Requirements and Risk-Based Capital. This working party produced a comprehensive paper on Risk-Based Capital in General Insurance, HOOKER et al. (1995). The paper stopped short of allocating percentages to each type of risk as it did not suggest ways to quantify each of the risks mentioned. In this paper the following areas of risk were identified:

1. *The uncertainty of claim costs.* These uncertainties vary by line of business and by the trends and cycles to which the business might be exposed in the market.

[38] There is a paradox in this method in that the RBC requirement for a company with prudent reserves is higher than that for a company with liberal reserves.

[39] These percentages were set by the NAIC after investigating the financial results of general insurance companies for the period 1983 - 1993. The factors found to have led to insolvency of companies were investigated. The most frequent factors are given together with their assessed contribution to the possible failure of a general insurance company.

[40] The additional complexity has to be weighed against the additional benefit obtained by including these areas of risk.

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2. *Volatility in asset values.* This risk is increased when the liabilities and assets are not matched. The variability in liability outgo makes it extremely difficult to match assets with liabilities.

3. *Inflation.* Several forms of inflationary pressure exist on the outflow of the insurance company. These relate to earnings of personnel, escalation of claim handling expenses and escalation of claim costs. There are a variety of reasons why the claim costs could increase but these reasons depend on the line of business. For example, liability claims will be influenced by cost of living increases as well as by increases in court awards[41].

4. *Exposure to catastrophic losses.* The modelling of this risk is extremely difficult given the low frequency and high severity of these losses.

5. *Credit risks.* This is explained as the risk that brokers' balances will be lost in the event of bankruptcy as well as the risk that reinsurers will be unable to meet contractual obligations or be unable to pay claims promptly.

6. *Covariance.* The interaction between different factors is uncertain and these interactions are quite complex due to the fact that there are many areas of risk and uncertainty.

7. *Growth.* Reference was once again made to the study of REDMAN and SCUDELLARI.

8. *Ownership and corporate structure.* Reference is made to the security of borrowings and the security of a parent.

9. *Management competence.* This is referred to as a "soft" issue due to the fact that it is very difficult to assess.

Different areas of risk and uncertainty will be alluded to in the discussion of the modelling of different items of income and outgo.

3.3.3 The General Insurance Board Working Party

The general insurance board of the Institute of Actuaries have set up a working party to provide a framework for the *Financial Condition Assessment* of general insurance companies. The purpose of this assessment is to ensure that the FINANCIAL SERVICES AUTHORITY, the regulatory body in the UK, can be satisfied that a general insurance company is sufficiently solvent to meet its liability requirements. RYAN et.al. (2001) provides a comprehensive overview of the suggestions made by the working party.

The working party suggests a two tiered approach: The first is an identification of all the different types of risk and the second is the consolidation of all these risks

[41] These awards can also have catastrophic effects but are not quantifiable beforehand.

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into one on a holistic basis where the correlation between the different risks can be modelled. The paper mentions two bounds on the risk requirement:

1. If all risks were 100% dependent then the capital requirement would be the sum of the capital requirement for all the individual risks[42].
2. If all risks were 100% independent then the capital requirement would be the square root of the sum of all the squares of the individual capital requirements.

The paper provides the following non-exhaustive appendix of possible areas of risk and uncertainty that will need to be considered in the process of assessing the financial condition of the company.

It considers risk split by underwriting risk, asset risk and other risk:

3.3.3.1 Underwriting risk

1. Market issues
    a. Lack of innovation relative of others
    b. Exposure to market forces
2. Underwriting controls
    a. Inappropriate underwriting strategy
    b. Failure to apply underwriting guidelines
    c. Mis-classification of business
    d. Mis-selling
3. Premiums (growth risk)
    a. Rapid growth as a result of under pricing
    b. Fall in volumes
4. Pricing
    a. Incorrect pricing
        i. Claims
        ii. Expenses
        iii. Reinsurance price
        iv. Earnings
        v. Actuarial / accounting system
    b. Incorrect rate relativities
        i. Methodology
        ii. Data
5. Portfolio management
    a. Changes in business mix
    b. Lack of diversification
    c. Increases in line size

[42] This will be discussed in further detail in chapter 9.

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6. Claims
    a. Frequency of claims
    b. Frequency of large claims
    c. Catastrophe claims
    d. Mass tort claims
    e. Latent claims
    f. Unexpected exposures
    g. Inadequate claims reserves
    h. Discounting risk
        i. Interest rate assumption
        ii. Cash flow patterns
    i. Excessive claims reserves
    j. Correlation between claims
7. Expenses
    a. Excessive expenses
    b. Incorrect expense reserve
8. Social
    a. Change in the propensity to claim
9. Currency
    a. Movements in exchange rates
    b. Devaluation
10. Reinsurance
    a. Inappropriate reinsurance programme
        i. Net retentions
        ii. Gaps / coverage
        iii. Nature / basis of cover (not matched to business)
    b. Assessment of exposures
    c. Failure of a reinsurer
    d. General reinsurance market failure
    e. Substantial reinsurance price rise
    f. Unavailability of reinsurance
    g. Reinsurance mis-match
    h. Reinsurance disputes
    i. Financial reinsurance
11. Legal / Legislative
    a. Changes in legal system
    b. Changes in court awards
    c. Policy wording interpretation
12. Political
    a. Taxation
    b. Nationalisation
    c. Change in responsibility of claims

3.3.3.2 Asset risk

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13. Asset risk
    a. Valuation risk – incorrect asset values
    b. Fall in values
    c. Movement in interest rates
    d. Impaired subsidiary
    e. Default risk (credit risk)
    f. Liquidity
    g. Concentration
        i. Counter party / credit risk
        ii. Diversification / volatility risk
        iii. Diversification (return) risk
        iv. Portfolio management risk
14. Premium reserves
    a. Incorrect premium recognition
    b. Incorrect unexpired risk assessment
15. Financing risk
    a. Dividend commitments / expectations
    b. Return on capital expectations
    c. Repayment
    d. Access to capital debt
    e. Debt interest / repayment commitments (cash flow issues)
16. Other economic
    a. Inflation (claims and expenses)
    b. Economic impact on claims frequency

3.3.3.3 Other risk

17. Operational risks
    a. Fraud (management / staff / policyholder)
        i. Inadequate controls
        ii. Inadequate procedures for dealing with fraud
        iii. Inadequate prevention / detection mechanisms
    b. Management risk
        i. Not sound and prudent
        ii. Not fit and proper
        iii. Insufficient development of staff
        iv. Unsuitable / insufficient resources / staff
        v. Over-reliance on key persons
18. Lack of information
    a. Technology risk
        i. Inadequate / outdated IT systems
        ii. Technology failure
        iii. Inadequate backup / disaster recovery
        iv. Inadequate security
        v. Failure of processes

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b. Administration risk
    i. Failure of procedures / processes
    ii. Failure of outsourcing (service / reputation / monitoring)
    iii. Inappropriate organisational structure
    iv. Inappropriate reporting structure
    v. Roles and responsibilities linked to firm's mission / objectives
    vi. Inappropriate segregation of duties
c. Planning risk
    i. Inadequate strategic / business / marketing plan
    ii. Business structure / direction
    iii. Market share / competition management
    iv. Investment / underwriting strategy
    v. Mission statement business principles and philosophy
    vi. Identify, measure, manage risk to mission
    vii. Resilience testing
    viii. Budgeting and forecasting
d. Business risk
    i. Expense / cash flow / credit controls
    ii. Market knowledge
    iii. Business knowledge
    iv. Change in market conditions and business environment
    v. Mergers and acquisitions
e. Reputation risk
    i. Moral obligation
    ii. Reputation protection risk
f. Control risk
    i. Inadequate corporate governance
    ii. Inadequate systems and control
g. Regulatory risk
    i. Cost of non-compliance (fines, reputation)
    ii. Cost of compliance UK / EU / International
h. Audit risk
    i. Inadequate internal audit
    ii. Inadequate external audit
    iii. Non-functional audit committee
i. Reporting risk
    i. Reliability and timelines
    ii. Usefulness / relevance
    iii. Data integrity
j. Exposure risk
    i. Product and liability insurance
    ii. Inadequate directors and officers insurance
    iii. Inadequate security procedures
    iv. Inadequate / incorrect legal advice
    v. Inadequate risk management

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k. Risk management risk
    i. Inadequate risk identification and controls
    ii. Risk exposure limits
    iii. Inappropriate risk / exposure levels
l. Disaster risk
    i. Fire / power cut / strike action
    ii. Natural disaster
    iii. Unsuitable / insufficient continuity plan
m. Initiative risk
    i. New products / processes
    ii. Financing risk
    iii. Poor understanding of business
    iv. Inadequate systems and controls
    v. Acquisition risk
    vi. Growth risk
    vii. Implementation risk

19. Policyholders' reasonable expectations
    a. Marketing should give fair representation
    b. Management of policies should be consistent with PRE
20. Dependency on others
    a. Underwriting – giving the pen away, binders, follower
    b. Concentration of distribution – reliance on a single broker
    c. Outsourcing
    d. External models
21. Group structure
    a. Impaired parent
    b. Impaired affiliate / subsidiary
    c. Non-insurance activities
    d. Off balance sheet items

The paper also includes the results of the study conducted by A.M. BEST (1999). In this study BEST analysed 683 insolvencies in the USA between 1969 and 1998. The reasons for the company failures are summarised below:

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Table 2: Reasons for company failures in the USA between 1969 and 1998

Underwriting risks	Insufficient reserves / premiums	22%	
	Too rapid growth	14%	
	Catastrophe losses	6%	42%
Asset risks	Overvalued assets	6%	
	Failure of ceded reinsurance	3%	9%
Other risks	Subsidiaries	4%	
	Significant change of core business	4%	
	Fraud	7%	
	Miscellaneous	7%	
	Non-identifiable	27%	49%
			100%

3.4 Synthesis on the areas of risk and uncertainty

The results of the empirical studies by FINNIS (1995) and A.M. BEST (1999) differ in quantum. In particular, non-quantifiable risks form a substantial proportion of the risks identified by A.M. BEST.

The investigation by the NAIC is important. This shows the importance of assessing the liability risk for a company properly. The underwriting and reserving risks both refer to proper appraisal of the liability risk.

The analysis also indicates that there are a wide variety of risks that need to be taken into account. The quantification of these risks is not always intuitively obvious.

In this study, the risks that will be first considered are:

1. The liability risk. This risk includes the risk of setting insufficient rates as well as setting insufficient reserves. As indicated in both studies, for general insurance companies this is the most important risk.
2. The asset risk.
3. Credit risk.
4. Management risk.

In this dissertation the liability risk, asset risk and credit risk will be considered in detail and in particular the quantification of these risks. The other risks are all grouped under management risk and are discussed under the heading of corporate governance. The assumption here is that these risks will be mitigated through the proper implementation of corporate governance.

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4. Data and information requirements

4.1 Introduction

This chapter provides the considerations to be taken into account when setting up the information requirements for a model insurer. The information requirements are very broad and they can be divided into two categories:

1. Data requirements on the individual model points.
2. Information required on the general economic and commercial environment.

It is crucial that sufficient time and other resources are spent to ensure the adequacy and accuracy of the data. Without proper data the model of the insurer will have very little value. The analogy of the flight simulator can be used once again. If the simulator is unable to generate life-like experiences (at least to some degree) the trainee pilot will be unable to call upon his training in a real life situation.

The approach followed in this chapter is to consider all items of information required for costing purposes[43] when considering the individual model points. These requirements will differ by line of business. Private motor business will be used as an example in this chapter. The methodology can, however, be applied in similar fashion to other lines of business.

4.2 The methodology underlying the data on individual model points

The overall aim of theoretical costing of risk is to calculate as accurately as possible the cost to the insurance company of writing a policy. To this end it has become evident that the claims experience of a company varies according to the risk characteristics of the insured. There are three generic areas[44] that need to be addressed:

1. The frequency of claims
2. The severity of claims (this will include separate allowance for recoveries)
3. Delays in claim payments

In order to calculate these details, policy and claim information records have to be kept separately with appropriate links to ensure that a claim can be traced back to a certain policy and also to a certain period of cover.

[43] Costing of risk refers to the theoretical assessment of the true cost of risk.

[44] A full explanation and further discussion on these three areas will be given in the next chapter.

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This means that extensive record keeping on the underwriting or policy side is also required over time[45]. This will ensure that the office's exposure[46] can be determined at different stages.

4.3 The principle of correspondence

A crucial aspect of rating is to ensure that actual experience can be traced back to all the policies from which this experience has originated[47]. If exposure information is not available, testing the experience against the exposure information is of little value. The reason for this is that the experience information cannot be applied to any other exposure information and is therefore of historic interest only.

Many companies in the general insurance arena today do not have the appropriate information to solve this problem. In the sections below an explanation is given of the information requirements for private motor business as an example of the thinking behind the data requirements.

4.4 The policy information

The policy information will eventually be consolidated into the different model points. This is done by investigating the different risk characteristics of each policy and subsequently identifying which risk factors have a significant impact on expected experience. The policies are eventually grouped by these risk factors. Details of these investigations are discussed in the next chapter.

The starting point is to consider each policy individually. Where this is not possible, appropriate approximations will need to be made. For each policy the company will need to determine the risk inherent in that policy. This can be done by investigating the risk factors[48] relating to the policy. Risk factors are determined through investigation as well as discussions with underwriters and other persons who carry knowledge of the risks underlying the experience.

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[45] Normal practice in the short-term insurance market tends towards capturing only transaction data over time while policy information is amended and only the current records are kept. This means that changes in policy information cannot be traced. This has a direct implication for the ability of the office to relate its claims experience to its exposure.

[46] The term "exposure" has a variety of meanings in the insurance industry and should always be read in context. It generally refers to the exposure a company has to underwriting risk as explained earlier in this study.

[47] This is, in essence, the principle of correspondence.

[48] A distinction between risk factors and rating factors is often found in actuarial literature. Risk factors often refer to all factors affecting the risk relating to the policy while rating factors refer to the factors used in rating the risk. This distinction is of less concern for the purpose of this study. Risk factors will be taken to mean all *quantifiable* factors affecting the risk inherent in a policy. Whether this factor will then be used in rating at a subsequent stage is a marketing or underwriting consideration and not the prime drive behind this study.

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Details regarding the insured and, if different, the drivers of the vehicle, the vehicle itself and the type of cover are required. Furthermore the following list may be considered assuming an investigation of policies with the same type of cover:

- Clarification is required as to who the principle driver of the vehicle is.
- The date of birth of the principle driver.
- The gender of the principle driver.
- The residential address of the principle driver. Postal addresses are more crude in determining location but may be considered instead.
- The date on which cover was first obtained from the company - this is different to the number of claim free years, etc. It has been found that the idea of claim free years is often abused in order to obtain lower rates. This suggestion would need to be investigated.
- Number of claim free years - to test the above-mentioned argument.
- Renewal date of policy.
- Date of cancellation or endorsement.
- Premium.
- Occupation of principle driver.
- Date on which license was obtained.
- Number of speeding fines in the last 5 years.
- Details of excesses[49].
- Private or business use.
- Details of broker.

Note that for each endorsement on a policy a new record must be created. This is to ensure that changes such as change of address are appropriately allowed for. It is also preferable to reflect the number of endorsements and renewals in the policy number but this is not essential. This means that the same policy number is kept but a subsection is allocated to the number of endorsements. The endorsement date is crucial in order to be able to calculate the exposure accurately. The following diagram gives a visual explanation:

[49] It is often found that persons who choose to take a higher excess or deductible on claim payments are more conscious of the risks and their costs. The result of this is that such persons tend to be better risks as they actively apply risk management themselves.

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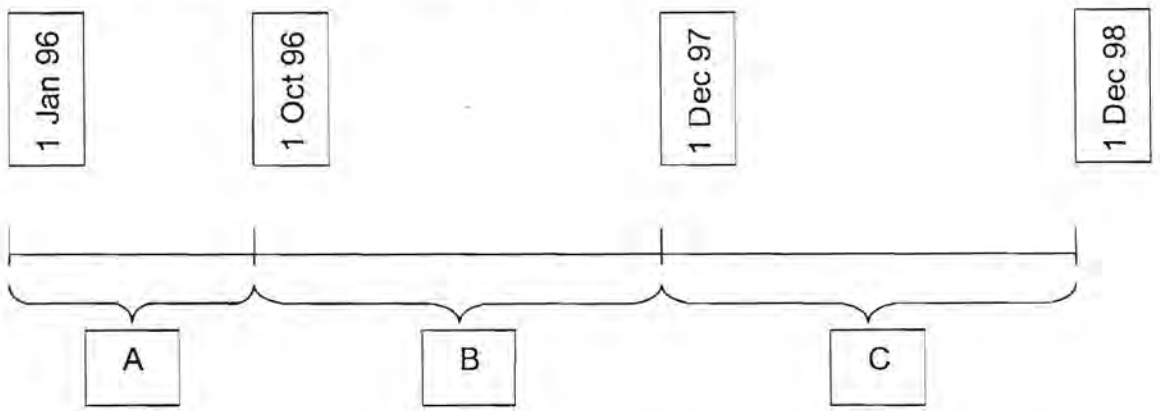
Figure 5: Evaluating exposure over time



When a specific policy is considered the characteristics might change. For example in the diagram above the period from 1 October 1996 to 1 December 1997 (period B), the policyholder might have chosen a different excess level or nominated another principle driver or any other change relating to the risk factors might have taken place. As the company will need to compare similar risks it may therefore need to allocate period A, B and C to different risk classes when measuring exposure.

This distinction has to be balanced against the volume of information available.

Details of the vehicle to be insured are also required:

- Age of vehicle.
- Vehicle name and specification.
- Engine capacity.
- Original purchase price.
- Sum insured.
- Security features. Alarm, tracking, gear-lock etc.

It must be stressed that not all factors would necessarily have a significant impact on the cost of risk. The more risk factors that are included, the more scenarios can be tested. It has been found that considerable variation in experience exists between different books of business due to differences in marketing techniques and source[50] of business. This leads to the necessity of investigating all risk factors.

[50] This is based on the author's personal experience in the analyses of such risks.

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4.5 The claims information[51]

The following is required for each claim:

- The policy number.
- The claim number.
- The date of loss.
- The date of reporting.
- Date of payment.
- The amount paid.
- Status of claim – outstanding or settled.
- The gross cost of claim prior to assessment.
- The gross cost of claim following assessment.
- The excess applicable.
- The type of claim.

If the claims are paid on a one-off basis then no further information will be required. Where settlement takes longer, however, each payment relevant to a specific claim has to be recorded. Outstanding claim records have to be recorded in similar fashion.

As the structure of each claim is different it is important to recognise the different types of claims. The type of claim can be grouped according to the requirements of the company. The following provides a suggestion only:

- Own damage, i.e. claims relating to accidents or damage caused by the insured to the vehicle.
- Third party, i.e. claims caused by the insured to a third party to indemnify the third party against the loss incurred.
- Theft. Theft risk might be further subdivided between theft of vehicles and theft of electronic equipment in the vehicle.
- Hi-jack. This risk can be grouped with theft. Note that the impact of theft and hi-jack is substantial when compared to the other risks as the severity of these claims are for the full sum insured. Consequently careful investigation of the frequency of these risks is required.
- Windscreen

[51] This list applies to other transactions as well, such as recoveries.

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- Fire
- Hail

Depending on the level of information, each of the types of claims can be investigated according to the frequency, severity and delay of payment pattern as mentioned earlier. This will be dealt with in the liability valuation section of this study.

In addition, claims experience will be affected by recoveries and reinsurance. Claims will, however, first be considered from ground up and subsequently allowance can be made for all other elements affecting claims.

If claims are captured net of excess payments they will consequently need to be grossed up for any excess paid.

If zero amount claims are not captured then the claim sample will be censored. In order to solve this problem different approaches may be needed such as extrapolating from the distribution fitted to the captured data. The failure to capture zero amount claims impacts significantly on the determination of claims frequency.

If the approach in documenting claims were to change and as a result the frequency of claims were to change, this has to be taken into account. The same holds true for claims management. Hence changes in procedure must be investigated before setting assumptions for modelling.

Full details of recoveries are also required:

- Claim number
- Date of recovery
- Amount of recovery
- Type of recovery for example from salvage, subrogation or reinsurance.

The details set out above provide a framework on which to base the theoretical costing of motor insurance. The lists given are not appropriate to each and every situation but serve as a broad outline. The above should also give the reader an insight into the level and depth of information required to conduct such an analysis.

4.6 Data validation

The data available to an insurer is crucial in any investigation regarding past or future experience. As a result the data available must be scrutinised to ensure

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appropriate and accurate knowledge can be drawn from it. In validating data, potential problem areas include the following:

1. Data specification. Information is often summarised before it is captured. Claims might be captured net of recoveries or net of excess levels. It is important to ensure that full details of each and every transaction are available. This means that details regarding zero claims[52] should also be captured.
2. Incorrect data. This can arise from free form fields or from the incorrect capture of information. It is important to customise a user interface to as great a degree as possible in order to ensure accurate data. It is also important to allocate ownership of the data to a certain department in a company. This is to ensure that the data integrity is maintained at all times.

   Incorrect data can be identified through a variety of tests. Such tests could be spot checks for reasonableness. In addition data reconciliation can be performed by policy numbers, sums insured, premium and duration of cover.
3. Reporting and administrative delays. It is important to track transaction payments over time in order to identify trends in reporting and processing delays. This can be done by capturing the transaction date together with the date of loss or date of reporting.

   It is important to conduct similar investigations by business sources, especially for broker business.
4. Adequate data. This refers to the database design rather than the size of the portfolio. The database must be designed in such a fashion that each and every transaction, once captured, can only be changed by a counter transaction. This will ensure that all details are made available. The system should also be able to accommodate re-opened claims.
5. Exposure details. The principle of correspondence was mentioned earlier. It is crucial to identify the characteristics of the exposure giving rise to claims. Furthermore the underlying structure of homogeneous groupings used in the past may change and as a result inappropriate conclusions may be drawn in future.
6. Missing data. Data may go missing in the extraction process and should be compared to previous data sets and accounting information to ensure all data is considered.
7. Random variation in the data may yield incorrect results. The data may also include abnormal events which are not necessarily an appropriate reflection of future experience.

[52] Zero amount claims can arise from a number of reasons e.g. claims below the deductible, fraudulent claims or claims assessed to be zero. Whatever the reason, it is important to capture this information in order to identify trends and take whatever action is considered necessary.

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4.7 The volume of data required

Many practitioners, statisticians, actuaries and other interested parties question the level of data required in order to make a proper analysis. The answer to the question lies in the interpretation of what a proper analysis would be.

4.7.1 Conventional statistical theory in setting a required sample size

Conventional statistical theory states that if X(t) is the number of occurrences in the interval [0,t], and $P_n(t)$ in the probability on n occurrences in an interval [0,t] then $P_n(t)$ has a Poisson distribution with parameter λ where λ is the average number of occurrences in a unit time period[53].

The value of λ must be estimated. This is done by investigating the frequency of claims as each claim can be viewed as an occurrence in a Poisson process. The best approach to this is to determine the number of claims and divide it by the exposure of policies that give rise to these claims. The question then arises as to how many claims are required.

The answer to this depends on the underlying distribution of the claims as well as the level of certainty required in estimating the frequency. By using the central limit theorem[54] an approximate number of required claims can be determined:

Assume that the difference between the point estimate and the true population value has to be less than *c* with probability *prob*. If L is the point estimate of λ based on the number of claims then the above can be expressed as:

$$P(|L-\lambda| \le c) = prob \qquad (4.1)$$

Using the central limit theorem the following expansion can be made:

$$P\left(\frac{-c\sqrt{n}}{\sigma} \le Z \le \frac{c\sqrt{n}}{\sigma}\right) = prob$$

[53] This theorem is subject to the following constraints:
1. X(0) = 0,
2. P[X(t+h) – X(t) = n | X(s) = m] = P[X(t+h) – X(t) = n] for 0 <= s <= t and 0 < h,
3. P[X(t + Δt) – X(t) = 1] = λΔt + o(Δt) for some constant λ > 0, and
4. P[X(t+Δt) – X(t) >= 2] = o(Δt).

This means the following:
1. The possibility of an occurrence in a nil time period is nil.
2. Occurrences are not affected by occurrences in other time periods.
3. The probability of an occurrence is proportional to the time exposed.
4. The probability of more than one claim at a time is nil.

[54] The central limit theorem states that the sum of n independent identically distributed variables with mean μ and variance σ^2 will be normally distributed with mean $n\mu$ and variance $n\sigma^2$. Therefore the average has mean μ and variance σ^2/n.

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as $$Z = \frac{L - \lambda}{\frac{\sigma}{\sqrt{n}}}$$

has a standard normal distribution. For practical purposes σ can be taken to be equal to L as the number of claims follow the Poisson process and n is the exposure in time of the number of policies exposed to the risk of a claim. The value of n can be determined by using the equation

$$\frac{c\sqrt{n}}{\sigma} = \Phi(prob) \qquad (4.2)$$

where Φ is the inverse function of the standard normal distribution. It will often be the case in practice that n is known i.e. the number of policies on risk is known and therefore the level of certainty of the test will be determined. For example, where the number of thefts and the exposure of policies during a certain period is known.

The preceding argument shows that lower frequencies are more difficult to model.

4.7.2 Conventional practice

In the past, offices often found themselves with inappropriate data. In these circumstances heavy reliance was often placed on the assessment and opinion of the underwriter or insurance manager[55].

Statistical analyses can now be used to support the views of underwriters and insurance managers. It has been found that tremendous synergy can be had by combining the practical viewpoint of such experts with statistical analysis.

4.8 Information requirements on the general economic and commercial environment[56]

Information will be required on the areas of risk stated earlier in this dissertation. The areas to be addressed can be investigated to a great degree of detail. The aim of this study is only to stress the fact that these areas should be taken into account. Details of investigations of such areas are, however, not given.

Some of the information required will include:

1. The statutory requirements imposed by the state of domicile as well as other states in which the general insurance company might operate.

[55] In Baysian terminology this can be viewed as a prior function regarding the distribution of the parameter sets.

[56] The areas of information mentioned here are extremely important in ensuring proper understanding of the business environment. Substantial investigation may therefore be necessary.

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2. The tax environment imposed by the state i.e. detailed tax rules.
3. Government policy regarding regulation of premiums as well as other regulations such as those regarding investments.
4. Current economic outlook. This will be indicative of future growth of business as well as possible moral risks in poor economic situations. In particular, interest rates and rates of inflation must be considered.
5. Past, present and projected levels of economic growth, investment income, asset growth. These factors, together with the factors mentioned in 4. above, are crucial in setting the model points for the assets held by the company. The methodology applied in setting model points for the assets will be discussed at a later stage in this study.
6. The current political situation and any expected changes in future.
7. Demographic movements.
8. The current market situation. This will be indicative of the level of current competition as well as future levels of competition.
9. Current expense structures within the company.
10. Current claims management practices within the company.
11. Current credit control practices within the company.
12. Current reinsurance structures within the company.
13. Credit ratings of external parties.
14. The level of free assets of the company. This will form a crucial part in the analysis of the model office as the solvency of the company is a very important aspect to investigate.
15. The structure of the company with reference to shareholding in the company and the security of the shareholders.
16. The type of business sold by the company.
17. Technological advances made and the impact of these on the business process.
18. The level of adherence to corporate governance and legal compliance.

This list is not exhaustive.

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4.9 Summary

This chapter has dealt with the considerations of obtaining data for the model insurer investigations. Substantial attention to detail was paid to the structure required on individual model points as this will form the basis for the model insurer.

The data structures required on policy and transaction information were discussed to underline the importance of such information for stochastic modelling purposes. Stochastic modelling will be discussed in the next chapter.

The importance of data validation was stressed and an indication was given of the sample size required to ensure a proper investigation of experience.

Other items of data were also mentioned. In normal business many of these items are certain or fairly predictable and will lead to easier implementation of a cash flow model[57].

In short, quality data is crucial in setting up the model insurer.

[57] Tax structures, for instance, are taken to be fixed. Any other outcome cannot be projected by statistical means.