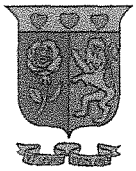

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DEVELOPING CAPITAL CHARGES FOR THE GENERAL INSURERS UNDER THE NON LIFE UNDERWRITING RISK MODULE IN KENYA

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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 Project contains no material previously published or written by another person except where due reference is made in the Research Project itself.

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

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List of Abbreviations

CAR	Capital adequacy requirement
CEIOPS	Committee of European Insurance and Occupational Pensions Supervisors
CV	Coefficient of variability
EU	European Union
IFRS	International Financial Reporting Standard
IRA	Insurance Regulatory Authority
MCR	Minimum Capital Requirement
LOB	Line of business
ORSA	Own Risk and Solvency assessment
PDF	Probability density function
QIS	Quantitative Impact Studies
RBC	Risk Based Capital
SCR	Solvency Capital Requirement
TVaR	Tail Value at Risk

VaR	Value at Risk

1 Introduction

1.1 Background Information

. Financial institutions are in the business of accepting risk from their clients and also managing risk exposure from within. Hence it is essential for financial institutions to have safe and sound risk management systems. In the banking world, Basel Accords were introduced while in the Insurance sector Solvency was introduced. The three major objectives that both regulations set out to achieve are to contribute to financial stability, to level playing fields among financial institutions in terms of regulatory costs, and to be based on measures and tools that are risk sensitive, i.e. ones that are reflective of the risks faced by financial institutions. (Jacobs, 2013)

Today, different developed countries all over the world have their own surveillance systems. United States of America (USA) have a rules based risk based capital formula. Switzerland has their Swiss Solvency Test (SST) which employs a static factor and a dynamic cash flow model. Solvency and SST are younger regimes than U.SA risk based capital regime. Other countries which have adopted risk based standards similar to Solvency 2 include China and Australia. Insurance regulators globally are developing capital adequacy frameworks in their specific countries. Only South Africa has been successful in developing a solvency framework which is a statutory view of solvency called CAR (Capital adequacy requirement). Statutory CAR represents the capital that is required by risk based financial services companies to meet its liabilities as they fall due with a 95% confidence. (Beukes, 2008)However we must recognize that Rwanda is already carrying out quantitative studies as they introduce their own framework.

Insurers and regulators need to understand the true determinants of and the relationship between regulatory and economic capital. (Laere & Baesens, 2009) (Jacobs, 2013)Across Africa Insurance regulators have begun to realize the importance of proper risk management and have been studying the possibility of introducing RBC (Risk based capital) into their respective regimes. In Kenya, several insurers have been placed under statutory management due to insolvency issues. Adoption of risk based capital by Kenyan life insurance companies will not only manage their risks but enhance policyholder protection and overall company performance. Insurance Regulatory Authority (IRA) in Kenya is currently building a

suitable model, using Solvency 2, which insurers can employ to manage their risks and capital more efficiently.

The pillars of regulation under Solvency 2 are the similar to the pillars of Basel 2. Pillar 1 is 'Quantification of capital requirements'. This consists of two capital requirements: a solvency capital requirement (SCR) and a minimum capital requirement (MCR). Both levels of capital represent the different levels of supervisory intervention. This framework reinforces risk sensitive requirements by laying out principles for insurance companies to assess the adequacy of their capital. (McNeil et al, 2005).Pillar 2 is 'Qualitative requirements'. Also called the supervisory review process, local regulators review the insurers' internal assessments of their overall risk. These internal assessments are called own risk and solvency assessments (ORSAs).Insurers employ their own risk management processes to determine their internal capital adequacy requirements. Pillar 2 acts as a bridge to gaps in Pillar 1. This is the stage where economic capital is introduced. In house models are allowed by the regulator which is supposed to reflect the truest risk. Pillar 3 is 'Reporting and disclosure requirements'. There will be public disclosures of business overview and performance, governance, and the valuation basis employed. In addition, there will be non-public disclosures on risk and capital management. (Jacobs, 2013)

Insurance companies protect themselves from going insolvent by hedging, reinsurance and capital cushions .Capital cushions is what this paper builds around. This paper focuses on the importance of introducing risk based capital modeling in Kenya and an in-depth view of the non-life underwriting risk module to determine the capital charges among different lines of business the Kenyan Market. Currently there are no papers done on this study in the Kenyan context since it is a generally new in the insurance industry. This paper will contribute to the current introduction of risk based capital modeling where will analyze capital charges per line of business. (LoB)

1.2 Problem statement

Kenyan regulators need to introduce the risk based capital regime tailored to the uniqueness of the Kenyan market. If they achieve this will not only control risks insurance companies are facing but increase the competiveness of Kenyan Insurers (Sharara, Hardy, & Saunders, 2010).Currently the Kenyan regulator IRA are

developing a solvency system model for all insurers that will consist of a standard formula and an internal model. This study focuses modeling non-life underwriting risk where we will develop capital charges for premium risk and reserve risk.

1.3 Research objectives

To formulate a framework for calculating capital charges under the non-life underwriting risk module in Kenya.

1.4 Research questions

What is the appropriate framework for calculating capital charges for underwriting risk in the Kenyan market?

1.5 Scope of the research

Economic capital is a very wide topic is a very wide topic on its own. Due to time constraints, the focus is only on underwriting risk for general insurers and its impact on different insurers in Kenyan context. For each line of business capital requirements for premium risk and reserve risk modules will be developed.

2 Literature Review

2.1 Economic capital

Regulators have developed different approaches of measuring insolvency of general insurance companies since the 1980's.Today insolvency is measured through capital requirement and companies are allowed to use internal models to calculate their chance to failure. Economic capital is the best practice risk measurement methodology used in the financial industry that relates the concept of risk to the worst case loss that can arise due to that particular risk (Doff, 2008). According to (Porteous & Tapadar, 2008) economic capital is the amount of capital, or excess assets, required to ensure that the market value balance sheet of the firm remains solvent, over a specified time horizon, with a prescribed high probability. Sherris (2006) agrees that insurer solvency is based on the economic value of the balance sheet of the insurer and the allocation of capital to the lines of business. The author adds that the economic value of the balance sheet ensures that liabilities are fairly priced and that equity earns a fair expected rate of return. The economic value of the balance sheet shows the market value position of assets and liabilities of a firm.

Economic capital is termed as a 'common currency' for risk since economic Capital is a measure to calculate the amount of capital required for each risk present in business. (Kuritzkes, Schuermann, & Weiner, 2003)Different authors have their own definition of economic capital but all agree that economic capital acts as buffer to insolvency.

The emergence of economic capital arose due to a conflict. Beukes (2008) explains the both sides of the conflict. On one side debt holders, customers, regulators and rating agencies seek to minimize the risk to capital at a high degree of confidence. On the other hand, shareholders are concerned with whether the institution is earning a sufficient return on capital invested to support risk taking. Shareholders expect compensation for risk that affects their returns. They are concerned with maximizing return on capital.

As cited by Jacobs (2013), Elizalde & Repullo (2007) finds that shareholders prefer to hold zero economic capital because it will not be needed, since capital can be raised when needed through recapitalization.Recapitalization is when a company restructures their debt and equity. It should be noted that insurers strive to keep relevant economic capital invested into the company. Holding too much risk capital will cause excessive

cost of insurance since the company would have to price their products highly to compensate for the equity held to support risk taking. While holding too little capital, causes higher chances of insolvency.

2.2 Importance of Economic Capital

The main advantage of economic capital according to (Doff, 2008) is it allows an 'apple to apple comparison'. Since economic capital ensures a true reflection of risks inherent in a firm, managers are able to make a sensible trade-off between risk and reward. This enables economic capital to be used in budget cycles and other management control applications (Doff, 2008)Research by (Porteous & Tapadar, 2008) supports that economic capital can be used to compare financial strengths across business lines and across financial sectors.

The importance of economic capital according to Porteous & Tapadar (2008) is (1) Economic capital as a risk measure. Economic capital allows firms, capital providers and regulators to measure explicitly how much risk a firm is taking, holistically, across the entire spectrum of risks the firm accepts. (2) To help risk adjust a firm's business. If a firm is earning high returns, but is taking high risks, then firm performance should be measured after having allowed for its high risk strategy. This will allow capital providers to compare the performance of the firm's management against the management of another firm, which may also be earning good returns, but with a lower risk strategy. Measuring firm performance using a type of risk adjusted measure based on economic capital, allows capital providers to assess firm performance on a risk adjusted, or risk consistent, basis. (3) Customer interests. Economic capital is usually defined as the amount of capital required to keep a firm solvent with a prescribed probability over a certain time horizon. Economic capital is therefore of great interest to customers as it quantifies their level of security when doing business with a particular firm. Customers strictly prefer to have their payoffs on their contracts as unaffected as possible by the fortunes of the issuing firm. (Merton & Perold, 1993)

Economic capital calculations are important to support fungibility. Fungibility is the ability to transfer capital around the organization where it is required. This is mostly through dividends which are capital gains distributed among shareholders. (Beukes, 2008)

Permanent changes in the environment will lead to companies making permanent changes assuming their objective is to survive. Permanent changes in the environment are with regard to business-risk events. Economic capital would not only be sufficient to absorb the financial losses but a business needs to strengthen their strategic and organizational management. Organizational flexibility is also necessary to mitigate risk.

However, economic capital is an excellent buffer against temporary changes. Temporary changes include economic recessions or a short price of war with a competitor may be overcome without a permanent change in the organization .In addition to address this risks one can hedge the risk. Gradual changes in the competitive environment are often better addressed by adapting the organization (i.e. avoiding a financial loss) than by financing the loss via economic capital. In the case of abrupt temporary changes, holding economic capital may be an appropriate instrument for an organization to survive the crisis. In the case of abrupt permanent changes holding economic capital may be useful to absorb the: 1) The time lag that often lies between occurrence of the event and the management intervention, 2) initial investment of the organizational change, 3) time frame required for the management intervention to be implemented and 4) unavoidable costs (both fixed and variable costs) (Jacobs, 2013)

There is a need to create a formal link between risk management functions and their economic capital program. Insurers cannot arrive at a realistic economic capital valuation without employing a comprehensive risk management strategy. They need a solid risk governance structure place first.

2.3 Empirical analysis of non-life underwriting risk

This study focuses on the calculation of risk capital under the non-life underwriting risk module. Based on, (CEIOPS, QIS3:Calibration ofthe underwriting risk,market risk and MCR, 2007), non-life underwriting risk module entails three risk components; premium risk, reserve risk and catastrophe risk. However we will focus on premium and reserve risk. Premium risk is the risk incurred when premiums are lower than expenses plus volume of incurred losses for the claims including both paid amounts during the period and provisions made at the end of the year. (Savelli &

Clemente, Hierarchical structures inte aggregation of premium risk for insurance underwriting, 2011)

The overall capital requirement and risk charges are calculated using a modular approach under Solvency 2. (Sandstrom, 2007)The modular approach ensures that consistency throughout the process of calculating risk charges until their aggregation. Aggregation of risks charges of sub modules are estimated using the linear correlation matrix as proposed by CEIOPS (2007a). This level involves aggregating risk capitals within the different risk modules.This phase coresponds to an intra-modular aggregation. (Devineau & Loisel, 2009).Following next is the inter modular aggreagtion where capitals of each risk module re aggregated to obtain economc capital.Some work done analysing underwriting risk involves (Savelli, 2006) where he focuses on modelling premium risk specifically for a multiline general insurer.He uses the standard model and internal model approach to compare capital charges under each approach for four diferrent companies.Under the estimation of premium risk one could use the market estimate approach or the undertakings approach.He concluded form his results that the for large insurance companies,using the market approach leads to an overestimated capital charge compared to the undertakings approach.

2.4 Premium and Reserve risk

Reserve risk is the risk that the ultimate loss will significantly vary from the best estimate. (Busse, Muller, & Dacorogna, 2010).Reserve risk is mostly calculated using the Chain ladder algorithm or the Mack Method or the bootstraping approach.However Busse, Muller, & Dacorogna (2010) discover solution to deal with an inaccuracy of the approaches.That is when the data has outliers or large artificial jumps or when there are flunctuations in the earning patterns due to wrong representation of the triangles in the underwriting years insteads of accident years.They propose a method where they have developed a filter for outlieres and large jumps and a robust version of Mack's variance estimator.The robust version of a variance estimator can also be used for the boot strapping method.Murphy (2007) analyses the differences in Mack's reserve risk formulas and Murphy's recursive formulas for the chain ladder reserve risk. Murphy's uses the same assumption as Mack's. They notice the difference lies in the parameter risk component which ultimately is a bias.

3 Research Methodology

3.1 Introduction

This chapter gives the detailed procedures that will be used to solve the research question. It describes the research design the study follows, data collected and the empirical approach will use to analyse the data.

3.2 Research Design

This study employs a quasi-experimental research design. This is because there is no specific method to calculate capital charges. With the rise of economic capital in risk based capital modelling then most companies will have their own models designed to their risk profile.

3.3 Data

Data employed in this study was secondary data obtained from IRA reports from 2002 to 2013.Net earned premiums, incurred claims, net commissions and management expenses were the data sets required. Using these sets of data operating loss ratios and incurred loss ratios were computed. These loss ratios will enable us to calculate the standard deviation for premium risk and reserve risk.

3.4 Empirical Approach

The methodology used in this paper will adopt a few concepts from the qualitative impact studies written by CEOIPS. The approach used in this paper has been tailored to the Kenyan market and the data available.

3.4.1 Capital requirements for non-life premium and reserve risk

According to QIS5 Premium risk "*results from fluctuations in the timing, frequency and severity of insured events. Premium risk relates to policies to be written (including renewals) during the period, and to unexpired risks on existing contracts. Premium risk includes the risk that premium provisions turn out to be insufficient to compensate claims or need to be increased.*"

Expense risk can be implicitly calculated with premium risks since expense risk is significant in some lines of business (LoB).Especially for motor private vehicles LoB.

According to QIS2 Reserve Risk "*stems from two sources: on the one hand, the absolute level of the technical provisions may be mis-estimated. On the other hand, because of the stochastic nature of future claim pay outs, the actual claims will fluctuate around their statistical mean value.*"

Calculation

The premium and reserve risk capital requirement delivers the following output information:

NL_{pr} = Capital requirement for premium and reserve risk

The capital requirement for the combined premium risk and reserve risk is determined as follows:

$$NL_{pr} = \rho(\sigma) \cdot V$$

Where,

V = Volume measure

σ = Combined standard deviation

$\rho(\sigma)$ = A function of the combined standard deviation

The function $\rho(\sigma)$ is derived as follows:

$$\rho(\sigma) = \frac{\exp(N_{0.995} \cdot \sqrt{\log(\sigma^2 + 1)})}{\sqrt{\sigma^2 + 1}} - 1$$

Where,

$N_{0.995}$= 99.5% quartile of the standard normal distribution

The function $\rho(\sigma)$ is set such that, assuming a lognormal distribution of the underlying risk, a risk capital requirement consistent with the VaR 95% calibration objective is produced. Roughly, $\rho(\sigma) \approx 3.\sigma$

3.4.2 Volumes measures and standard deviations

The volume measure V and the combined standard deviation σ for the overall non-life insurance portfolio are determined in two steps. First, for each individual LoB, the standard deviations and volume measures for both premium risk and reserve risk are determined. Then the standard deviations and volume measures for the premium risk and the reserve risk in the individual LoBs are aggregated to derive an overall volume measure V and a combined standard deviation σ.

Simplification

We will assume that the standard deviations for premium and reserve risk will remain unchanged. (CEIOPS, QIS5 Technical specifications, 2010)

Step 1: Volume measures and standard deviations per LoB

Table 1: Lines of business in Kenya (Source: IRA annual reports)

Number	Lines of business
1	Aviation
2	Fire-domestic
3	Liability
4	Motor-private vehicles
5	Personal accident
6	Workmen's compensation
7	Engineering
8	Fire-industrial
9	Marine
10	Motor-commercial
11	Theft
12	Non-proportional reinsurance-property

For each LoB, the volume measures and standard deviations for premium and reserve risk are denoted as follows:

$V_{(prem,lob)}$ = The volume measure for premium risk

$V_{(res,lob)}$ = The volume measure for reserve risk

$\sigma_{(prem,lob)}$ = standard deviation for premium risk

$\sigma_{(res,lob)}$ = standard deviation for reserve risk

Input

The following variables need to be determined:

PCL_{lob} =Best estimate for claims outstanding for each LoB. This amount should be less the amount recoverable from reinsurance and special purpose vehicles

$P_{lob}^{t,written}$ = Estimate of net written premium for each LoB during the forthcoming year

$P_{lob}^{t,earned}$ = Estimate of net earned premium for each LoB during the forthcoming year

$P_{lob}^{t-1,written}$= Net written premium for each LoB during the previous year

P_{lob}^{PP} = Present value of net premiums of existing contracts which are expected to be earned after the following year for each LoBs.

The volume measure for premium risk in the individual LoB is determined as follows:

Equation 1

$$V_{(prem,lob)} = \max\left(P_{lob}^{t,written}; P_{lob}^{t,earned}\right) + P_{lob}^{PP}$$

There are two approaches to calculating the standard deviation for premium risk; using market wide estimates and the undertakings approach using historical loss ratios. Under QIS3, The standard deviation for premium risk in the individual LOB is derived as a credibility mix of an undertaking-specific estimate and the market-wide estimate as follows:

Equation 2

$$\sigma_{(prem,lob)} = \sqrt{c_{lob} \cdot \sigma_{(U,prem,lob)}^2 + (1 - c_{lob}) \cdot \sigma_{(M,prem,lob)}^2}$$

Where,

$\sigma_{(prem,lob)}$ = Resulting estimate of the standard deviation for premium risk

c_{lob}= Credibility factor for LOB

$\sigma_{(U,prem,lob)}$= Undertaking-specific estimate of the standard deviation for premium risk

$\sigma_{(M,prem,lob)}$= Market-wide estimate of the standard deviation for premium risk

It is assumed that:

1. The net earned premium can be used as a proxy for premium risk exposure.

2. The net provisions for claims outstanding can be used as proxy for the reserve risk exposure. (EIOPA, 2009)

The credibility factor c_{lob} is defined as:

Equation 3

$$c_{lob} = \begin{cases} \frac{n_{lob}}{n_{lob}+k_{lob}} & \text{If } n_{lob} \geq 7, \\ 0, \end{cases}$$

Where,

k_{lob}= credibility constant depending on the individual LOB

n_{lob} = number of historic loss ratios available (at most 15) for insurer i in the LOB (In our case we will use 14 ratios (2002-2014) to determinen_{lob}.)

Under the classical Bülmann-Straub credibility model assumption, the credibility factor c_{lob} is given by:

Equation 4

$$c_{lob} = \frac{n_{lob,i} - 1}{n_{lob,i} - 1 + 2 \cdot \frac{E(\sigma^4(\Theta_i))}{V(\sigma^2(\Theta_i))}} = \frac{V(\sigma^2(\Theta_i))}{V(\sum_i^2)}$$

Where

$$\sum_i = \sqrt{\frac{1}{(n_{lob,i} - 1)} \cdot \sum_j P_{lob,ij} \cdot (LR_{lob,i}^j - \mu_{lob,i})^2}$$

Unbiased estimators for the structural parameters,

$$\xi = V(\sum_i^2)$$

And

$$\varphi = V(\sigma^2(\Theta_i))$$

Are constructed using statistical data hence estimated of credibility factor c_{lob} are then determined. Then values for the credibility constants k_{lob} are then determined. Different business lines will have different credibility constants k_{lob} so we will set the same credibility constants k_{lob} for each LOB. For example if the range from 3-5, we can pick 4 for each LOB.

Reserve Risk

The volume measure for reserve risk for each individual LoB is determined as follows:

Equation 5

$$V_{(res,lob)} = PCO_{lob}$$

Where,

PCO= the net provision for claims for the overall business

Step 2: Overall volume measures and standard deviations

The overall standard deviation σ is determined as follows:

$$\sigma = \sqrt{\frac{1}{V^2} \cdot \sum_{r,c} CorrLob_{r,c} \cdot \sigma_r \cdot \sigma_c \cdot V_r \cdot V_c}$$

Where,

r, c = All indices of the form (lob)

$CorrLob_{r,c}$ = The entries of the correlation matrix $CorrLob$

V_r, V_c = Volume measures for the individual lines of business, as defined in step 1

Hence,

The standard deviation for premium and reserve risk in the individual LoB is defined by aggregating the standard deviations for both sub risks under the assumption of a correlation coefficient of α=0.5:

Equation 6

$$\sigma_{(lob)} = \frac{\sqrt{(\sigma_{(prem,lob)} V_{(prem,lob)})^2} + \sqrt{2\alpha\sigma_{(prem,lob)}\sigma_{(res,lob)}V_{(prem,lob)}V_{(res,lob)} + (\sigma_{(res,lob)}V_{(res,lob)})^2}}{V_{(prem,lob)} + V_{(res,lob)}}$$

4 Research findings

4.1 Distribution and standard deviation per line of business

Table 2 presents the results of standard deviations of premium risk and reserve risk per line of business for the years 2002-2013.Although for Medical insurance the standard deviations of 6% and 4% respectively are only for the years 2010-2013.This is because medical insurance was introduced as a new class of business according to section 150A (1) of the Insurance Act.

From the analysis, aviation class of business is the most volatile class among all having a SD of 366% under premium risk. Also aviation is the most volatile class of business under reserve risk. Globally aviation insurance is known to be very volatile due to the inherent nature of the risk and the underwriting cycle of insurance. (Ashenbrenner & Kyle, 2005)

Table 2: Distribution and standard deviation of each line of business under premium risk module

LOB	PDF	$(\%)\sigma_{(prem,lob)}$
Aviation	Cauchy	366%
Engineering	Cauchy	29%
Fire domestic	Pearson 5P	4%
Fire Industrial	Logistic	19%
Liability	Burr4P	31%
Marine	General Pareto	9%
Motor Private	Gen. extreme values	8%
Motor Commercial	Dagum	7%
Personal Accident	Log Pearson 3	8%
Theft	Gen. extreme values	8%
Workmen's compensation	Beta	30%
Medical	n/a	6%*
Miscellaneous	Cauchy	14%

Table 3: Distribution and standard deviation of each line of business under reserve risk module

LOB	PDF	$(\%)\sigma_{(res,lob)}$
Aviation	Cauchy	58%
Engineering	Pert	12%
Fire domestic	Beta	4%
Fire Industrial	Cauchy	10%
Liability	Laplace	12%
Marine	Nakagami	10%
Motor Private	Inv. Gaussian	7%
Motor Commercial	Cauchy	5%
Personal Accident	Gen. extreme values	14%
Theft	Gen. extreme values	7%
Workmen's compensation	Uniform	29%
Medical	n/a	4%*
Miscellaneous	Johnson SB	11%

4.2 Capital amounts required per line of business

Table 4: Capital amounts to hold for premium risk

Line of Business	Premium risk capital required	Reserve risk capital required
Aviation	372%	131%
Engineering	49%	20%
Fire domestic	15%	5%
Fire Industrial	31%	28%
Liability	27%	20%
Marine	13%	16%
Motor Private	13%	11%
Motor Commercial	107%	10%
Personal Accident	14%	31%
Theft	16%	13%
Workmen's compensation	36%	46%

Miscellaneous	22%	11%

4.3 Goodness of fit tests

Easy fit software can also perform goodness of fit tests. It used Kolmogorov Smirnov to rank all distributions. In this study we picked the best fit according to Kolmogorov Smirnov. This test checks whether one distribution differs with theoretical expectations. It also calculates the P value in which we used to find capital amounts under each risk. Other tests available on website are Anderson darling and Chi squared.

5 Summary of Findings and Conclusions

5.1 Summary of study

The concept of risk based capital modelling was introduced and the rise of these technique all over the world. It was brought in the African context and a review of what African regulators have been practising. This paper seeks to determine the capital charges non-life insurers should hold according the line of business they operate. These amounts are shown in the table below given including the best fit distribution. Averages calculated from data set showed how much each insurer is currently holding or what they think they should hold. Using a confidence interval of 95% that is, 1 in 200 years, we got the additional amount of capital that insurers should hold according to the tails of each distribution.

Capital amounts were derived per every line of business under the premium risk and reserve risk module. The highest amounts were observed under Aviation line of business due the volatility of loss ratios while lowest capital amounts were observed in fire domestic under premium risk module. Capital amounts projected in this study should provide benchmark to Kenyan insurers particularly in capital management. For each line of business an insurer writes the capital backing should be sufficient to enable smooth operations.

5.2 Conclusions

From observing results from the study, each class of business in unique according to the amount of capital held and it's best fit distribution. Capital requirements obtained per line of business are a market estimation which insurers may use to compare themselves. Bermudez, Ferri, & Guillen (2013) carry out the same study but conclude that the system is overly rigid when using QIS-5 parameters that only depend on a volume measure. This the reason we opted to use EasyFit to predict the tails of each distribution then find the capital required per lob.

Aviation ranks as the class with the highest amount of capital to be held. This is due to the volatile loss ratios shown by the standard deviation. This line of business is very volatile and cyclical Following aviation is motor commercial insurance with the second largest capital required for premium risk. This means the loss ratios in motor commercial will be higher than expected due to the high uncertainty and frequency of claims. Accidents in Kenya have been showing a rising trend.

Reserve risk is the risk that loss reserves are less than the payments that eventually will be necessary to satisfy the loss obligations of the company. (Cummins, Grace, & Phillips, 1999) Following aviation with the highest capital amount for reserve risk is workmen's compensation insurance. This could be due to using optimistic assumptions when determining reserving requirements.

Risk based modelling should be taken up by all regulators in Africa to protect policyholders against insolvency of insurance companies. Solvency capital requirements standardised model should be developed to fit all insurance companies despite their sizes.

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Appendix 1

The following is an illustration of the risk structure of a general insurer according to (CEIOPS, QIS5 Technical specifications, 2010)