Strathmore UNIVERSITY

Motor Private Vehicle Rating Model

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Submitted in partial fulfillment of the requirements for the Degree of
BBS Actuarial Science at Strathmore University

Strathmore Institute of Mathematical Science
Strathmore University
Nairobi, Kenya

November, 2017

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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ACKNOWLEDGEMENTS

I would like to appreciate my immediate supervisor Mr. George Odera for his guidance, insights and encouragements where necessary. Without his support, it was impossible to accomplish the research. His contributions and immediate feedback to this research has made it a success. I am forever grateful.

I would like to pay special thankfulness, warmth and appreciation to my parents, lecturers, friends and classmates who contributed in assessing my research topic. Their moral support and company has made the research very successful.

My sincere gratitude goes to Strathmore University for considering me to pursue this course and undertake this project. Their mentorship and basic support have made the entire journey of my undergraduate degree fruitful.

Above all, I would like to thank God for his blessings on me.

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ABBREVIATIONS

1. IRA: Insurance Regulatory Authority
2. AKI: Association of Kenya Insurers
3. KNBS: Kenya National Bureau of Statistics

ABSTRACT

Most motor insurance companies in Kenya collect about 5-10 rating factors in their proposal forms. Despite having these data, these companies have in the past used the minimum rates prescribed by the Insurance Regulatory Authority (IRA). This implies that they are less likely to be aware of rating factors and their importance in pricing. This may justify one of the major reasons as to why motor insurance companies have been loss making. Although the minimum rates were specified, there was no regulation that compelled insurance companies not to price using rating factors. Thus although they collected data on the rating factors, they used the minimum rates possibly due to competitive pressure and market practice. However, IRA has recently issued a circular[1] to insurance companies that abolishes the use of minimum rates from 2018 thus insurance companies will be required to price based on their own experience. Rating factors form the basis for pricing. Therefore, the overall objective of this study is to assess the use of rating factors to price motor premiums in light of the new IRA regulations. The past experience and data will be used to evaluate the use of relevant rating factors to price motor insurance policies and develop a simplified pricing model to compute premiums. A motor rating factor model is a simplified model that enables you to calculate the premium to be charged on a particular motor depending on the various rating factor such as type of cover, year of manufacture, engine rating, body type, make, color, carrying capacity, value of the car, age and profession of policyholder. Each of these factors contribute to the pure risk premium. The total premium payable is the combination of pure risk premium, expense premium, commission premium, profit loadings premiums and any other optional benefits. The findings of this model show that the premium rate varies significantly from the current model that assumes a fixed minimum rate on the value of the car.

[1] IRA Circular No IC & RE 12/2016 CONF/1RA/00/001/03A

1 INTRODUCTION

1.0 Background Information

1.0.1 Definitions

A policyholder is a person who purchases an insurance cover. An insurer is an individual or organization that provides insurance covers. The policyholder may be faced with an event leading to a loss and the insurer provides compensation against the loss in return of regular payments paid by the policyholder.

An insurance policy is therefore a promise by the insurer to the policyholder to pay for future claims in return for specified payments paid upfront by the policyholder. The upfront payments are known as premiums. The total premiums contributed to the insurer has to be sufficient to meet all expected cost of losses incurred within the duration of cover as well as other operational costs.

1.0.2 Insurance

Insurance is a way of cushioning against risks. Risk exists when people are exposed to the likelihood of a future loss, which is uncertain. In most instances people are risk averse, i.e. instead of being exposed to a risk, they would prefer bearing a certain loss, even if its amount exceeds their expected loss under the risk. One of the most important feature of the insurance mechanism is the reduction of risk by pooling, (Skogh, 1991).

Smith (1994) emphasized on operation of the law of large numbers, which states that uncertainty decreases when many similar but independent risks are brought together. However, it is highly uncertain for instance, whether one particular driver will be involved in a car accident in future and how serious the damage will be. The insurer will only take up the individual risks against a premium which will cater for the expected loss administering costs and profit loadings, only if the individual risks can be minimized by pooling, (Wils,1994).

Shavell (1979) noted that one of the major setback with insurance is moral hazard, which is the possible negative effect of insurance on loss prevention effects. In the absence of

insurance, those individuals highly engaged in risky activities are incentivized to prevent losses by either reducing their activity level or by taking precautions when conducting the activity, (Shavell S. , 1987). Insurance sabotages the loss prevention incentives only if the premiums are not related to the risky activity or event. Therefore, differentiated premiums may be more valid as a means of improving the loss prevention incentives.

Akerlof (1970), poses a very complex drawback in insurance markets because the individuals willing to buy insurance usually know more about their risk characteristics than it is possible for an insurer. The asymmetric information leads to adverse selection within the insurance pool as most of the high-risk individuals realize that insurance is a good deal for them. This leads to a point where the insurance pool is highly constituted with high-risk individuals which means high payouts by the insurance company. The cost of providing insurance to the insurer increases due to adverse selection as most low-risk individuals tend to opt out, (Dionne G. R., 2014).

1.0.3 General Insurance

General insurance is non-life insurance which includes different classes such as Aviation, Engineering, Fire Domestic, Fire Industrial, Liability, Marine, Motor Private, Motor Commercials, Personal Accident, Theft, Workman's Compensation, Medical and Miscellaneous. These classifications are as per the Insurance Act (CAP 487).

Motor insurance covers a policyholder against loss or damage to his/her own vehicle due to accidents, fire and theft. It also covers against third–party bodily injury or death and third-party property loss or damage. Motor insurance is usually offered on a short term, usually 1 year in duration. The first party in motor insurance contracts is the policyholder and the second party is the insurer. The third party is a person who suffers property damage or loss or death or bodily injury as a result of an accident involving the motor vehicle of the policyholder. A third party may be any person including a property owner, a pedestrian, a driver or passengers in another vehicle. There are various classes of motor insurance under Kenyan Laws; Public Service Vehicles (P.S.V), Commercial, Private and Motor cycles.

P.S.V are classified as class A and it includes all passenger service vehicles that are fare paying, e.g. buses, matatus, taxis, tuk-tuks (3-wheel cabin motor cycles). Commercial vehicles are classified as class B and includes vehicles used for commercial purposes e.g. lorries, trailers, pick-ups and any institutional vehicles that transport or carry goods. Private vehicles are classified as class C and includes vehicles that are used for social and domestic purposes. Motor cycle are classified as class D.

1.0.4 Motor Insurance Covers

The major types of Motor Insurance Covers include; Third-party cover, Third-party fire and theft and the Comprehensive cover.

Third party cover is the bare legal requirement made compulsory by the Government of Kenya. It covers third party bodily injury/death and property damage through accidents which are caused by the Motor vehicle.

The Third-party Fire and Theft policy covers the third party bodily injury/death, property damage caused by the vehicle and in addition any loss or damages to the motor vehicle due to theft and fire.

The Comprehensive policy covers any third-party liability or property damage or damages that arise from fires or theft are covered. In addition, any damages to the vehicle due to accidents are also covered.

1.0.5 Risk Classification

Risk classification is a key component of insurance pricing. Dionne G. R. (2014), defines risk classification as the use of observable characteristics by insurers to group individuals with similar risks for the purpose of computing appropriate premiums. Risk classification is therefore grouping of different risks according to their estimated cost or likely impact or likelihood of occurrence.

Motor rating factors are factors or variables which are measurable and have a correlation with the likely claims experience. Some of them include age, gender, value, make, body, year of manufacture, color, carry capacity and engine rating. A risk class or risk

characteristic represents the various subsections in the rating factors that have different risk exposures.

Jee (1989), states that the purpose of risk classification system is to group homogeneous risks and charge each rating factor a premium corresponding with the average expected loss of its risk characteristic. This means that individuals with similar risk characteristics are treated in a consistent manner. Furthermore, it enables insurers to charge differentiated premiums corresponding to an insured's expected loss. This way, cross subsidies associated with an average pricing model would be avoided i.e. low risk individuals will pay a premium below the overall average and high-risk individuals will pay a premium above the overall average.

Risk classification therefore groups individuals with similar risk characteristics based on a rating factor and subsequently charging an appropriate premium. This approach of rating is known as experience rating.

Risk classification systems have been used as an initial step to deal with the practical problem of how to determine the expected costs of coverage based on the available information. Each outcome reflects the frequency and the severity. For instance, if a class includes a number of risks, its probabilities can be estimated by observing outcomes over time. These estimates can be used in turn to estimate the estimated coverage costs for the risks in the risk class. Thus, an effective risk classification system facilitates the estimates of expected costs. A risk classification system can promote internal consistency of the estimates, decrease the likelihood of adverse selection[2] and aid the tracking of data, (Dickle, 2011).

However, a major drawback in risk classification is that it assumes that each individual in the risk class behaves in a similar way. Although, this may not be the case as every individual is unique. This would therefore, no longer be fair to some individuals.

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[2] Adverse selection refers to a situation whereby the policyholder (or the insurer) takes an action that is to his financial advantage based on the information that he has but the other party (insurer) does not have.

1.0.6 Trends in Motor Insurance

Motor insurance is compulsory in Kenya under the Insurance Act CAP 405 of motor vehicle third party risks. This Act requires that all drivers in the country, to insure their vehicles against any third-party injuries or damages to property. Therefore, it is illegal for any person to drive a motor vehicle in Kenya without, at a minimum, third-party insurance cover

According to KNBS[3], the number of new registration of road motor vehicles per year has increased from 205,841 in 2009 to 218,057 in 2014. Car Registrations[4] in Kenya averaged 14,385 from 2006 until 2016. This exhibits that the market for motor insurance is highly attractive and large.

According to IRA Annual Reports, Motor Private Insurance has been one of the most loss-making class of business under General Insurance. It shows that in 2009, the total Gross Loss recorded amounted to Kshs 1.278 billion, which has increased to Kshs 1.923 billion in the year 2015. Furthermore, IRA through AKI, introduced minimum rates for motor insurance. These rates were based on average industry experience and were not based on any rating factors. Most insurers, to remain competitive, use this minimum rate (as a percentage of the estimated value of motor vehicle), as a price ceiling rather than a price floor.

Therefore, some drivers are paying higher premiums while others are paying a lower premium than they should. This, therefore shows a need to change the premium pricing approach used for motor insurance in order to ensure that the correct premium is charged and the current losses curtailed. IRA has recently issued a circular[5] to insurance companies that abolishes the use of minimum rates from 2018 thus insurance companies will be required to price their own experience. Rating factors form the basis for pricing.

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[3] Kenya National Bureau of Statistics 2015

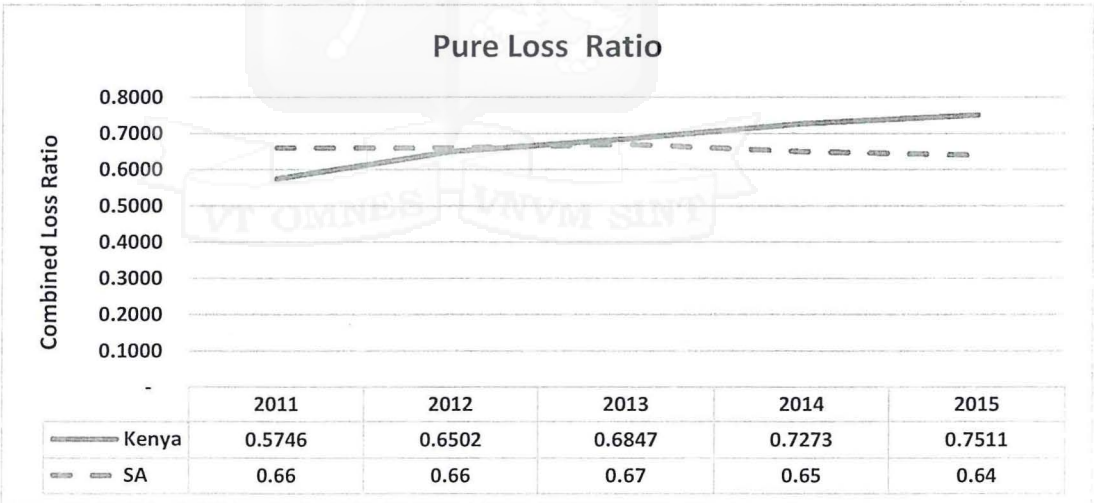
[4] Kenya New Vehicle Registration

[5] IRA Circular No IC & RE 12/2016 CONF/1RA/00/001/03A

When pricing, two major aspects are supposed to be considered. First the relative premium levels need to be determined, for instance, it is important to charge correct premium for inexperienced drivers' relative to experienced drivers, new cars relative to old cars. The second aspect is that the overall level of premiums must be adequate to meet the particular profit objectives, (Brockman & Wright, 1992).

Differentiated pricing using rating factors can be used to compute premiums that best reflect the risk profile of a particular applicant. The motor rating factors that can be used in the pricing basis either relate to the policyholder or the vehicle or the type of cover purchased. This implies that for the same individual, the premiums charged could vary if different cars are insured. Having considered the above, an analysis is performed to compare the performance of a country (South Africa) that use rating factors as a pricing basis for motor insurance to that of Kenya which has not been using these factors.

The analysis demonstrated a more stable pure loss ratios for a country that applies rating factors as compared to Kenya. This could be illustrated as shown in figure 1.



	2011	2012	2013	2014	2015
Kenya	0.5746	0.6502	0.6847	0.7273	0.7511
SA	0.66	0.66	0.67	0.65	0.64

Figure 1 Pure Loss Ratio

Source: IRA Reports, Annual reviews, http://www.saia.co.za/info-center/saia-documents/publications/annual-reviews/

1.1 Problem Statement

Most motor insurance companies in Kenya collect about 5-10 rating factors in their proposal forms. Despite having these data, these companies have in the past used the

minimum rates prescribed by the IRA. This implies that they are less likely to be aware of rating factors and their importance in pricing. This may justify one of the major reasons as to why motor insurance companies have been loss making. Although the minimum rates were specified, there was no regulation that compelled insurance companies not to price using rating factors thus although they collected data on the rating factors, they used the minimum rates possibly due to competitive pressure and market practice.

Looking into the comparison done between South Africa and Kenya, it is clear that in South Africa where motor insurance companies use rating factors as pricing basis, tends to make high profits compared to countries that do not incorporate rating factors.

Having considered the above, the insurers are expected to change their premium pricing approach. Given the new regulation by IRA, the change in premium pricing should incorporate the use of rating factors. Therefore, to fill in this gap, the study intends to suggest a simplified motor rating factor model that uses rating factors and is simple for the insurers to understand.

1.2 Research objectives

The overall objective of this study is to assess the use of rating factors to price motor premiums in light of the new IRA regulations. The past experience and data will be used to:

a) Evaluate the use of rating factors and the relevant rating factors for the pricing of motor insurance policies.
b) Develop a simplified pricing model to compute premiums using the rating factors.

1.3 Research questions

a) What rating factors are relevant for the pricing of motor insurance policies
b) How can a simplified model be used to compute premiums using these rating factors?

1.4 Significance of the study

The study will be beneficial to insurers in determining the premiums for the different risk profiles. The findings could also be used for research by doing further analysis on the more risky profiles.

The study will be beneficial to the potential policyholders who will be keen to know the different premiums that could be charged by various insurance companies based on a specific car.

The study will also be helpful to potential students interested in motor insurance related subjects.

2 LITERATURE REVIEW

2.0 Introduction

This section contains empirical and theoretical studies on the use of rating factors as a basis for premium pricing and the various statistical models done to estimate pure premiums.

2.1 Theoretical Studies

2.1.1 Additive and Multiplicative Models

Most pricing models have a combination of multiplicative and additive models. A multiplicative model implies the multiplication of two or more variables while an additive model involves the summation of two or more variables.

There tends to be a correlation between different rating factors within a model and thus a diversification benefit needs to be allowed for.

This can be done via the use of correlation matrix or a simplified approach such as the square root of sum of squares.

2.1.2 Simple Pure Premium Model

Pure risk premiums are based on frequency and severity of claim amounts. Frequency represents the incidence rate of claims occuring in a given year. The severity of a claim represents the average claim cost associated with each claim. In most studies carried out, severity and frequency are treated independently, (Weisberg, 1982). The expected value of the observed pure premium for a rating factor is then computed as;

$$E\,(P_i) = \lambda_i * \mu_i \qquad (1)$$

Where λ_i represents the incidence rate related to the risk class i under the rating factor; μ_i corresponds to the average claim cost attached to the corresponding risk class. For instance, in a motor insurance company, risk class could be Toyota or Jaguar or many others, λ_i could represent the proportion of the number of Toyota cars which were

claimed in a particular duration and the total number policies of Toyotas for a particular type of motor cover.

For various rating factors the overall risk premium is the square root of sum of squares of all the rating factors

$$E\ (P_i) = \sqrt{\sum (\lambda_i * \mu_i)^2} \quad (2)$$

2.2 Empirical studies

2.2.1 Considerations when selecting rating factors

Dickle (2011), stated that when coming up with a risk classification system, an insurer has to consider the selection of risk classes under each rating factors is large enough to measure costs with accuracy. Having fewer risk classes means each risk class will have a greater volume of historical data on which to base estimates of its risk probabilities. This is important because a small group may not necessarily reflect the expected loss accurately as there is a greater probability that the group may be biased and have a volatile experience due to insufficient volume.

Abraham (1985), points out that homogeneity needs to be considered when selecting the rating variables. Homogeneity indicates that since all individuals belonging to a particular risk class pay same premiums, their risk of loss should be very similar. He further adds on that the rating variable should be highly stable and reliable. Reliability measures how much simple and evident differences are utilized to classify the insured in an accurate way.

In addition to the above considerations made by Abraham (1985), Porrini (2015), points out that separation, causality and incentive worth should be considered when selecting rating variables. The separation measures all risk classes' mean expected losses which ought to be sufficiently different in terms of loss expectation to warrant their identification as a separate class. Causality measures whether category distinctions are supported by characteristics associated with loss. Incentive worth means that a good

category ought to classify the characteristics inside the insured's control so as to produce the inducement to adopt low-risk characteristics.

Insurers sell insurance covers at prices that are sufficient to cover the anticipated cost of claims, expenses and usually a profit loading, (an expected profit to compensate for the cost of capital necessary to support the sale of cover). The insurers aim to classify risks they underwrite in order to charge premiums commensurate to risks undertaken. Anderson (2005), explains that the amount of loss to the insurer depends on two major variables. The first one is the frequency of losses which is the number of losses that will occur in a specified period. The other major variable is the severity of losses which is the average cost of claims. These two variables affect pure premium. Therefore, when selecting rating variables, the insurer should ensure that risk classes under each rating factor reflects the different premium values.

A key consideration when selecting a rating factor is legislation in that particular jurisdiction. The rating factor should not be restricted under the laws. If it is restricted, then insurers are not permitted to apply these rating factors to premium pricing.

For maintaining a viable insurance system, the risk classification should be fair, should reflect expected cost differences, should distinguish among risks on the basis of relevant cost-related factors and should be practical and cost-effective. In addition to these, the risk classification system should be accepted by the public.

Rating factors could fall under three major categories; factors associated with the policyholder the vehicle and the coverage. Some of the factors related to the policyholder include age, profession, gender and marital status. Factors related to the vehicle include year of manufacture, make, body, vehicle, carry capacity, engine capacity and color. Factors related to the coverage may include type of cover purchased by the policyholder.

It is worth noting that motor rating in countries like UK uses up-to 20 rating factors, many of which are gathered when a policy is taken out. In Kenya, insurance companies collect between 5-10 rating factors. As earlier stated, these factors have not been used in the actual pricing process.

Dahlby (1983), found evidence that low-risk individuals (safer drivers) tend to leave the market when risk classification in automobile is excluded.

Dionne G. G. (1998), studied motor insurance markets and concluded that risk classification removes residual adverse selection. The same authors in the later years, (Dionne G. G., 2001), showed that adverse selection in motor insurance market could be controlled by using an appropriate risk classification system.

However Schwarzwe (2005), showed that risk classification was inefficient in the German automobile insurance market during the 1990s. In addition, risk classification is viewed as an effort in avoiding risk. Such a competition based on use of rating factors has a limited value in producing a public good.

2.2.2 Rating factors

2.2.2.1 Age

McKnight & McKnight (2003), noted that young individuals are risk takers. This means that they are more likely to take higher risks compared to the rest of the population. This can be explained by lack of driving experience.

Kelly & Nielson (2006), carried out a study which examined the use of age in the delivery of personal insurance to Canadians. The use of age as a rating factor had been justified on the basis of its existing strong intuitive causal relationship. In addition, they reviewed the relationship between age and driving ability in relation to young drivers and old drivers. Also, they considered the various risk-taking behaviors of the young individuals, the time duration for an individual to drive proficiently and the effects of these on the level of accidents caused by young drivers. They examined between ageing, sensory and the cognitive skills required for an individual to drive. This study demonstrated functional limitations and the environmental factors that are highly correlated with age and that make both young and elderly drivers high risk drivers. This study reflected that young drivers are more likely to be involved in road accidents that tend to have a significant impact.

In UK, Groupe Consultatif Actuariel Européen (2011), assessed the use of age as a rating factor and found that males aged 17 are over are 8 times more expensive than males aged 65 in regard to claims experience over the insured individuals.

Braver & Trempel (2004) and Teff (2008) exhibited higher accident tendencies for young and elderly drivers. Their analysis resulted to a U shape curve for loss against age. Such results were applied in this study for Kenyan insurance company reflecting higher rate coefficients upon young and elder drivers.

A study by Bennet, et al (2008) in UK examined the implications of removing age as a rating factor. It concluded that the cost of motor insurance of young individuals, (under 25 years), would drop by approximately 17%. This would imply that motor insurance will become more affordable for these individuals. Therefore, encouranging most young individuals to buy higher powered motor cars. This would increase the number of motor vehicles being bought by these individuals which will reflect an increase in the expected claim costs as more inexperienced drivers on the road results to more accidents of significant impacts.

Groupe Consultatif Actuariel Européen (2011), illustrated that age is an essential risk factor in managing adverse selection to an acceptable level for particular types of insurance. Adverse selection could cause a market to be unsustainable. On the other hand, if age were not used in pricing, insurance covers would become unfair for low-risk individuals and high-risk individuals would tend to drive recklessly as the premium rates are to their advantage.

In addition to this, it is believed that young drivers tend to use cell phones while driving and thereby resulting to an increase in the number of accidents.

2.2.2.2 Gender

Gender is one of the most basic rating factors which the insurance industry uses to classify individuals. Storie (1977) carried out a study that presented the differences in driving characteristics between male and female based on speed, skill and attitude. The major findings for this study reflected that females are more likely to drive at lower

speeds and overtake more carefully while males are more likely to drive in a risky manner.

Butler, Butler, & Williams (1988) analyzed motor accidents records for both male and female drivers using US actual data. Based on the claim losses and the premiums collected, the study reflected that females were overcharged for their vehicle.

Using data from three personal vehicle insurance policies in Georgia, USA, Puelz & Kemmsies (1993) examined how gender and other demographic variables impacted on premium pricing. This study demonstrated that gender significantly affects premium rates although its level of impact is relatively less than rating factors such as driving record, location, vehicle type and age.

Waylen and McKenna (2002) noted that the pattern of road accident differs by gender. Men are more likely than women to be involved in crashes that occur on bends, in the dark or those that involve overtaking. Women, on the other hand, have a greater frequency of crashes occurring at junctions than men. This supports the suggestion by Storie (1977), that men are more at risk from accidents involving high speed while women are at more likely to be involved in accidents resulting from perceptual judgement errors.

In addition, there is a high probability of men driving at night or midnight are under the influence of drugs or alcohol. Noting the eye vision is impaired at night, there are high chances of accidents with higher severity of loss. On this basis, men tend to drive in a risky manner and causing more accidents compared to women.

As at December 2011, across Europe, gender had been used as a rating factor by insurers in many insurance markets. However, from December 2012, insurers in Europe had been restricted to treat men and women differently in computing premiums and benefits for any new insurance contracts. This was as result of a landmark ruling on 1 March 2011 by the European Court of Justice, (Groupe Consultatif Actuariel Européen, 2011).

2.2.2.3 Color

Newstead & D'Elia (2007) analyzed the relationship between the color of the vehicle and the accident risk using data from two Australian states and found a clear statistically

significant relationship between the two. The study showed that vehicles with lower visibility colors tend to have a higher accident risk as compared to those with higher visibility colors. White vehicles were proved to be the safest in terms of accident risk. In addition, the study also mentioned that environmental factors could modify the relationship between the vehicle color and accident risk.

2.2.2.4 *Year of manufacture*

National Highway Traffic Safety Administration (2013) examined how a vehicle's age would relate to the driver's injury severity in fatal crash. The study demonstrated that the percentage killed is lowest among newer cars and highest for old vehicles.

National Highway Traffic Safety Administration (2013), analyzed how age of vehicle at time of crash and the vehicle's model year are correlated with the accident rate. The results of this study can be summarized below:

Vehicle Age (years) by Vehicle MY	MY 2008–2012	MY 2003–2007	MY 1998–2002	MY 1993–1997	MY 1985–1992
Age 0–3	0.29	0.33	0.35	0.37	0.42
Age 4–7	0.31	0.35	0.38	0.40	0.45
Age 8–11	0.33	0.37	0.39	0.42	0.47
Age 12–14	0.35	0.40	0.42	0.45	0.49
Age 15–17	0.38	0.43	0.45	0.48	0.52
Age 18+	0.42	0.46	0.48	0.50	0.56

Table 1 Vehicle Year of manufacture and accident rate

Source: https://www.google.com/webhp?sourceid=chrome-instant&ion=1&espv=2&ie=UTF-8#q=discount+FACTOR+FORMULA

The above results could be attributed to increased safety record of newer car models compared to older car models.

2.2.2.5 *Type of cover*

Claims from comprehensive motor insurance covers are higher than third party covers since additional payments are made to cover the cost of material damage to the vehicle. Under both types of cover, third party claims are payable owing to damage to property or injury to persons inside and outside the car.

2.2.2.6 *Make and models*

Claims analysis from a local underwriter in the Kenyan market indicates that the claims experience differed significantly between different car makes and models. Toyota forms

the largest proportion of cars in the Kenyan market, followed by Nissan. Due to law of large numbers, the claims experience associated with a car brand that has significant volumes like Toyota is expected to be more stable and less volatile compared to a brand that has fewer cars.

The repair costs associated with a car brand that has few volumes is also higher than a car brand that has larger volumes due to lack of readily available spare parts.

2.2.2.7 Engine rating

The engine rating of a car is directly proportional to the speed and power output. Cars with very high engine ratings are likely to be expensive, have extra safety features and are likely to be purchased by owners who either have a driver or are experienced in driving, having owned another car.

Cars with a low engine rating are likely to be cheaper, have basic features and are popular with individuals as an entry level car

2.2.3 Pure premium models

A number of studies have been conducted on the use of models to compute pure risk premiums based on multiple rating factors. Researchers have suggested various statistical procedures for risk classification. A functional form for a statistical model is required to estimate pure premiums using regression methods.

Almer (1957), conducted a study on modelling of pure premiums within the risk classification system. He emphasized on a multiplicative model for use with rating factors with the general form:

$$P_{ij} = P_0 \, a_i \, b_j + e_{ij} \qquad (3)$$

Where P_{ij} represents the claim proportion for class ij; P_0 represents the overall mean; $a_i \, b_j$ represent the effect of the levels i and j for rating factors a and b respectively; e_{ij} represents the error term. He used weighted least squares approach as an estimation method and found a fine goodness of fit of residuals being generated by equalization and not by random choice of factors.

Bailey & Simon (1960) examined loss ratios for additive model and multiplicative model. The additive model could be expressed as follows; (Bailey & Simon, Two studies in Automobiloe Insurance Ratemeking

$$P_{ij} = P_0 + a_i + b_j + e_{ij} \quad (4)$$

Bailey & Simon (1960) analyzed Canadian automobile insurance data and showed that the multiplicative models produced systematic overestimates for the highest risk driver classes. He used minimum chi squares as an estimation method.

Bailey R. (1963) examined the multiplicative model using the minimum bias method. His study provided evidence that a multiplicative form is preferable if all factors are percents and additive approach is preffered if all rating factors are cents.

Jung (1968) tested the multiplicative model using the Heuristic method, (Modified chi-square minimum) and found out that multiplicative model will result to biasness.

Chang (1979) used a loglinear form of function to derive the parameters for the multiplicative model. He demonstrated that loglinear models tend to overestimate high risks by double counting classification factors. The estimation method used was weighted least squares. The study showed that predictive accuracy of the additive model was better. Furthermore the study suggested separate estimation for claim frequency and severity.

Ajne (1980) analyzed multiplicative model using method of moments, (modified chi-square minimum). Based on the analysis, the study demonstrated that the estimator may have a positive finite sample bias.

Sant (1980) realized the need to apply statistical modelling and parameter estimation. He suggested a multiplicative model and applied the principle of least squares to get the relativities. One of the major findings was bias for high risks and low.

Fairley, Tomberlin, & Weisberg (1981) analyzed New Jersy data by applying additive log-linear models using weighted least squares. This study noted the tendency of log-linear models to overestimate high risks.

DuMouchel (1983) introduced a hybrid functional form expressed as;

$$P_{ij} = P_0 + a_i + b_j T_i + e_{ij} \quad (5)$$

For which T_i represents the additional parameter for the multiplicative factor for class-ij. He estimated pure premiums using iterative wieghted least squares and demonstrated that pure premiums are determined by a Bayesian credibility scheme.

Harrington (1986) used auto insurance claims data from the state of Massachusetts and from United Kingdom to estimate pure premiums using maximum likelihood estimation. In addition the study tested for functional form using the power transformation suggested by Box and Cox. The study concluded that estimation and testing of functional form using Box and Cox procedure may provide more accurate predictions than simply assuming either a linear or log-linear model. In overall the study findings reflected that flexible functional forms produce better goodness fit and more accurate estimates.

Jee (1989), carried out a comparative analysis of alternative pure premium models in the automobile risk classification system. The alternative pure premium models were compared in terms of their predictive accuracy and adequacy of underlying distributional assumptions. These models include Box and Cox heteroskedastic model and the Bayes estimation models.

Furthermore, Noriszura & Abdul (2005), demonstrated the Generalized Poisson Regression models as an alternative to risk classifcation. It showed that Generalized Poisson distribution is superior to Poisson distribution. Thus contributing to a more accurate claim frequency rates.

2.3 Conceptual framework

The conceptual framework for this study could be illustrated as shown below;

Figure 2 Conceptual framework

2.4 Research gaps

Insurers in Kenya have the necessary rating factor data required to estimate pure premiums. Despite having this data, they are unable to incorporate it on the pure premium pricing mainly because they lack knowledge on the use of rating factors as they have never been applying minimum rates.

The study emphasizes on the use of the simple approach to estimate the pure premiums charged to a policyholder incorporating the various rating factors. This is because most insurers in Kenya have less knowledge on the use of rating factors and therefore applying a complicated model to estimate pure premiums may not be understood by the salesforce and clients. The use of a simple approach can be easily communicated and understood by the insurers.

In addition, most of the pure premium models are time consuming and expensive to monitor.

3 RESEARCH METHODOLOGY

3.0 Introduction

This chapter provides an outline of the data and methodology used in the study. It explains the research design, target population, sample design and sampling technique, data collection and data analysis.

3.1 Research Design

The study is descriptive and quantitave in nature as it tends to assess the various rating factors to be used in premium pricing as well as computing a simplified model for premium pricing which uses numeric claims data.

3.2 Target population and Sample Technique

The target population for this study are the existing insurers in Kenya. There are about 37 general insurance companies out of which 35 companies underwrite motor private insurance. Sample selection is based on non-probabilistic sampling method because strongly established company is required to be selected as a good representative of a motor private insurance provider in the industry.

3.3 Data collection

The data collection will be cross-sectional in nature. This is because the study involves claims data collection over a period of time i.e. from 2009 to 2015. Past claims data will be collected from a local Kenyan insurance company. About 65, 003 policies have been obtained from the company as sample data corresponding to the industry. The total sum assured and the total premium collected from this data are KES 32,489,574,214 and KES 1,435,208,226.

For each policy, the following information will be required;

Inputs	**Description of the inputs**
Motor Vehicle Registration Number	Claim Verification purposes
Policy Number	
Age	Policyholder related Rating factors

Inputs	Description of the inputs
Profession	Policyholder related Rating factor
Value of the vehicle	Vehicle related Rating factors
Make of the vehicle	
Type of body	
Engine Rating	
Color	
Year of manufacture	
Seating capacity	
Type of cover	Policy related Rating factors
Other benefits paid out such as windscreen	
Claims paid out, (Yes/No)	Claims Data
Claim Number	
Claim Amounts paid	
Premiums charged	Collected for analysis purposes
Sum assured	

Table 2 Description of Inputs

3.4 Data Analysis

A motor rating factor model is a simplified model that enables a company to calculate the premium to be charged on a particular vehicle depending on the various motor rating factors. Each of these rating factors contribute to the pure risk premium charged to the policyholders.

Each rating factors could be split into the type of motor covers. For example, a rating factor such as make of vehicle will have the available makes for each type of motor cover. This would make it easier when performing analysis. Analysis on each rating factor could be divided into two; Frequency of claims and severity of claim amounts.

3.4.1 Frequency of claims

For analyzing the claims frequency, we need to have the total number of policies, the total number of policies claimed and total premium paid out.

The frequency or incidence of claims can be computed using the formula below;

$$Frequency\ or\ Incidence = \frac{Number\ of\ policies\ claimed\ in\ a\ risk\ class}{Total\ number\ of\ policies\ exposed\ per\ risk\ class} \quad (6)$$

For instance, assuming a particular company provided motor cover to 1000 Toyotas, out of which only 100 Toyota policies had been claimed during some time interval. The frequency of Toyota claims could be represented as;

$$Frequency\ or\ Incidence = \frac{100}{1000} = 10\%$$

3.4.2 Severity of claim amounts

Severity represents the average claim amount paid out.

$$Severity = \frac{Total\ claim\ amount\ for\ a\ risk\ class}{Total\ number\ of\ claims\ per\ risk\ class} \quad (7)$$

For instance, assuming a particular insurance company received 10,000 Toyota claims within some time interval for which the total claim amount summed to 80,000,000. Thus, on average, the severity cost of claims per policy could be represented as;

$$Severity = \frac{80{,}000{,}000}{10000} = 8{,}000$$

3.4.3 Pure Premium

Pure premium is the summation of the product of frequency and severity.

$$\sqrt{\sum_{i=1}^{n} (Frequency_i * Severity_i)^2} \quad (8)$$

Where i represent the various risk classes.

3.4.4 Total Premium Main Cover

The pure premium is then adjusted to loadings such as expenses, commissions, profits plus any additional benefits an insurance company offers;

$$\begin{aligned} &\textit{Total Premium main cover } (P) \\ &\quad = [\,\textit{Pure premium} + (P * \textit{expense loading rate}) \\ &\quad + (P * \textit{commission loading rate})] + (P * \textit{profit loading rate}) \end{aligned} \tag{9}$$

$$\textit{Total Premium main cover } (P) = {}^{\textit{Pure premium}}/_{1 - \textit{expense loading rate} - \textit{comission load rate} - \textit{profit load rate}} \tag{10}$$

3.4.5 Total Premium Payable

The total premium payable is adjusted to include the optional benefits provided by insurance companies.

$$\begin{aligned} &\textit{Total Premium Payable} \\ &\quad = \textit{Total premium main cover} + \textit{optional benefits} \end{aligned} \tag{11}$$

4 RESULTS AND ANALYSIS

4.0 Introduction

This chapter provides an outline of the preliminary analysis, model rating factors, assumptions used, model description, analysis of the findings on each rating factor used, comparing the results with the current existing model and a sensitivity analysis.

4.1 Preliminary Analysis

The data was collected from a local general insurance company in Kenya from the year 2006 to 2015. The data received included the policy number, client names, effective dates, underwriting year, sum assured, premiums charged per policy, type of cover, registration number, make, body type, engine number, chassis number, engine rating (CC), color, year of manufacture, carry capacity, claims paid and claim date.

Data on client name, ID number, KRA pin, registration number, chassis number and engine number have been used for claims verification process.

For this analysis, the rating factors related to the vehicle used include Year of manufacture, CC, Body, Make, Color, Carry Capacity and Value. Rating factors related to the policyholder include age and profession. Rating factors related to the policy include type of cover.

The above rating factors have been used for the analysis due to the fact that there is data on it and it is sufficient for performing an analysis.

The overall statistics for the data collected can be shown below:

Overview statistics from 2005-2016	
Cars Insured	**65,003**
Sums Assured (Sum Values of the cars)	**32,489,574,214**
Premiums	**1,435,208,226**
Average Rating	**4.42%**

Table 3 Overall Statistics from 2005-2016

The percentage captured for each column by the data can be summarized in the table below;

Data Requested	Total Entries	Non Blank	Blank	Percentage Captured
POLICY	65,003	65,002	1	100.00%
CLIENT	65,003	65,003	-	100.00%
UW YEAR	65,003	65,003	-	100.00%
SUM INSURED	65,003	64,992	11	99.98%
PREMIUM	65,003	65,003	-	100.00%
TYPE OF COVER	65,003	65,003	-	100.00%
REGISTRATION	65,003	64,970	33	99.95%
MAKE	65,003	64,691	312	99.52%
BODY TYPE	65,003	65,003	-	100.00%
ENGINE NO.	65,003	3,737	61,266	**5.75%**
CHASIS NO.	65,003	3,901	61,102	**6.00%**
CC	65,003	48,154	16,849	74.08%
COLOR	65,003	1,884	63,119	**2.90%**
YOM	65,003	47,844	17,159	73.60%
CARRY CAPACITY	65,003	52,505	12,498	80.77%
VALUE	65,003	61,886	3,117	95.20%
CLAIMNO	65,003	4,175	60,828	**6.42%**
CLAIMDATE	65,003	4,175	60,828	**6.42%**
PAID	65,003	4,175	60,828	**6.42%**
TOTAL	**1,625,075**	**1,138,363**	**486,712**	**70.05%**

Table 4 Data Percentage Captured

From the summary it can be noted on average about 70% of the columns are not blank. This justifies the use of the data for this analysis. Columns such as engine number, chassis number, claim number, date and paid capture 6.42% which is relatively low. However these information is required for claim verification and not used for computing premium amounts. Color captures only 2.9% but is used as a rating factor in the analysis because literature review indicates a high correlation between the claims experience and the color of the vehicle. However the results for the color will be biased and so not highly reliable.

However for the analysis, data used was from 2009- 2015 because only 2,010 policies were recorded from 5 years (that is 2005 to 2008 and 2016) which on average represents

a very small number (402) of policies per year and therefore analysis on this would not be reliable and hence has been ignored for this analysis.

Overview statistics from 2009-2015	
Cars Insured	**62,993**
Sums Assured	**30,137,489,113**
Premiums	**1,355,080,995**
Average Rating	**4.50%**

Table 5 Overview Statistics from 2009- 2015

4.2 Model Rating factors

The rating factors used for this analysis include age, year of manufacture, engine rating, body, make color carry capacity value all of which are split by type of cover. The type of covers include Third party act only, third party fire and theft , comprehensive cover and standard cover.

However the data received as shown below only had 1 standard cover policy which is insignificant and therefore has been excluded in the model.

TYPE OF COVER	Number of policies
Comprehensive	38,312
Standard Cover	1
Third Party Act Only	21,714
Third Party Fire And Theft	65
Total Exposure	**60,092**

Table 6 Number of policies per type of cover

4.3 Assumptions

Expense premium

Expense premium rate assumed for this study is 15%. Previous study estimate the expense to lie between 5-20% and is very subjective to the company. This model therefore assumes a few scenarios for expense premium rate (such as 5%, 10%, 15% and 20%).

Commission

Commission rate assumed for this study is 20%. Commission rates also vary from company to company. This model therefore assumes a few scenarios for the commission rates such as 5%, 10%, 15% or 20%.

Profit loading

Profit loading rate is assumed to be 5%. Profit loading rates also vary from one company to another. This could range from as low as 0% to as high as 10%. The 0% profit loading applies to insurance companies who intend to attract more business by offering lower premiums, while 10% is mostly applied to unique products with no substitutes in the market. However, higher profit loading reflects high premiums, high profits but may affect marketability of the product negatively.

Age distribution and factor

Based on literature review, the age factor is normally U-shaped. But due to insufficient data, this was not possible fir this model. Therefore a factor of 1 for each age has been used. Although this is not a good representation of reality, therefore would recommend a further study that could justify factors based on research on policyholders' age and accident rate in Kenya

Profession

This assumption is also very subjective. Therefore for this study a factor of 1 is assigned to all professions. However, a further study needs to be done about analyzing the relation between profession and accident rate in Kenya.

Windscreen replacement

The maximum amount for windscreen is assumed to be approximately KES 20,000 with an incidence rate of 2%. Therefore the risk premium due to windscreen replacement is approximately KES 400.

4.4 Model Description

The model is deterministic in nature in that it includes fixed inputs and when run, it results to a single premium value. The model is dynamic in the sense that the raw data worksheet could be altered or replaced by individual company's claim experience. This means that different companies could use this model by incorporating their company experience and adjusting assumptions based on their perceptions or past experience.

The total pure premium payable that incorporates the various motor rating factors can be computed as shown below;

$$\sqrt{\sum_{i=1}^{n}(Frequency_i * Severity_i)^2} \quad (8)$$

Where i represents the different rating factors, such as Year of manufacture (YOM), Engine rating (CC), Body, Make, Color, Carry Capacity and the value of the vehicle.

The table below summarizes the pure premium value using the data and the above formula;

TYPE OF COVER	COMPREHENSIVE

RATING FACTORS	DETAILS FORM MODEL		INCIDENCE RATE	AVGE CLAIM AMOUNT	RISK PREMIUM
YOM	YOM.COMPREHENSIVE	2006-2015	7.74%	153,274	11,870
CC	CC.COMPREHENSIVE	101-1100	4.19%	145,757	6,109
BODY	BODY.COMPREHENSIVE	SALOON	4.57%	159,812	7,304
MAKE	MAKE.COMPREHENSIVE	TOYOTA	6.50%	153,946	10,000
COLOR	COLOR.COMPREHENSIVE	BLACK	11.18%	236,758	26,480
CARRY CAPACITY	CARRY.COMPREHENSIVE	5	4.73%	161,179	7,617
VALUE	VALUE.COMPREHENSIVE	100,000-1,000,000	5.80%	194,804	11,295
			ARITHMETIC RISK PREMIUM		80,673
			GEOMETRIC RISK PREMIUM		34,904

Figure 3 Geometric Pure Premium

The above geometric risk premium is thereafter adjusted to incorporate the policyholder related factors (such as age, gender, profession), expense premium, commission premium and profit loading premium and other optional benefits (such as windscreen replacement, radio and entertainment).

The total premium payable can be computed using geometric risk premium as shown below;

Pure Risk Premium	34,904	
Age adjusted Risk Premium	34,904	
Expense Premium	7,222	
Commissions	4,814	
Profit Loading	1,204	
Total Premium Main Cover	48,144	
Optional Benefits		
Windscreen Replacement	Yes	400
Radio and Entertainment	Yes	750
Total Premium Optional Benefits		1,150
Total Premium Payable	49,294	

Figure 4 Model Output

4.5 Analysis of the findings

This section provides an analysis of the results obtained from the model using the various rating factors.

4.5.1 Year of manufacture

It was deduced from the model that the value of premium increased with the year of manufacture. This result was unexpected as the literature review showed that newer car models have increased safety record compared to the older car models. The converse could be true because newer car models have more expensive spare parts and thus the premiums will be expected to be higher.

4.5.2 Engine Rating (CC)

The results showed that the value of premium increased as the engine rating, (CC), increased up to 5100 CC and reduces thereafter. Literature review also showed that the

engine rating of a car is directly proportional to the speed and power output. Cars with very high engine ratings are likely to be expensive, have extra safety features and are likely to be purchased by owners who either have a driver or are experienced in driving, having owned another car. Therefore the premium is likely to increase in line with high engine rating.

The results showed a decrease in premium for cars with an engine rating beyond 5500 CC. This could be attributed to the fact that most of the insured cars in this data had a CC below 5100 CC as shown below:

Engine Rating (cc)	%Exposure
101-1100	2.72%
1101-2100	85.73%
2101-3100	9.81%
3101-4100	0.94%
4101-5100	**0.75%**
5101-6100	**0.02%**
6101-7100	**0.01%**
7101-8100	**0.02%**
9101-10100	**0.00%**

Table 7 Exposure of Engine Rating

The above justifies as to why the results reflected a very low incident rate for cars with CC greater than 5100.

4.5.3 Color

The results also deduced that darker colored cars such as black and maroon had higher premiums than light colored cars such as white. This result was expected as the literature review showed that vehicles with lower visibility colors tend to have a higher accident risk as compared to those with higher visibility colors. In addition, results showed that green colored cars are associated with low incidence rates. This could be attributed to the fact that the data was skewed which means there were very few green cars in the data received and therefore low premium rate.

4.5.4 Body of the car

Furthermore, it was deduced that vehicles with larger body are charged higher premiums than those with smaller bodies. This is because of the fact that large body vehicles tend to be more expensive and have more costly spares.

4.5.5 Carry capacity

For carry capacity, the results were evenly spread and therefore no conclusion can be based from this data. Further analysis need to be done to prove whether there is a correlation between the claims experience and carry capacity.

4.5.6 Make and model

The results showed that expensive makes (such as ford) have a higher premium compared to cheaper makes such as Toyota. This could be attributed to the fact that there were very few such makes which either had a high incidence rate or high severity amount. Furthermore, it was also deduced that makes such as KIA had a low premium. This was because the data comprised of few insured KIA cars with a low incidence rate. This result was expected because the literature review stated that the claims experience associated with a car brand that has significant volumes like Toyota is expected to be more stable and less volatile compared to a brand that has fewer cars. In addition, the repair costs associated with a car brand that has few volumes is also higher than a car brand that has larger volumes due to lack of readily available spare parts.

4.6 Scenario Analysis

A premium rate for a particular car with a value of 1 million had been computed using the current existing model and the motor rating factor model. The current model assumes a minimum rate on the value of the car that is approximately 4.5%.

Assuming there are about 6 different scenarios which could be summarized in the following table;

	Value (in KES)	YOM	CC	Make	Body	Color	Premium (rating factor model)	Premium (current model)
1	1M	2006	1500	Toyota	Station Wagon	Black	50,149	45,000
2	1M	1995	3000	Toyota	Saloon	Black	46,484	45,000
3	1M	2001	3000	Toyota	Saloon	White	34,992	45,000
4	1M	2006	1500	Ford	Saloon	Black	76,188	45,000
5	1M	2005	5100	Toyota	Saloon	White	32,946	45,000
6	1M	2006	1500	Toyota	Saloon	White	37,228	45,000

Table 8 Scenario Analysis

From the results above, it could be noted that the rating factor model leads to different premium rates for different combinations of rating factors for a car whose value is 1 million. The existing model would charge a constant premium of 45,000 for all the above scenarios. This means that some policyholders have been overpriced (for instance scenario 3,5,6) and others have been underpriced (for instance scenario 1,2,4). This is consistent with any pricing model that charges an average rate. Therefore, the rating factor model provides a better estimate for premium rates.

4.7 Sensitivity of analysis

Spread of the premium effect on each rating factor had been computed and ranked so as to find out the most relevant rating factor for insurers that could be contributing to the losses. Based on the results, it was noted that color had an abnormal premium effect. This was because the data was skewed in that it included one maroon car that had claimed an amount approximately KES 453,000. Because of this entry the spread of premium effect of color was highly skewed and unreliable. The spread of the premium

effect was the highest for value followed by body type, make, carry capacity, year of manufacture and engine rating

The results are illustrated below:

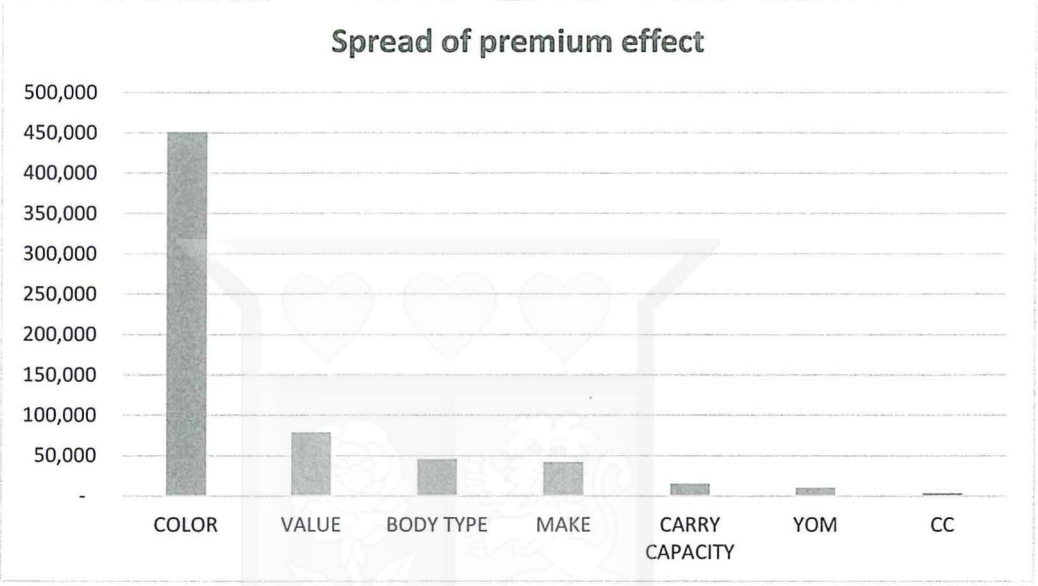


Figure 5 Spread of Premium

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5 DISCUSSIONS

5.0 Introduction

This chapter provides conclusions, limitations and recommendations for this study.

5.1 Conclusions

In overall, the model findings reflected different premiums for different rating factors which therefore showed a correlation between the claims experience and the motor rating factors. The findings reflected an increase in premium rate in line with an increase year of manufacture, engine rating and dark colored cars.

Based on the spread of the premium effect in the various sub-categories, color had the maximum effect followed by value of the car, body type, make and model, carrying capacity, year of manufacture and lastly engine rating which had the least impact on premiums. On the above basis, the most relevant rating factors were value of the car, body type, make and model, year of manufacture and engine rating.

The geometric risk premium model provides a simple and practical method to compute the risk premium using rating factors as the square root of sum of squares provides some diversification benefit between the rating factors.

5.2 Limitations

Developing an initial motor rating factor model could be very time consuming.

It requires regular updates and modifications to the model due to changes in policies for which expertise are required.

In order to conduct an effective analysis, a lot of data may be required which is difficult to obtain due to confidentiality and limited publicly available information.

Past data may not be in the format required. Therefore cleaning of the data may be required which could be very challenging.

The assumptions made on age and profession factors were difficult to obtain because of privacy issues, limited data and information.

The motor private vehicle rating model demonstrated how rating factors can be incorporated in the calculation of premiums. However it fell short because some values used, could not be obtained or estimated precisely.

5.3 Recommendations

The analysis assumes independence among the rating factors. However to minimize the correlation between different rating factors the model uses square root of sum of squares approach. This may not be the case in reality and therefore a further study could be done to identify the exact correlation between the various rating factors.

The analysis assumes that all professions are likely to have similar claims experience and therefore a factor of 1 has been used all through. This is because of lack of data on the profession of the policyholder. But this is usually not the case in reality because some occupations are much riskier and tend to have higher frequency or severity of claims than others for example a car rally driver. Therefore, further analysis on different profession and the effect on claims experience could be studied.

A further recommendation is an analysis on how age affects the level of accidents in Kenya. This further research will make the model more realistic and accurate compared as it currently assumes that both old and young are equally likely to claim.

For rating factors such as color of the vehicle, which had limited data (2.9%) could be re-analyzed using different reliable and sufficient data so as to confirm the impact of color on claims experience.

Further studies should seek to determine precise values for the assumptions that will be suitable for various insurance companies.

The effect of other rating factors such as marital status, age of license, convictions, geographical location, alarm/immobilizer, modifications, use of vehicle and excess on motor premium pricing could be studied.

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