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Calculating Risk Based Capital Requirement Using Correlation Method

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DECLARATION

I declare that this work has not been previously submitted and approved for the award of a degree by this or any other University. To the best of my knowledge and belief, the Research Proposal contains no material previously published or written by another person except where due reference is made in the Research Proposal itself.

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This Research Project has been submitted for examination with my approval as the Supervisor.

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Table of Abbreviations

RBC	Risk Based Capital
VaR	Value at Risk
TVaR	Tail Value at risk
SAM	Solvency Assessment and Management
CAR	Capital Adequacy Ratio
SCR	Solvency Capital Requirements
CCR	Capital Cover Ratio
CR	Capital Requirement

CHAPTER 1: INTRODUCTION

1.1.Background of the Study

In Africa, Insurance penetration levels also remain very low, (with a penetration rate estimated at 3 per cent), and this is largely due to a lack of trust from the public who find insurance companies unable to pay claims when they arise and this brings us to ask the question of what is considered in calculating the minimum capital required by an insurer to stay solvent.

A lack of proper risk management has seen many insurers in Africa become insolvent. Kenya, for example, has seen at least seven insurers in the last decade being placed under statutory management, and eventually liquidated, due to inadequate capital.

Capital provides a safeguard that allows a life insurance company to remain solvent through certain adverse selection fluctuations in results. The more capital a scheme holds, the less likely it is to go insolvent. An insurer's probability of ruin/insolvency depends on the risks that it faces, as well as the amount of capital it holds. Thus two companies with di□erent risk profiles but same capital levels would have di□erent probabilities of ruin. By changing the amount of risk and/ or capital held, insurers can influence their probability of ruin. (RBC, 2002)

Risk-Based Capital (RBC) provides an opportunity for African insurers to improve on their risk assessment and increase public confidence on how these companies are managed. By implementing RBC African insurers would strategically position themselves to compete with their counterparts in other parts of the world who are currently reviewing their risk management models to tackle the ever complex nature of insurance risks that they face.

Risk-Based Capital (RBC) is a method of measuring the minimum amount of capital appropriate for a reporting entity to support its overall business operations in consideration of its size and risk profile. RBC limits the amount of risk a company can take. It requires a company with a higher amount of risk to hold a higher amount of capital. Capital provides a cushion to a company against insolvency. RBC is intended to be a minimum regulatory capital standard and not necessarily the full amount of capital that an insurer would want to hold to meet its safety and competitive objectives. (Links to Canada's Capital Requirements for a variety of institutions, 1999)

RBC is not designed to be used as a stand-alone tool in determining financial solvency of an insurance company; rather it is one of the tools that give regulators legal authority to take control of an insurance company.

RBC is used in both the banking and insurance industries. Regulators, rating agencies and company management may each use different methods, procedures and formulas for estimating RBC. As an indicator of the financial strength of a company, RBC information is also of interest to customers, creditors and investors.

RBC is usually expressed as a risk based capital ratio. This is the total capital of the company (as determined by the RBC formula) divided by the company's risk-based capital (as determined by the formula). For example, a company with a 200% RBC ratio has capital equal to twice its risk based capital.

Certain risks and risk mitigation factors are difficult to incorporate in a RBC formula and therefore are usually not accounted for in the formula. Such risks would include liquidity risk, operational risk, and the risk of fraud. Some risk mitigation factors could be the strength of management, the loyalty of customers and a competitive advantage of the company. (Olsen, 1998)

Capital calculation engine is driven by three processes (Margaret Oyugi, 2013):

i. **Risk classification and measurement**

The firm must consider all material risks that may have an impact on the firm's ability to meet its liabilities to policyholders. The RBC for a firm would depend on the risks that the company is faced with; it's risk appetite (measured as the probability of survival within a specified time period) and regulatory requirements.

UK's ICA, Europe's Solvency II and South Africa's SAM require a 99.5% probability of survival within a year (otherwise known as a 1 in 200-year event). Currently, South Africa's CAR is based on a 95% ten-year survival probability

ii. **Stress test calibration**

Stress testing is a simulation technique. Stress tests are used to gauge how certain stressors will affect a company, industry or specific portfolio. Stress tests are usually computer-generated simulation models that test hypothetical scenarios; however, highly customized stress testing methodology is also often utilized. (FSC, 2008)

Stress testing is calibrated in terms of risk driver moves. Setting the severity of the extreme events at the required confidence level involves analysis of historic moves and judgment to formulate a view about what is a 1-in-200-year event. Because of the complexity of stress test calibration this is often determined by the regulator. (PWC, 2015)

For the purpose of deriving the level of stress tests for each risk, companies must determine how they will measure risks in terms of the variability of outcomes. Commonly used risk metrics are **Value at Risk** and **Tail Value at Risk**.

Value at Risk is defined as the potential loss in a portfolio in a year at a specified confidence level. Tail Value at Risk defined simply as the value at risk of a portfolio plus the expected loss above the Value at Risk.

iii. Net asset value function and capital aggregation methodology

Capital aggregation refers to the task of incorporating the financial impact of multiple types or sources of risks into a single capital figure.

There are a number of capital aggregation techniques that have been implemented in different regulatory regimes. The most common being:

a. Correlation method
b. Monte Carlo Simulation
c. Risk Geographies
d. Copulas

1.2.Problem Statement

Kenya has 49 insurers, five re-insurers and almost 200 brokers in a country where about 3 percent of the population has cover.

A lack of proper risk management has seen many insurers in Africa become insolvent. Kenya, for example, has seen at least seven insurers in the last decade being placed under statutory management, and eventually liquidated, due to inadequate capital.

In view of this, this project will examine risks that a□ect capital calculation of a life insurance company in Kenya.

1.3.Research Objective

The research objective is to calculate the Capital requirement using the Correlation method in accordance with the RBC regulations.

1.4.Research Questions

I. Finding the minimum required reserve to cover risk of selected life insurers?

1.5.Significance of The Study

The amount of Capital and reserve is vital to keep Insurance Companies solvent. Many insurers have found it di□cult to stay solvent due to certain risks that surround the business. This project will look at Risk Based Capital and how it can assist in capital calculation for an insurer in Kenya.

CHAPTER 2: LITERATURE REVIEW

This chapter reviews the past literature on the UK Risk Based Capital system and Aggregation techniques.

4.1. 2.1. The UK Risk Based Capital System

Here we look at the UK's RBC System as discussed by (Margaret Oyugi, 2013) and (Rosa Cocozza, 2006)

Risk classification and measurement

The firm must consider all material risks that may have an impact on the firm's ability to meet its liabilities to policyholders. The RBC for a firm would depend on the risks that the company is faced with; it's risk appetite (measured as the probability of survival within a specified time period) and regulatory requirements.

This risks include: Market risk, insurance risk, Default risk, Operational risk

UK's ICA, Europe's Solvency II and South Africa's SAM require a 99.5% probability of survival within a year (otherwise known as a 1 in 200-year event). Currently, South Africa's CAR is based on a 95% ten-year survival probability.

Stress test calibration

Stress testing is a simulation technique. Stress tests are used to gauge how certain stressors will affect a company, industry or specific portfolio. Stress tests are usually computer-generated simulation models that test hypothetical scenarios; however, highly customized stress testing methodology is also often utilized.

Stress testing is calibrated in terms of risk driver moves. Setting the severity of the extreme events at the required confidence level involves analysis of historic moves and judgment to formulate a view about what is a 1-in-200-year event. Because of the complexity of stress test calibration this is often determined by the regulator. (Andreas A. Jobst, 2014)

For the purpose of deriving the level of stress tests for each risk, companies must determine how they will measure risks in terms of the variability of outcomes. Commonly used risk metrics are **Value at Risk** and **Tail Value at Risk**.

Value at Risk (VaR) :A one-year value at risk is defined as the potential loss in a portfolio in a year at a specified confidence level, say 99.5%. Under Solvency II and SAM frameworks it is the basic risk measure to calculate capital requirements.

One method that may be used to calculate VaR is the Variance-Covariance method (or delta-normal method). It assumes that all asset returns are normally distributed and the portfolio return is a linear combination of normal variables. (HUI, 2006)

One limitation of VaR is that it is uninformative about the extreme tail. It only tells us what we could lose in normal states, where the tail event does not occur, but nothing about what we could lose in bad states where a tail event occurs. Also, linear form cannot adequately express the risk when options or other non-linear instruments are contained in the portfolio.

Tail Value at Risk(TVaR) may be defined simply as the value at risk of a portfolio plus the expected loss above the VaR. TVaR at a specified confidence level is therefore generally greater than VaR. However, TVaR is more difficult to calculate than VaR since information on the full distribution of outcomes is required, and this is usually not available in practice.

TVaR has been adopted by the Canadian Institute of Actuaries, the American Academy of Actuaries and the Swiss regulators.

In this paper, it is recommended that a VaR method be adopted to decide on level of stresses that may be applied for the African markets. It is recommended that the stresses be calibrated at (a less stringent) 95% confidence level over one year to reduce the impact of capital requirement on balance sheets of African insurers who are less capitalized.

Net asset value function and capital aggregation methodology

Capital aggregation refers to the task of incorporating the financial impact of multiple types or sources of risks into a single capital figure.

There are a number of capital aggregation techniques that have been implemented in different regulatory regimes.

The most common being: Correlation method, Monte Carlo simulation, Risk Geographies, Copulas.

In this present paper we will use the correlation method to calculate capital requirements.

4.2. 2.2. Aggregation Techniques

Having chosen a risk measure and calculated the risks involved, the next step is to aggregate risks across different products, lines geographic areas etc.

Here we look at different aggregation techniques as discussed by (T. Androschuck, 2015), (Richard Shaw, 2009) and (Joshua Corrigan, 2009)

2.2.1. Types of aggregation techniques

2.2.1.1. Simple Summation

This involves adding together the stand alone marginal risk capital amounts. It ignores potential diversification benefits and produces an upper bound for the economic capital number. Mathematically this is equivalent to assuming a perfect dependency between risks.

Advantages

No data is required to calibrate the model correlations as it assumes there is a perfect dependency between risks. Secondly it is very easy to compute. It is very easy to communicate the method and final result. Finally, it is also deemed very conservative.

Disadvantage

This method overestimates the amount of required capital, and therefore incurs a cost of holding extra capital and it doesn't allow for meaningful interactions between risks.

2.2.1.2. Fixed Diversification percentage

This method is very similar to the simple summation however it assumes a fixed percentage deduction from the overall capital figure.

Advantages

There is simplicity in data and computation the data. It is also very easy to communicate the method and the final result.

Disadvantage

It's a crude method, but allows for some diversification benefit to reduce the capital. It does not allow for meaningful interactions between risks. The fixed diversification is not sensitive to changes in underlying risk exposures. It does not capture non-linearity.

2.2.1.3.The Covariance –correlation approach

It's one of the simplest methods and the same principle is used to calculate the SCR using the Standard Formula method in Solvency II.

Covariance-correlation is an analytical framework for aggregating capital that has been used widely by UK firms since the introduction of the ICAS regime in 2004. Under this method univariate stresses are run on the balance sheet and capital requirements for each risk are calculated at the 99.5th percentile. These univariate capital requirements are then aggregated through a correlation matrix.

A possible formula is:

$$SCR = \sqrt{\sum_{i,j} Corr_{i,j} \bullet SCR_i \bullet SCR_j}$$

The covariance-correlation approach might be deemed to be an appropriate method where risks follow an elliptic distribution (such as a multivariate normal) and there is no significant non-linearity or other interactions between risks; it might also be the preferred approach for some insurers due to its simplicity.

The approach might be deemed to be more transparent by some after allowing for the assumptions implied in the method; and it is easier to make like-for-like comparisons, for benchmarking against peers.

For some insurers, the copula and proxy model development costs may outweigh the benefits and a firm may prefer to use the simpler Covariance approach, either as is, or by making appropriate refinements to reflect features specific to its risk profile (e.g. add-ons based on scenario analysis, or use more prudent correlation factors). This is more likely to be the case for smaller companies, which are not deemed to pose a systemic risk to a country's economy.

Limitations of the Covariance – correlation approach

In its purest form, the method implies that the multivariate risk factor distribution is elliptical and that the relationship between risk factors and univariate capital losses is linear. However, these assumptions are not usually borne out in practice, and would be difficult to justify under the Solvency II Statistical Standards.

For some insurance contracts and particular risks, the linear relationship might hold (e.g. equity risk and linked liabilities), but there will be examples where this relationship will break down. This can be as a result of guarantees of some kind (e.g. minimum benefits) or stop-loss reinsurance contracts, or in the case of interest rates where valuations exhibit convexity.

The method also assumes that the risks are separable, i.e. the univariate losses from each risk plus the correlation matrix are sufficient to determine the aggregate loss. This is not always the case, as there will be additional effects from considering the two risks together, which can be material. Examples can be the relationship between interest rates and longevity on an annuity contract and levels of equity returns and interest rates on the "Value in Force" of a unit linked contract.

Overall, there are a number of limitations within the method, but it can still produce a valid result.

2.2.1.4.Delta/Gamma approach

The Delta/Gamma approach is an extension of the pure correlation matrix approach where, instead of assuming a linear Value Response Function, the formula now includes quadratic terms, including interactions between pairs of risk factors. (HUI, 2006)

The method is calibrated by applying two stress tests in each of the individual risk factors and one joint stress test for all combinations of two risk factors.

2.2.1.5.Copulas

Under this technique, a combination of historical data and expert judgement are used to identify a suitable statistical distribution for each material, quantifiable risk factor. A copula is chosen to model the dependencies between changes in those risk factors. A large number of simulated changes in each individual risk factor is generated and "glued together" using the copula to generate a set of simulated scenarios which reflect the assumed dependencies.

Advantages of copulas

The use of Copulas is consistent with a typical actuarial and financial risk modelling process whereby marginal risk distributions for each risk are first determined and then one considers separately the aggregation process.

There are a range of different copulas that can be used, each varying in their mathematical properties.

Copulas are very flexible in that one can combine a varied number of marginal risk distributions together with a varying number of copula distributions. Various types of copulas can be selected depending on one's views on such characteristics of a dependency structure as skewness, kurtosis and tail dependence.

Even for a selected copula type, there is a wide range of dependency structures that are possible from the use of different copula parameters.

If one chooses to have a simple model for dependency (e.g. correlation matrix) combined with asymmetric heavy-tailed distributions, this can be done using a Gaussian copula with non-Gaussian MRDs.

Copulas can more accurately reflect the dependency structure between risks than correlation coefficients can. They avoid the deficiencies of correlations, in particular, using a suitable copula allows the modelling of a non-zero tail dependency. (McNeil, 2010)

Copulas allow us to express dependencies in terms of quantities of loss distributions. A multivariate loss function constructed using a copula allows the estimation of losses at any given percentile level. (Luder, 2005)

Most types of copulas are easily simulated using Monte-Carlo methods.

Copulas are gaining greater recognition as best practice by the various international actuarial and supervisory organisations, which should help in the internal model approval process. (International Actuarial Association, 2010)

Disadvantages

There is usually not enough data to perform a credible calibration of a copula, especially in the tail. By definition the extreme joint loss events from various risks that one is trying to reflect in the modelling process are sparse in historical data.

Any economic capital model becomes more of a 'Black Box'. There is often a lack of transparency in the modelling process. The model is harder to understand and check by a non-mathematician.

Communication both internally and externally becomes more of an issue when dealing with non-technical people. This should not be underestimated given the advent of Solvency II and the Pillar III disclosure requirements.

Copulas are essentially static models and a more realistic way of modelling dependency through time would be through use of stochastic process or time series models.

2.2.2. Selection of an aggregation technique

The choice of aggregation technique is fundamental to the way in which economic capital is modelled and the technology and processes involved. Each technique has its strengths and limitations and the choice may not be straightforward.

In this paper we have chosen the Correlation matrix approach as our ideal aggregation technique since it is relatively simple, intuitive and transparent and the use of a cascade of correlation matrices permits the easy addition of further risks.

CHAPTER 3: METHODOLOGY

3.1.Introduction

This chapter details the actual process that is going to be used in finding plausible solutions to the research questions that have been formulated earlier on.

3.2.Research Design

This is a Quantitative, descriptive study making use of capital aggregation techniques to calculate the capital requirements for selected life insurance

3.3.Population and sample design

As the objective of this paper is to calculate the capital requirements of a life insurance company in accordance with RBC, then the population for this study is all life insurance companies.

Given that there are more than 47 insurance companies offering both general insurance and life insurance products we will reduce the sample size to 2-3 insurance company. The insurance companies selected has to be registered by the Insurance Regulatory Authority.

3.4.Data Collection

The required data will be obtained from secondary sources with the main source of data being Kenyan insurance companies.

The type of data required is quantitative/numerical in nature. The data require will be the annual claims data from a selected time period between the years 2006 and 2016.

3.5.Model Used

I. Correlation method

Correlation method is the simplest and most widely used method to calculate diversified capital requirements. It is the approach implemented in South Africa's CAR, UK's ICA and has also been adopted for Solvency II and SAM standard formula.

Correlation method makes two assumptions:

- Risk drivers have a multivariate normal distribution.
- A firm's net assets are a linear function of risk drivers

The correlation method calculates the solvency capital requirement(SCR) based on the formula:

$$SCR = \sqrt{\sum_{i,j} Corr_{i,j} \bullet SCR_i \bullet SCR_j}$$

SCR_i is the impact on net assets after individual stressing of risk i and $Corr_{i,j}$ is the matrix of correlation between risk factors i and j.

The correlation matrix may be derived using historical data. One important aspect of the correlation matrices is that they need to be positive definite. Positive definiteness ensures consistency between the different risk factors. There are several mathematical methods used to test positive definiteness of a matrix, for example checking that all the "eigenvalues" of a matrix are strictly positive.

One major short-coming of correlation method is that it does not allow for non-linearity. Non-linearity arises because the occurrence of one risk changes the exposure to another. The only way to allow for non-linearity is to test combined stress tests where more than one risk appears at once.

Capital Requirements

The capital requirements proposed reflect the risks faced by a life insurance company and will act as an effective buffer to absorb losses.

The framework should serve as an indicator of financial strength or weakness, and facilitate progressive intervention by regulators if need be.

a. Capital cover ratio

The Capital Cover Ratio (CCR) measures the adequacy of the capital available in the insurance fund to support the capital required. This is calculated as follows:

$$CCR = \frac{Capital\ Available}{Capital\ Required} \times 100\%$$

b. Capital available

This is composed mainly of the core capital available to an insurer and reflects the shareholders' funds. The regulators need to ensure that the capital is available to meet any losses arising from the risks that insurers are exposed to.

c. **Capital required**

Capital required (CR) is calculated as:

$$CR = Max\ \{C_1, \sum (C_2 + C_3 + C_4 + C_5)$$

It consists of five components **(C_1, C_2, C_3, C_4, C_5):**

1. C_1 = surrender value capital requirement
2. C_2 = credit risk capital requirement
3. C_3 = market risk capital requirement
4. C_4 = insurance risk capital requirement
5. C_5 = operational risk capital requirement

Determination of capital requirements

a. Surrender value capital requirement (C_1)

This aims to address lapse risk in excess of the levels assumed in the calculation of reserves for the life insurer.

This is defined as:

$$C_1 = Max\ \{0, Surrender\ Value\ of\ inforce\ business - Policy\ Reserves\}$$

The company is required to calculate the aggregate C_1 for all the policies in force taking into account the probability of lapse and the expected surrender value.

b. Credit risk capital requirement(C_2)

This aims to mitigate risk of losses resulting from asset defaults, related losses of income and the inability or unwillingness of a counterparty to fully meet its contractual obligations.

Credit risk capital requirement is calculated as:

$$C_2 = \sum_i (Exposure_i \ \times\ Credit\ risk\ charge_i)$$

where $\boldsymbol{i}$ refers to the different exposures to counterparties in the fund.

c. Market risk capital requirement (C_3)

This aims to mitigate risks of financial losses arising from the level or volatility of market prices of financial instruments. Market risk will affect both assets and liabilities and consists of the following three risks:

- Equity risk
- Property risk
- Interest rate risk

The market risk capital requirement is given by:

$$C_3 = \sqrt{\sum CorrMkt_{i,j} \times C_{3,i} \times C_{3,j}}$$

d. Insurance risk capital requirement(C_4)

This aims to address the risk of under-estimation of the insurance liability, over and above the amount of best estimate liabilities. The life insurance risk requirements consist of the following five risk factors:

- Mortality
- Longevity
- Morbidity
- Lapse
- Expenses

The insurance risk capital requirement, C_4 is given by:

$$C_4 = \sqrt{\sum CorrLife_{i,j} \times C_{4,i} \times C_{4,j}}$$

e. Operational risk capital requirement(C_5)

This aims to mitigate the risk of loss arising from inadequate or failed internal processes, or from personnel and systems, or from external events.

Finally, we summarise the capital requirements under each of the five components and for each investment strategies selected. Check for sensitivity and interaction between the individual capital component.

CHAPTER 4: Data Analysis and Interpretation

4.1. Introduction

This chapter presents the findings of the study. The data relied on was from secondary sources such as an insurance company that has been in operation for over decade, South Africa's Solvency, Assessment and Management (SAM) QIS, National Association of Insurance Commissioners(NAIC), Insurance regulatory authority (IRA), Association of Kenyan insurers (AKI). The data analysis was conducted exclusively on Microsoft excel.

4.2. General information

In order to calculate the capital required to be held for each specific risk component, we use a specific non-profit endowment policy in order to demonstrate the capital calculation framework.

4.3. Details of the non-profit endowment policy

Let us consider a simple non-profit endowment policy with a term of 35 years. Consider a sample model point for a policyholder that is aged 30 as at valuation date, 31st December 2012, with a sum assured of 1,000,000kshs. The policy has been in force for duration of exactly 10 years and premiums of 4,702 have been paid annually to the company.

Policy Details	
Product type	Non-profit endowment policy
Term	35 years
Age	30
Sum assured	1,000,000
Duration	10
Annual Premium	4,702
Valuation date	31 December 2012
Surrender value at valuation date	15,000
Policy reserve	19,274
Capital available	25,000

	Valuation basis
Mortality	100% of SA 56-62
Expenses	
Initial	8,000
Renewal	1,300
Expense inflation	5%
Surrender rates	
Year 1	25%
Year 2	20%
Year 3	15%
Year 4	15%
Year 5+	10%
Interest rate	7.50%

4.4. Investment strategy

Three different investment strategies were adopted when selling this policy. With the first one being very conservative and the third strategy very risky. This done in order to show the impact the investment strategy taken affects capital reserves.

Note: The impact of taxes and reinsurance shall be excluded from the analysis.

Investment Strategy	Exposure		
Asset class	1	2	3
Equity	10%	30%	60%
Property	4%	15%	20%
Government Bonds	70%	40%	5%
Bond AA	15%	10%	7%
Bond B	1%	5%	8%

4.5. Important data needed for the analysis

Risk Charges	
Credit rating	Risk charges
Government Bond	0.00%
AAA	1.00%
AA	1.00%
A	4.10%
BBB	5.00%
BB	13.60%
B	22.40%
CCC and below	44.80%
Asset class	Risk charges
Equity	53%
Property	25%

Interest rate stress factors	
s^{up}	50%
s^{down}	-50%

Mortality Table	
Age	qx
30	0.00446

Insurance risk stress factors	
Valuation parameter	Stress factor
Mortality	15% increase in best estimate rates
Longevity	20% decrease in best estimate rates
Morbidity	35% increase in best estimate rates
Lapse	50% increase/decreases in best estimate rates
Expenses	10% increase in best estimate rates
	1% increase in best estimate inflation rate

4.6. Results of capital calculation

We analyse the results of capital calculation for the above product based on the framework suggested in chapter 3.

We first calculate each of the five risk components:

1. C_1 = surrender value capital requirement
2. C_2 = credit risk capital requirement
3. C_3 = market risk capital requirement
4. C_4 = insurance risk capital requirement
5. C_5 = operational risk capital requirement

4.6.1. Surrender Value Capital Requirement (C_1)

This aims to address lapse risk in excess of the levels assumed in the calculation of reserves for the life insurer.

This is defined as:

$$C_1 = Max\,\{0, Surrender\ Value\ of\ inforce\ business - Policy\ Reserves\}$$

The surrender value of the policy, as at valuation date, is 15,000which is below the value of policy reserves of 19,274. The surrender capital requirement is therefore zero (0).

4.6.2. Credit risk capital requirement(C2)

Credit risk capital requirement is calculated as:

$$C_2 = \sum_i (Exposure_i \times Credit\ risk\ charge_i)$$

		Strategy		
Credit rating	**Risk charges**	1	2	3
Government Bond	0.00%	-	-	-
AA	1.00%	28.911	19.274	13.492
B	22.40%	43.174	215.869	345.390
Total		72.085	235.143	358.882

We multiply the exposure from each strategy with the values of the risk charges which are based on Standard & Poor's International scale on South Africa' rand.

As expected Strategy 3 has the highest total capital requirement due to the high proportion of assets in the riskier Bond B asset.

Strategy 1 has the lowest capital requirements due to the low proportions of assets in Bond B.

4.6.3. Market risk capital requirement (C3)

This aims to mitigate risks of financial losses arising from the level or volatility of market prices of financial instruments. Market risk will affect both assets and liabilities and consists of the following three risks:

- Equity risk
- Property risk
- Interest rate risk

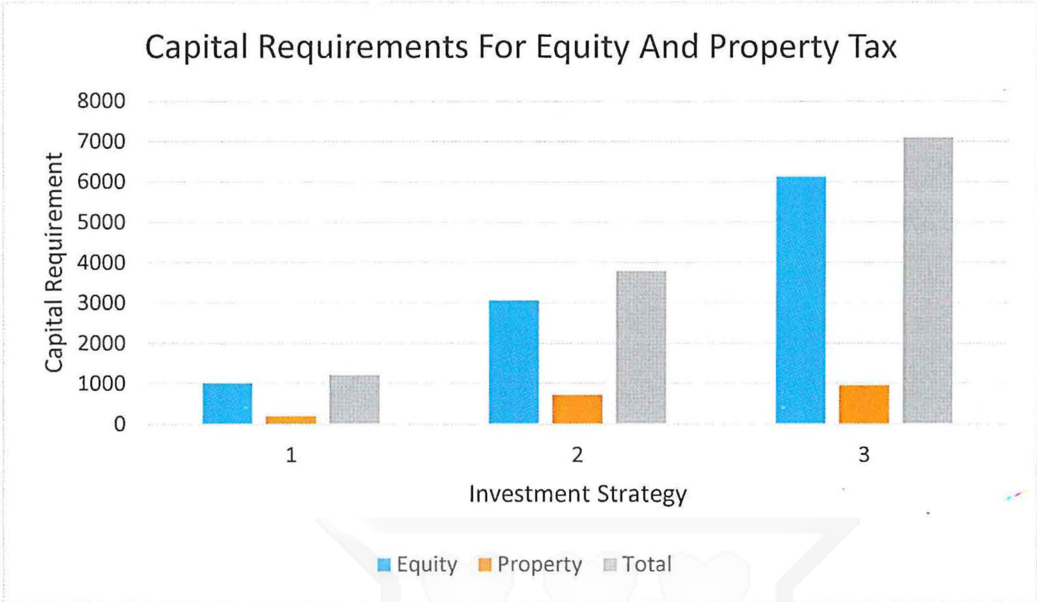
The market risk capital requirement is given by:

$$C_3 = \sum_i (Market\ Exposure_i \times Market\ risk\ charge_i)$$

4.6.3.1. *Equity and property risk*

		Strategy		
Asset class	**Risk charges**	**1**	**2**	**3**
Equity	53%	1,021.52	3,064.57	6,129.13
Property	25%	192.74	722.78	963.70
Total		1,214.26	3,787.34	7,092.83

With equity and property risk you multiply the market Risk charges with exposure for each strategy. The market risk charges are based on South Africa's SAM QIS1.



The total capital requirement for market risk for Strategy 3 is highest due to its risky approach. In this strategy, equity capital requirement is large due to the high proportion of assets in equity. This means the balance sheet is very sensitive to movements in equity markets.

The conservative nature of strategy one means that it has the lowest capital requirements for market risks especially for property and equity.

4.6.3.2. Interest rate risk

The formula to compute the risk capital requirement, $C_{3,int}$, for interest rate risk is defined as:

$$C_{3,int} = (A_{3,int} - A_0) - (L_{3,int} - L_0)$$

Where;

A_0 and L_0 are respectively the base market value of assets and best estimate liabilities.

$A_{3,int}$ and $L_{3,int}$ are the adjusted assets and liabilities computed for interest rate risk using the stress factor below.

s^{up}	50%
s^{down}	-50%

Under this technique our total capital requirements for interest rate risk is 2,168.33

The chart above shows the total market risk (equity, property and interest rate risk) and as expected the riskiest investment strategy (strategy 3) requires the most capital reserves.

Strategy 1(conservative approach) requires almost a ⅓ of the capital reserves used by strategy 3.

4.6.4. Insurance risk capital requirement(C4)

This aims to address the risk of under-estimation of the insurance liability, over and above the amount of best estimate liabilities. The life insurance risk requirements consist of the following five risk factors:

i. Mortality
ii. Longevity
iii. Morbidity
iv. Lapse
v. Expenses

Below are the stress factors to be used to calculate each of the five insurance risk factors.

Insurance risk stress factors	
Valuation parameter	Stress factor
Mortality	15% increase in best estimate rates
Longevity	20% decrease in best estimate rates
Morbidity	35% increase in best estimate rates
Lapse	50% increase/decreases in best estimate rates
Expenses	10% increase in best estimate rates, and 1% increase in best estimate inflation rate

4.6.4.1. *Mortality Risk*

Since this is an endowment policy that has a term of 35 years (with ten years already passed) for a policyholder currently aged 30 there is an inherent mortality risk that needs to be taken into account when determining the total insurance risk and final capital requirement.

The mortality risk for the policy holder regardless of the investment strategy is the same.

The results for mortality risk for the policy holder is show below.

Stress Factor(Increase)	15.00%
sum assured	1,000,000
Mortality rate	0.00446
Duration	25
Capital Requirement	2,549.00

The capital requirement of 2,549.00 is obtained by multiplying all the above factors.

4.6.4.2. *Longevity risk*

Longevity risk is any potential risk attached to the increasing life expectancy of policy holders. Due to the nature of a non-profit endowment policy this risk is irrelevant hence there no longevity risk attached to this policy hence no extra capital reserves are required.

4.6.4.3. *Morbidity risk*

Morbidity rate is the frequency with which a disease appears in a population. Similarly, Morbidity risk is not relevant when dealing with a non-profit endowment policy hence no extra capital reserves are required.

4.6.4.4. *Lapse risk*

Lapse risk is the adverse change in the value of insurance liabilities, resulting from changes in the level or volatility of the rates of policy lapses, terminations, renewals, and surrenders.

Surrender rates	
Year 1	25%
Year 2	20%
Year 3	15%
Year 4	15%
Year 5+	10%

Using the 50% best estimate stress factor we get the capital requirements for lapse risk as 9,051.35.

4.6.4.5. *Expenses risk*

Expense risk arises from the variation in the expenses incurred in servicing insurance contracts. The original policy has the following expenses

Expenses	
Initial	8,000
Renewal	1,300
Expense inflation	5%

We apply the following stress factors:

Stress factors	
Increase	10.00%
increase (inflation)	1.00%

Expense risk will only affect the liabilities. The formula to compute the risk capital requirements:

$$C_{4,i} = L_{4,i} - L_0$$

Where:

$C_{4,i}$ is the individual risk capital requirement corresponding to life insurance risk i.

L_0 is the base market value of best estimate liabilities while $L_{4,i}$ is the adjusted liabilities computed for life insurance risk i using the stresses shown in table above.

Below we have tabulated the expenses and the stressed expenses.

Time	expense	inflation adjusted	expense(+10%)	inflation adjusted (+1%)
0	8,000	8,000.00	8,800	8,800.00
1	1,300	1,365.00	1,313	1,379.31
2	1,300	1,433.25	1,313	1,448.96
3	1,300	1,504.91	1,313	1,522.13
4	1,300	1,580.16	1,313	1,599.00
5	1,300	1,659.17	1,313	1,679.75
6	1,300	1,742.12	1,313	1,764.58
7	1,300	1,829.23	1,313	1,853.69
8	1,300	1,920.69	1,313	1,947.30
9	1,300	2,016.73	1,313	2,045.64
10	1,300	2,117.56	1,313	2,148.94
11	1,300	2,223.44	1,313	2,257.47
12	1,300	2,334.61	1,313	2,371.47
13	1,300	2,451.34	1,313	2,491.23
14	1,300	2,573.91	1,313	2,617.03
15	1,300	2,702.61	1,313	2,749.20
16	1,300	2,837.74	1,313	2,888.03
17	1,300	2,979.62	1,313	3,033.88
18	1,300	3,128.61	1,313	3,187.09
19	1,300	3,285.04	1,313	3,348.03
20	1,300	3,449.29	1,313	3,517.11
21	1,300	3,621.75	1,313	3,694.72
22	1,300	3,802.84	1,313	3,881.31
23	1,300	3,992.98	1,313	4,077.31
24	1,300	4,192.63	1,313	4,283.22
25	1,300	4,402.26	1,313	4,499.52
26	1,300	4,622.37	1,313	4,726.75
27	1,300	4,853.49	1,313	4,965.45
28	1,300	5,096.17	1,313	5,216.20
29	1,300	5,350.98	1,313	5,479.62
30	1,300	5,618.53	1,313	5,756.34
31	1,300	5,899.45	1,313	6,047.04
32	1,300	6,194.42	1,313	6,352.41
33	1,300	6,504.15	1,313	6,673.21
34	1,300	6,829.35	1,313	7,010.20
35	1,300	7,170.82	1,313	7,364.22
Total	**53,500**	**131,287.22**	**54,755**	**134,677.34**

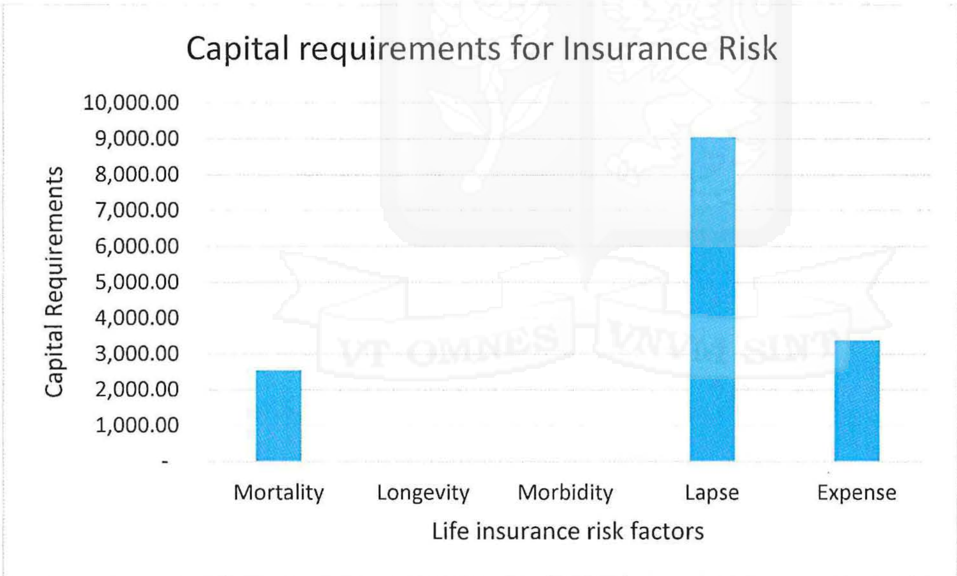
As shown by the formula below we subtract the expenses from the stressed expenses to get the capital requirements for expenses risk.

$C_{4,i} = L_{4,i} - L_0$

$L_{4,i}$	134,677.34
L_0	131,287.22
Capital requirement	**3,390.12**

The capital requirements for expense risk is 3390.12

We aggregate the capital requirement for each of the individual insurance risk factors we get 14,990.47.



The insurer's balance sheet is very sensitive to a reduction in surrenders. This is because of the high maturity payments to be made for lives that survive to end of term of policy. This is aggravated by the interaction between surrenders and low mortality rates.

4.6.5. Operational risk capital requirement(C_5)

This aims to mitigate the risk of loss arising from inadequate or failed internal processes, or from personnel and systems, or from external events.

The formula to compute C_2 is borrowed from Solvency II and is as follows:

$$C_2 = Min\left\{0.3 \times CR_{-Op}, BOp\right\} + 0.25 \times Exp_{ul}$$

Where:

Exp_{ul} is the amount of annual expenses incurred during the previous 12 months in respect to unit-linked business.

CR_{-Op} is the preliminary capital required before allowing operational risk and, for the risk requirements C_1, C_2, C_3 and C_4 defined above, it is defined as:

$$CR_{-Op} = Max\,\{C_1, \sum (C_2 + C_3 + C_4)\,\}$$

BOp is the basic operational risk requirement for all business other than unit-linked and is determined as follows:

$$BOp = Max\,\{Op_{premiums};\ Op_{provisions}\}$$

Where:

$$Op_{premiums} = 0.04 \times (Earn_{life} - Earn_{ul} + Max\,\{0, 0.04 \times \begin{bmatrix} Earn_{life} - 1.1 \times pEarn_{life} - \\ (Earn_{ul} - 1.1 \times pEarn_{ul}) \end{bmatrix}\}$$

and:

$$Op_{provisions} = 0.0045 \times Max\left\{0, L_{life} - L_{ul}\right\}$$

Where:

$Earn_{life}$ and $Earn_{ul}$ are the gross premiums earned for life and unit-linked business respectively during the previous 12 months.

$pEarn_{life}$ and $pEarn_{ul}$ are the gross premiums earned for life and unit-linked business respectively during the 12 months prior to the previous 12 months.

L_{life} and L_{ul} are the statutory best estimate for life and unit-linked businesses respectively.

Based on the above formula the capital requirements for operational risk is calculated as 1954.56

4.7. Aggregate Capital Requirement

The graph below summarises the capital requirements under each of the five components and for each of the three investment strategies:

In all the three Strategies, the insurer's balance sheet seems to be very sensitive to the life insurance capital requirement, C4, which is largely driven by the interaction of low surrenders and low mortality. The insurer may want to hedge this risk by selling more term assurance products.

4.8. Capital available

This is composed mainly of the core capital available to an insurer and reflects the shareholders' funds.

	Strategy		
	1	2	3
Capital Available	25,000	25,000	25,000

4.9. Capital required

Capital required (CR) is calculated as:

$$CR = Max\ \{C_1, \sum(C_2 + C_3 + C_4 + C_5)$$

Where:

C_1 = surrender value capital requirement

C_2 = credit risk capital requirement

C_3 = market risk capital requirement

C_4 = insurance risk capital requirement

C_5 = operational risk capital requirement

	Strategy		
	1	2	3
Capital required	20,399.706	23,135.843	26,565.073

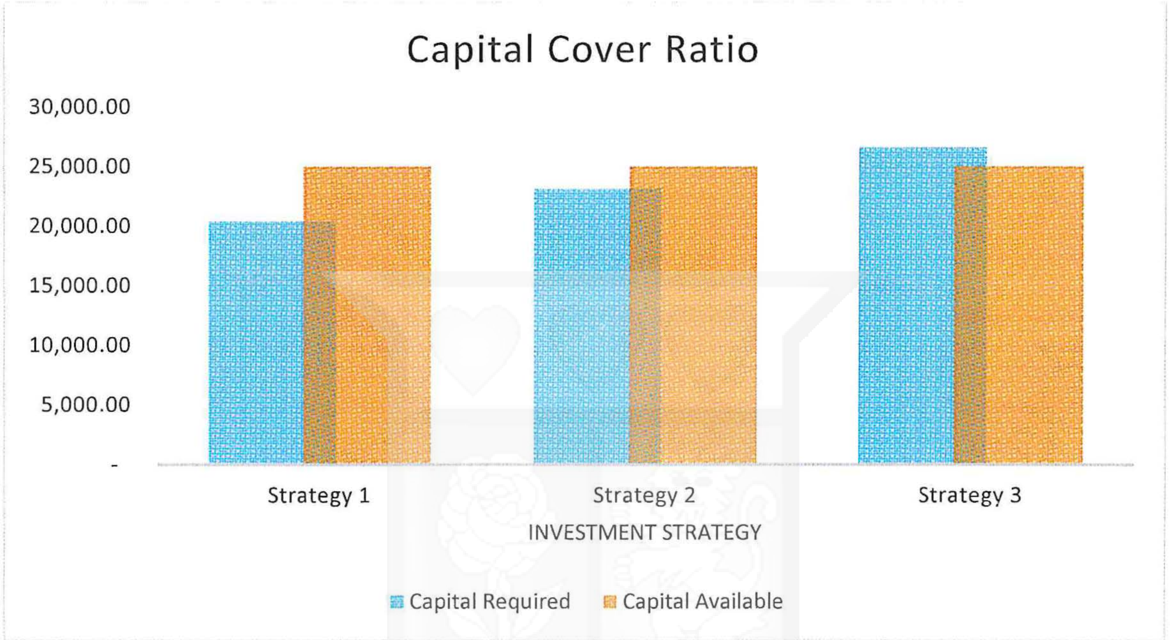
4.10. Capital cover Ratio

The Capital Cover Ratio (CCR) measures the adequacy of the capital available in the insurance fund to support the capital required. This is calculated as follows:

$$CCR = \frac{Capital\ Available}{Capital\ Required} \times 100\%$$

	Strategy		
	1	2	3
CCR	123%	108%	94%

The graph below summarises the results of Capital Cover Ratio for each of the three investment strategies:



Strategy 3 has a CCR of 94% indicating that the insurer's balance sheet is highly exposed and may require regulatory intervention. A reduction in equity investment is necessary.

CHAPTER 5: SUMMARY AND CONCLUSION

5.1. Summary

This study reveals the great difference in the level of risk for each type of risk and the resulting capital requirements for three different investment strategies for the exact same policy. This highlights the need for a risk-based capital framework for a life insurer in Kenya.

5.2. Limitations of the study

The parameters and stressors used in this paper were borrowed from South Africa's CAR, SAM QIS1 and Solvency II. Each Country will need to calibrate its own parameters and stresses based on data collected from their own industry.

A single risk-free rate has been proposed for use in liability valuation. However, a more modern approach is to use a curve based on yields on suitable government bonds. The stresses for interest rates may then vary according to bond terms as provided for in Solvency II and SAM.

This paper did not discuss the treatment of reinsurance. Under Solvency II, all liabilities are valued gross of reinsurance, with reinsurance incomes treated as assets in the balance sheet.

Other risk factors were not discussed such as currency risk, catastrophe risk, reputation risk etc.

This paper did not incorporate any tax in to the study.

This paper used single type of insurance product, but different types of product could easily be used instead with minimal tweaking.

5.3. Conclusion

Introduction of risk-based capital framework will highly benefit insurance industry in Africa. Using a solvency measure that is risk-based will lead to improved measurement and assessment of risk.

Risk-based capital will enhance management of insurance companies thereby improving public confidence. Low uptake of insurance products has been partly blamed on poor management of insurers' capital and RBC provides an avenue for Kenyan insurers to rectify this.

By implementing risk-based capital, Kenyan insurers would be applying a framework consistent with global trend. This will enhance their competitiveness in the global insurance industry.

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