KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

Estimating the Risk Premium of Motor Insurance in Ghana using the Empirical Bayesian Credibility Theory Model

By

Philip Nii Anang Laryea

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Declaration

I hereby declare that this submission is my own work towards the award of the MSc degree and that, to the best of my knowledge, it contains no material previously published by another person nor material which had been accepted for the award of any other degree of the university, except where due acknowledgment had been made in the text.

Philip Nii Anang Laryea (PG8734512) ....

Student **Signature** **Date**

Certified by:

Nana Kena Frempong ....

Supervisor **Signature** **Date**

Certified by:

Prof. S. K Amponsah ....

Head of Department **Signature** **Date**

Dedication

This work is dedicated to the Almighty God for his continuous protection, to my wife Marian Naa Asheley Laryea for all the support and encouragement, to my parents and to my supervisor Nana Kena Frempong for his patience and time.

Abstract

This research explores the use of actuarial principles in estimating motor insurance premium for non-life insurance companies in Ghana. Unlike other countries where the business of motor insurance has developed to the level where insurance companies determine motor premiums using parameters such as the risk associated with the make of the car, the distance driven within the insured period and the risk of an accident associated with the locations used by the insured, motor insurance premiums in Ghana are determined by the regulator using a tariff guide. The tariff guide used by the insurance companies in Ghana is not robust and fails to consider the various risks associated with the motor insurance portfolio of the various insurance companies. The Empirical Bayesian Credibility Theory model, a non-parametric approach and the Bayesian Credibility which assumes a parametric distribution of the data were used on reported motor insurance claim amounts for 18 insurance companies in Ghana to estimate the pure premium for motor insurance. The consideration of the parametric and non-parametric credibility models in estimating the risk premium of motor insurance is to establish how reliable actuarial tools can be in determining the risk premium of motor insurance in Ghana. Using the Kolmogorov-Smirnov test at 5% level of significance, the distribution of reported motor insurance claim was consistent with a normal distribution. The outcome of the test of a normal prior distribution resulted in the posterior distribution also being a normal distribution and this led to the use of the Bayesian Credibility model to estimate the risk premium for motor insurance. The estimated risk premiums using the EBCT and the Bayesian Credibility Theory model were compared and the outcome of the two set of estimates were tested using t-test and Wilcoxon signed-rank test at 5% level of significance and it was established that both estimates have the same mean and follow the same

distributions.

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Chapter 1

Background of the study

The insurance industry globally has witnessed significant transformation over the years in the area of product development and the number of policy holders buying one or serveral insurance products. This may be attributed to the impressive returns recorded by the insurance business and the continuous public sensitization on the need to share risk through the purchase of an insurance product. Borscheid *et al*., (2012) suggested that entrepreneurs were recognized for bringing modern insurance business to the international market in the eighteenth century.The insurance business in Ghana has expanded tremendously attracting international players like Old Mutual and Prudential Plc to invest in the sector.The competitive environment created as a result of the expansion in the insurance industry has led to the insurance companies developing more exciting insurance products all in the bid to grow their market share. Established under the Insurance Law 1986 (PNDC Law 227) and now operating under the Insurance Act, 2006 (Act 724), the National Insurance Commission essentially ensures effective administration, supervision, regulation and control of the insurance business in Ghana (NIC,2014). According to the National Insurance Commission, insurance products can be classified under fire, burglary and property damage, accident, marine and aviation, motor and general liability for the non-life business and universal life, funeral, whole life, endowment, term and group life for life business.

Despite the overall 8.9 percent growth of the service sector's contribution to Ghana's GDP (GSS,2014), the market penetration of insurance products has not been as rapid as that of the banks and telecommunication sectors. However, through the various partnerships with banks and telecommunication companies,

the insurance companies in Ghana are using the marketing channels of the banks and the telecommunication companies to reach a wider market.The bancassurance products sold by Ecobank Ghana Limited and Tigo's micro insurance campaign are examples of these partnerships with insurance companies to reach a wider market.

The steady growth in the insurance business for non-life products can be linked to growth in the number of new vehicle owners signing on for motor insurance. The increase in the number of policy holders means increase in premiums received as well as the risk associated with the motor insurance portfolio portfolio. There is therefore the need for insurance companies selling motor insurance products to employ actuarial tools which consider the impact of the risk factors associated with the policy in the pricing structure of motor insurance premiums. This will reduce the premiums paid by policy holders who are identified to have lower risk of making claims as well as avert a portfolio ruin from policyholders with a high risk of making a claim. In Ghana, pure premiums for motor insurance are computed using tariff guide provided by Ghana Insurers Association (GIA) in consultation with the National Insurance Commission and other stakeholders. These rates are adjusted for expenses, discounts and margins which are regulated and monitored by the National Insurance Commission.

According to the National Insurance Commission, insurance companies in Ghana were owed a little over GHC130 million in premium debt as at the end of December 2012. This amount is 0.35% less than what was recorded in 2011. This was largely due to insurance companies selling insurance products on credit basis and also the practice of insurance companies agreeing to spread the annual premiums over a period to entice customers further contributed to the problem of debt owed the insurance industry (NIC, 2014). Some attribute the default rate of premium accross the insurance sector to the lack of appreciation of the

dynamics of insurance business by some section of the public and the law compelling vehicle owners to have a minimum of a third party insurance makes people exploit every opportunity available not to pay for their insurance premium. To arrest this disturbing trend, the National Insurance Commission on April 2014 implemented the ”No premium, no cover” policy. This policy compels the insurance companies to collect premiums before providing insurance cover.The No premium no cover policy will go a long way to improve the liquidity of most of the insurance companies who hitherto are faulted for delaying claim payments. To compound this major challenge of liquidity risk faced by the insurance companies due to delayed and sometimes default premium payment, the claims paid by insurance companies increase from year to year with 35.8% increase from previous year to GHC99.8 million at the end of 2012 (NIC, 2014).

1.1 Statement of the Problem

Premiums remain the single most important income source for insurance companies in Ghana. Motor insurance forms a significant portion of the non-life insurance business in many countries. In Europe, motor insurance premium accounted for nearly 30.3% of the total non-life premium income with an estimated figure of EUR126.5 billion in 2008 (CEA, 2010). Same can be said about Ghana as records available to the National Insurance Commission estimated a total of GHS123.91 million representing 45.62% of total non-life premium were collected in 2010 (NIC, 2011).

The current premium computation for motor insurance in Ghana is done using rate tables provided by the National Insurance Commission. These rates in the tariff guide serve the sole purpose of standardization of motor insurance premium computation in the industry with minimal consideration for the risks

associated with the policy holders in the Insurance Company's motor insurance portfolio or the size of claims paid by the insurance companies. Despite the advantage of providing a level playing field which is aimed at helping the smaller insurance companies to remain competitive, the tariff guide is not consistent with any known actuarial pricing structure which may be more robust. The tariff guide does not guarantee flexibility which allows the premium pricing structure to consider key parameters such as the past claim patterns within the insurance company and the industry as a whole when determining the motor insurance premium. The advantage of using information relating to past claim patterns within the insurance company and the industry is premium computed will reflect the associated risk faced by the insurance company and this means the insurance companies will be adequately resourced to pay claims as and when they come up and individual policy holders pay for the risk they add to the motor insurance portfolio.

Many statistical models have been developed over the years to aid in the computation of the appropriate price for the risk that the insurance companies agree to take for selling motor insurance policy. The ruin theories, loss models and credibility theory are examples of the many tools used in determining the price of many of the non-life insurance products. Campbell (1986), established an integrated system for estimating the risk premium of individual car models. This approach infused into the computation the risks associated with the car models as well. The strength of this approach is the use of experience rating where premiums charged in the future are linked to the past claims made by the customer (Robinson *et al.*, 2010). This research will concentrate on the use of an actuarial tool in calculating the motor insurance premium in Ghana using the overall variability in insurance claims as well as past claims in estimating pure premiums.

1.2 Objectives of the study

The main Objectives are:

1. Determine the motor insurance credibility premium using Empirical Bayesian Credibility model and the Bayesian Credibility approach for non-life insurance companies in Ghana.

2. Determine the Credibility factor to estimate the motor insurance premium in Ghana.

3. Compare the parametric and non-parametric credibility premiums estimations for motor insurance in Ghana.

1.3 Methodology

The data for this research will be claim amounts by motor insurance policy holders reported by the insurance companies to the NIC from January 2012 to December 2014. Monthly inflationary figures reported by the Ghana Statistical Services for January 2012 to December 2014 will be studied to appreciate any major variations in the data collected. The overall economic outlook of Ghana as presented by Bank of Ghana will also be studied to appreciate the economic impact on the reported motor insurance claim.

The Empirical Bayesian credibility Theory and the Bayesian Credibility Theory were the models used to establish the credibility premium for the sampled insurance companies for their motor insurance pricing. A parametric approach to credibility analysis assuming the claim amounts follow a normal distribution will

also be used to compute the pure premium for motor insurance in Ghana. This alternate approach is to validate the outcomes of the estimates of the motor insurance claims using the non-parametric approach in pure premium estimation.

Descriptive statistics will also be used to analyze the samples data of motor insurance claims. The estimates obtained from the parametric and non-parametric approaches were tested using t test and Wilcoxon sign-rank test to confirm if theirs means are the same and also follow the same distribution.

1.4 Justification

This studies will open up the discussion on the use of actuarial tools in computing motor insurance premium is Ghana.This research may also serve as a reference point for decision making in motor insurance pure premium estimation. This research used a simple model in pricing non-life insurance product and hence it will be a useful tool for individuals with fair knowledge in statistics and actuarial science to compare premiums across insurance companies and make an informed decision when shopping for motor insurance products. The strength of this credibility approach makes it a useful tool for insurance companies in Ghana to consider since most of the pricing of their insurance products are outsourced to consultants. The use of this empirical method of pricing motor insurance will make the non-life business much more competitive and lead to overall industry growth.

1.5 Limitation

Data obtained from the NIC for motor insurance claim reported by the various insurance companies do not have the number of claims corresponding to the claim amounts. To address this the researcher used both parametric and non-parametric credibility models to estimate the motor insurance premium. There were missing data for a few of the insurance companies mainly due to late reporting and number of years in operation. This however will not have any significant impact on the outcome of the analyses since the reported claim data from 18 out of the

26 non-life insurance companies operating in Ghana used were assumed to be representative of the industry. Time constraint and the weak record keeping system at some of the institutions means information used in the analyses may be compromised and therefore a several assumptions had to be made to arrive at a conclusion.

1.6 Organization of Thesis

This research is organized into five main chapters. Chapter one provides the background and the overall direction of the research. The chapter two concentrates on the literature review. The methodology and the assumptions for the research are discussed in chapter three. The chapter four discusses the analysis and research findings with conclusions and recommendation under chapter five.

Chapter 2

Literature Review

2.1 Introduction

This section discusses the approaches employed by various researches in estimating the prices of motor insurance. A review of the models suggested by other researchers, their advantages and limitations are discussed in this section with the aim of widening the scope of knowledge in motor insurance premium estima-

tion.

2.2 Compulsory Motor Insurance

Compulsory motor insurance requires all those operating a motor vehicle purchase insurance to ensure or guarantee some compensation to those injured in an automobile accident. In the United States, compulsory insurance was introduced in Massachusetts in 1927 known then as Compulsory Automobile Liability Insurance Law (Cohon *et al*., 2004). The Road Traffic Act 1930 was enacted to commence compulsory insurance in the United Kingdom. Compulsory motor insurance observed in many countries is backed by some legislature with a minimum of third party insurance. This is known as Third Party Personal Injury Insurance (EU, 2015).

Faure (2006), argued that compulsory insurance may make the government to dependent on the insurance market and also create more problems than cure if

insurance is not sufficiently available. However Lawrence (2001), held a contrary view about the important role government can play in the implementation of compulsory insurance to achieve the objective of benefiting society as a whole.
He suggested that compulsory third party insurance needed the appropriate supervision from government to generate the needed economic growth in the motor insurance market. This growth may come as a result of increased in the total premium the insurance companies receive but may also increase the overall claim that is made on the insurance companies. According to Lawrence (2001), there is the need however to inject some liberalization in stages in order to match the increase competition and realize the opportunities that liberalization will bring.

Hoffer *et al*., (1991), suggested alternate system to financing uninsured motorist coverage to address the risk associated with the use of vehicle in public space. They proposed in their research that, premium for uninsured motorist coverage are collected by small universal motor fuel surcharge and thus premium distributed to insurers on the basis of the number of vehicles that they insure within that jurisdiction. Despite the advantage of lower cost for the average motorist using this approach over the various other mechanism of financing uninsured motorists, Hoffer *et al*., (1991) made a lot of assumptions about the fuel consumption pattern of vehicles, the driving skills and experience of the driver as well as the risks associated with the road the driver mostly used. These however are very critical parameters that determine the possibility of the risk of claim of ever occurring and ignoring them in pricing motor insurance premium eliminates the actuarial accuracy of the estimation.

The overall profitability and health of the motor insurance portfolio for the insurance companies taking the risk of third party liability motor insurance was discussed by Lili *et al*., (2014). Despite the relief compulsory motor insurance

brings to affected parties in the event of the risk insured occurring, the need to make the risk portfolio profitable to the insurance company is equally important. Lili *et al*., (2014) using comparative analysis and the China economy analyzed the third party liability compulsory insurance of motor vehicle practicality and suggested that the model used need improvement. This size of the economy studied by Lili *et al*., (2014) requires extremely large data size which comes with the downside of extremities in data points.

Keneley *et al*., (2007) analyzed the Australian insurance market a relatively smaller market compared to the China's market but suggested self-regulation implemented over the period as direct and specific regulations are introduced gradually as new entrants and products in the insurance business are developed. This self-adjusting scenario can be attributed to the market forces as well as some regulatory interventions. This mixture of liberation and regulation suggested by Keneley *et al*., (2007) must be closely monitored as insurance companies with large portfolio and have stayed in the industry longer may price out the younger and smaller insurance companies. Miller (2001), beleive the self-adjusting regime must be after the untested experiment in regulatory negotiation regime in the motor insurance market. Developing economies with relatively small market share of insurance business experiment the relaxation of regulation to somehow encourage the growth of the insurance industry but the may also lead to overall collapse of the industry as some unconventional methods may have its own risks.

Unlike the compulsory third party insurance, the tort system requires the insurer indemnifies the claim only if it is proven the insured was at fault in the accident or the third party sues the insured and provides evidence that he or she was at fault in the accident.

2.3 Distance-Based Vehicle Insurance

Premium paid on vehicles for the year are usually fixed amounts. However distance-based insurance introduces variability in premium computation. Thus one can save on premium payment by driving under the distance-based vehicle insurance (Litman, 2011).

Litman (2011), stated that annual claims have positive correlation with annual vehicle mileage even though he conceded that mileage is just one of the several factors that affect crash rates. The actuarial accuracy of the premium is improved when mileage is incorporated in addition to existing rate factor. Litman (2011) , therefore suggested that any other price structure without mileage factored in will over charge low mileage motorist and undercharge high mileage motorist. Zantema *et al*., (2009) also described distanced based pricing as Pay-as-you-drive (PAYD). The Pay-as-you-drive is a policy concept where drivers pay at least part of their insurance premium per actual kilometers driven. They suggested that PAYD can further be differentiated to reward safe driving behavior with lower premium by either avoiding driving during nighttime, not exceeding the speed limit or driving on safe roads (Zantema, 2009). This system of premium computation requires some level of technological advancement to detect fraud or tempering of measuring units which may come as additional cost to the insurance company. However Litman (2011), explained that a reduction in total vehicle mileage leads to low premium, a proportionally greater reduction in total claim from reduced crash cost is enjoyed by the insurance company. The various pricing alternatives under distance based pricing their strengths in the area of actuarial accuracy, equity, affordability, road safety, consumer savings and choice were discussed by Litman (2011).

2.3.1 Mileage Rate factor

This system incorporates an annual mileage rate factor into existing rate system. It is the easiest option to implement, but is constrained by the weight that can be placed on the self-reported mileage estimate. Incorporating the vehicle mileage as a rate factor allows premium to better reflect insurance cost but this system of the insured predicting their mileage is inherently inaccurate since no one can predict their future travel with certainty. Social dynamics such as change in jobs, health or lifestyle can make such prediction very inaccurate.

Advantage

- This method involves lower implementation cost

Disadvantage

- Depends on self-reporting data from the insured which may not be accurate
- Pricing is based on mileage unit range and not marginal mileage thereby over charging those who may fall in the lower region of the range
- Reward motorists for dishonesty since they may underestimate mileage when reporting mileage for premium computation.

2.3.2 Pay-at-the-Pump

This system of distance based pricing (Litman, 2011) uses surcharges as fuel sales to fund basic insurance. The universal coverage of this system makes payat-the-pump an attractive option in regions with high rate of uninsured drivers. This

system has been promoted by many experts and interest groups due to the comprehensive nature and the strength it possess over the other approaches in conserving energy.

Advantage

- It is easy to implement the pay-at-the-pump.
- This system leads to energy conservation since the less fuel consumed the less premium paid.
- Eliminates uninsured driving the needed legislature is in place and enforced

.

Disadvantage

- Only a minor portion of total vehicle insurance becomes distance-based.
- Travel impacts and related benefits are modest.
- This system is not equitable in terms of pricing since lower risk drivers with fuel inefficient vehicles are overcharged.
- This system may increase significant leakage of fuel sales across borders and to illegal fuel purchase.

2.3.3 Per-Mile Premium

This system charges the unit of exposure from the vehicle year to the vehicle mile incorporating all existing rating factors. This system relies heavy on the odometer and hence careful audit of the odometer to provide accurate mileage data. This

system could be mandatory or a consumer option but requires advance technology to detect any tempering of the installed equipment to measure the mileage. It significantly improves actuarial accuracy and provides significant consumer savings particularly to the lower income households.

Advantages

- Premiums are accurate and reflect each vehicle's crash costs.

- Due to low implementation cost and large potential consumer savings, it can be said to be the idle system.

- Advantage of reduce premium for reduce drive improves road safety.

Disadvantages

- It requires the establishment of new structures and technology which comes as additional cost
- Large consumer base means more audit of the mileage which may delay the holding period for claim payments

2.3.4 GPS-Based Pricing

Under this system, insurance premium are based on when and where a vehicle has been driven. Higher premium are charged for driving under higher risk conditions with other rating factors considered. Global Positioning System (GPS) technology allows vehicles to be tracked along their travel routes and appropriate risk associated with the area of travel applied in the premium computation. There may be concerns with privacy of the drivers' movement and

some school of thought may reach the argument to security concerns with this system.

Advantages

- This system can provide accurate pricing
- Billing can be done monthly or bi- monthly under this system
- Provides incentives for people to reduce their driving time on the road

Disadvantage

- The cost of the technology needed to operate this system are high
- Privacy concerns with this system makes it less attractive to motoring public

Butler (1993), supported the pay-as-you-drive system by suggesting that insurance companies charge premium using a cent-per-kilometer where the car kilometer is adopted as an exposure unit instead of the other variables like year of the car. The distance is given a lot of weighting in measuring the risk associated with driving but this cannot be entirely accurate as other researchers have established strong relationship between other parameters such as the experience of the driver, gender and region of driving the car and the risk of a claim.

Jason *et al*., (2008) highlighted the strengths of the pay-as-you-drive auto insurance premium pricing mechanism. They supported the suggestions by other authors that the lump sum pricing of auto insurance is inefficient and inequitable and therefore proposed that if vehicle owners paid for the accidents insurance per mile rather than in a lump sum, driving would decline by 8 percent nationwide, generating the equivalent of $50 billion to $60 billion a year and

reduce carbon emission by 2 percent and oil consumption by about 4 percent. Jason *et al.*, (2008) recognized the barrier of pay-as-you-drive auto insurance pricing system but made some recommendation to address these problems. They suggested the enactment of appropriate laws permitting mileage-based insurance premium to be used by insurance companies. This will encourage the widespread adoption and thereby improving the revenue generated by the insurance companies through reduced claim numbers. The additional cost of using the appropriate technology to monitor miles travelled will be less than the overall benefits from the widespread adaptation of pay-as-you-drive pricing system.

Automobile insurance forms a greater percentage of overall expense on consumer vehicle expenditure. This financial burden on the household from vehicle insurance compels most of them to drive uninsured or forego vehicle ownership even when they can afford it. Litman (2011), explained that pay-as-you-drive system of pricing auto mobile insurance premium allows vehicle owners to take control of their vehicle insurance expenditure. This system of pricing also favours vehicle owners with extra vehicle for specific purpose.

2.4 Pricing Motor Insurance

Several researchers have proposed various approaches of accurately computing the premium insurance companies need to charge the insured in order to cover fully when the risk occurs. The actuarial accuracy of these various approaches depend on the available data as well as what assumptions are admissible.

Edward *et al*., (2008) used detailed micro level records which includes experience at the individual vehicle level, the type of insurance claim as well as corresponding claim amount and employed a hierarchical model for the three components. These components include the frequency of claim, the type of claim and the severity of the claims. To assess the claim frequency, Edward *et al*., (2008) used a negative binomial regression model. The model used owner's gender, age, no claim discount as well as vehicle age and type to predict the event of a claim. These variables showed a strong relationship to the possibility of a claim as suggested by other researchers as well. The next model used to predict the type of insurance claim that is whether third party injury, third party property damage, insured own damage or some combination is the multinomial logit model. This model also considered year, vehicle age and vehicle type as important predictors for this model. The third model which this research is about is the severity component. Edward *et al*., (2008) proposed the use of a generalized beta of the second kind of long-tailed distribution for claim amounts and also incorporate predictor variables. This model also found year and vehicle age and insurers age to be important predictors of this model. They found in their research a significant dependence among the different claim types and concluded that the three component models provide a more efficient prediction of automobile claims compared with the traditional methods. This however cannot be said for countries where data integrity cannot be confirmed. Despite the actuarial accuracy in computing motor insurance premium using this approach, a lot of the information needed is provided by the insured and some audit or double checking is required which means more time and cost.

A more detailed personal information approach was suggested by Vlad *et al*.,

(2006) in estimating motor insurance premium. They predicted that in the foreseeable future, miniature sensor and networking technology will allow insurers to offer personalized insurance rates based not only on demographic data, but an actual customer behavior. This analysis presented by Vlad *et al*., (2006) used behavior-based personalized rates measuring

tool in motor insurance computation thereby significantly lessen the traditional information asymmetry between insurers and insured thus benefiting both parties of the insurance contract and the society in general. This approach requires consumers to disclose their entire personal data set thereby making it unattractive despite the significant cost saving advantage that comes with it. The legal framework that is required to implement this method of estimating motor insurance premium must be review regular to address the ever changing nature of our society.

Other predictive model for determining the credibility premium was discussed by Jean-Philippe (2007). He suggested that future premiums depend on past claims and the number of insured period with at least one claim. This approach used quadratic loss and exponential loss to derive the predictive premium and offered another way of analyzing the hunger for bonus phenomenon. The strength of using the zero-inflated model in credibility premium analysis according to JeanPhilippe (2007), is the flexibility that comes with it.

Motor insurance claim involves bodily injury claim or/and material damage claim. Both bodily injury and material damage claim can be made at the same time however bodily injury claims are less frequent but involves larger compensation payout, greater variability in the payment and higher litigation rates. Bodily injury settlement therefore forms a greater portion of insurers' claim expenditure and also has a longer handling period (Bell, 2006). The financial compensation depending on the legal framework operating within that jurisdiction is fixed according to the severity of the injury. Therefore the delay usually may be due to the actual amount due to the underlying severity of bodily injury rather than the sum to be awarded.

The European Committee on Legal Affairs and Internal Market defined disability as the "definitive reduction of physical and/or mental potential which can be identified or explained medically, together with the pain and mental suffering known by the doctor to be a normal concomitant of the sequela plus the everyday

consequences which commonly and objectively accompany that sequela" where sequel is any negative after effect resulting from the accident (EC, 2003). The bodily injury suffered may be permanent disability or temporary disability and whichever classification that must be compensated for must be proved by the claimant and verified by the insurer which further extends the litigation and handling period.

Miguel *et al*., (2009) used zero-inflated generalized Poisson regression model to estimate the severity score for victims of motor vehicle accidents that the insurance company has to compensate. According to Miguel *et al* (2009), the zero-inflated generalization Poisson regression model allows a regression on the over dispersion and is useful for analyzing over dispersed count data with large amount of zeros making the model an appropriate one for analyzing bodily injury insurance data.

Ayuso *et al*., (2007) proposed alternative model for estimating the injury severity of victims involved in motor claims. The model categorized by the degrees of severity and estimated by means of a sequential ordered logit model at different stages in the claim history. This approach which is qualitative is usually employed by other audiences such as medical scientists and public health planners. Ayuso *et al*., (2007) suggested that most insurance companies reserve automobile bodily injury compensation directly from initial medical report which underestimates the final cost since severity is often assessed during the recovery period. The suggested model considered different moments that estimation of bodily injury are made by the insurers. These include moment after the claim is reported to the insurance company, moment after the first internal medical report and moment after the final internal medical report. These different information levels of the claim are incorporated in an ordered multiple model at the different moments in the life of the claim reported to an insurance company.

The application of sequential ordered logit model leads to a significant improvement in the prediction of the bodily injury severity level and as a consequence an adequate estimation of the insurer's reserves may be derived (Ayuso *et al*., 2007).

Major challenge most insurance companies have to deal with in their daily operation is how to reduce if not eliminate illegitimate claims as well as exaggerated loss amount. Despite the laws that are supposed to make this fraud unattractive, some attempt is always made by the insured to defraud the insurance company either through claim fraud or claim build up. Sithic *et al*., (2013) define financial fraud as the deliberate act that is contrary to law, rule or policy with intention to obtain unauthorized financial benefit and intentional misstatements or omission of amounts by deceiving users of financial statements, especially investors and creditors. Sharon *et al*., (2002) using data from personal injury protection claim settled in the state of Massachusetts, statistical analysis and theoretical literature suggested an empirical strategy for the detection of fraudulent claims. Auditing as a deterrent mechanism is what Sharon *et al*., (2002) proposed and success of this approach is typically measured by the reduction in the payment amount on audited claims or the number of fraudulent or build up claims detected. Their research suggested several methods in auditing which include a site investigation, recorded or sworn statement from the claimants, the insured and/or a witness to the accident, referral to a special investigation unit and an activity check. The site investigation involves a claim adjuster visiting the scene of the accident by a specially trained anti-fraud unit of the insurance company but this clearly involves cost which in some instance may not be prudent considering the amount of claim. The approach suggested by Sharon *et al*., (2002) means some discretionary skill is required to determine which claim amount must be audited and in this instance the size of the claim amount is the most likely option. Irrespective of the amount, fraud whichever

form may be or amount can lead to increase in premium size which may make the idea of insurance unattractive.

The increasing fraud in the insurance market in Italy as reveled various studies and discussed by Stefano *et al*., (2001) has compelled insurance companies to embed real fraud units into their activities in order to identify suspicious cases and fraudulent patterns either in the insuring phase or in the settlement of claims. Stefano *et al*., (2001) in their work stated that Insurance Companies face three opposing problem when it comes to insurance fraud. These include the high cost of expert activity, request for fast settlements and the requirement to cover anyone who asks for a policy. They suggested that insurance companies need to put in place standard, automatic and fast control systems to filter real suspicious cases to fraud experts giving room to pay the majority of claim settlement. The size of the claim amount plays a key role in determining which case must be referred to the fraud experts. This approach is certainly recognizing the fact that delay payments have its negative impact on the insurance industry and despite the attempts to check fraud prompt payments of claims most still be one of the core goals of the insurance companies. Stefano *et al*., (2001) proposed the use of the fuzzy logic control model to efficiently evaluate an index of suspects on each claim in order to stress fraudulent situations to be investigated by the experts.

Ming-hua's (2011) work on insurance fraud suggested that there are two main methods for insurance fraud identification namely statistical regression and neurological network. Using motor claim sample statistics of the Chinese property insurance companies, Ming-hua created an effective integration of statistical regression and nuerological network by applying parameters retrieved from the Logit discrete model as the concise explanatory variable for toning the neurological network. The analysis concluded that there is the need to improve on the neurological network method of fraud identification.

The use of statistical distribution to estimate claim in the motor insurance has received attention from several researchers. The recommendation usually is informed by the data points as well as which assumptions are admissible in their analysis. One of such work is by Batsirai *et al*., (2013) where four distributions were used namely gamma, Pareto, exponential and lognormal to model the claims from motor portfolio in Zimbabwe. Using the classical and Bayesian method to estimate the parameters from the data and comparing the four models, Batsirai *et al*., (2013) established that the Pareto and lognormal distributions fitted the data properly with the lognormal distribution producing the best fit for the lower claims whiles the Pareto produced the best fit for huge claims. The recommendation is that both distributions be applied at the same time at those parts which they fit best. The practicality of using both methods as well as lack of consistency makes the recommendation by Batsirai *et al*., 2013 to employ both approaches in projecting claim amount not reliable.

Bermudez (2009), used generalized linear models to be specific the most widely accepted Poisson regression model to achieve a priori ratemaking in analysis automobile insurance claims. Insurance companies distinguish between claims with or without bodily injuries or claims with full or partial liability of the insured driver. According to Bermudez (2009), assuming independence between claim types, the premium can be obtained by summing the premiums for each type of guarantee and is dependent on the rating factor chosen but relaxing the independence assumption between the claim types, it is unclear as to how the tariff system might be affected. To address this, the research done by Bermudez (2009), introduced the bivariate Poisson regression models which is suitable for paired count data exhibiting correlation. Applying these models to an automobile insurance claims database containing 80,994 contracts belonging to a Spanish insurance company, the usual assumption of independence was established to be unrealistic.

Several research works on general insurance have suggested the traditional Poisson distribution for the claim frequency data. Karen *et al*., (2005) explained that extra dispersion appears as the number of observed zeros exceeds the number of expected zeros under the Poisson or even the negative binomial distribution assumptions. Their work presented several parametric zero-inflated count distributions to accommodate the excess zeros for insurance claim count data. To allow flexibility in order to control the distribution shape, different count distributions are considered. The generalized Pearson chi-square statistic, Akaike's information criteria and the Bayesian information criteria are used as goodnessof-fit and the model selection measures. Karen *et al*., (2005), concluded that with the presence of extra zeros in a data set of automobile insurance claims the application of zero-inflated count data models and in particular the zero-inflated double Poisson regression model provide a good fit to the data.

2.5 GIA Motor Tariff Guide

Several jurisdictions have regulatory bodies supervising, monitoring and controlling the activities of insurance companies through the use of price control mechanisms and other close monitoring systems in those countries. Ghana and Nigeria are several of the many examples of bodies established by an act of the legislature to see to the business of insurance in these countries. In Nigeria, the National Insurance Commission (NAICOM) oversees the activities of the insurance business the country. National Insurance Commission (NIC) is the mandated body in Ghana regulating the insurance business. Established under Insurance Law

1989 (PNDC Law 227) but now operating under the Insurance Act 2006 (Act

724), the commission is Ghana controls the business of motor insurance pricing by publishing Motor Tariff Implementation Guideline (NIC, 2015).

The Motor Tariff Implementation Guideline issued jointly by the Ghana Insurers Association in collaboration with National Insurance Commission provides guidelines to insurance companies operating the motor insurance business in determining the minimum chargeable motor premium of the Ghanaian insurance market. The motor tariff guideline was first introduced by the National Insurance Commission in 1994 and reviewed in 1999 and 2002. Several factors provided by the two bodies in amending the motor tariff implementation guideline include high claim cost, dwindling premium incomes, high inflation pressures and increased operating expenses (NIC, 2010). The researcher identified the high claim cost reason for the regular upward adjustment of the minimum premium charged is informed by the non- actuarial method employed in the pricing of the motor insurance premium. However the need to regulate the insurance market and is to check the practice where insurance companies increase their market shares by resorting to premium undercutting and offering over generous commissions to entice intermediaries.

Below are highlights of the motor tariff guideline 2010 extracted from the National Insurance Commission Motor Tariff Guideline for 2010. This document according to the guideline was prepared and produced by the Ghana Insurers Association and the National Insurance Commission. The minimum quote or the office premium is pricing structure is displayed in appendix 1.

The premium computation for each risk of motor insurance according to the guideline follows these steps:

a) Quote the basic risk premium as indicated in the tariff. This according to the guideline is categorized by the type of vehicle, the purpose and the engine capacity. The engine capacity was used as a differentiator in premium pricing for heavy duty vehicle and other specialized vehicles.

b) The relevant loading factor where applicable is then added to the basic risk premium to arrive at the office premium. The risk loading consideration are the extra seat loading (refer to appendix F fig. 5.6), age of the vehicle (refer to appendix F fig. 5.7) and the cubic capacity loading of the vehicle (refer to appendix F fig. 5.8). Additional peril such as loss of or damage to vehicle occasioned by flood, typhoon, hurricane, volcanic eruption, earthquake or other convulsion of nature, strikes, riots and civil commotion are considered under this section when pricing the premium for motor insurance according to the tariff guideline. Also included in the additional peril loading is the gratuitous passengers/members of the insured household where the private comprehension and the third party pay full compensation for the bodily injury or death to occupants of the motor vehicle other than the insured or the person driving.

Emergency treatment, ECOWAS peril which caters for third party liabilities incurred whilst visiting an ECOWAS member state and personal accident benefit are all factored in the loading factored computation. Also added are the National Insurance Commission contribution, National Health Insurance levy and the National road safety commission levy as required by law. The age and driving experience of the driver according to the document is the most often abused by the policyholders or drivers. This is also appropriately assigned its loading based on the associated risk stated by the motor tariff guideline.

After the office premium, the necessary approved discounts are applied. The discount considered here include No Claim Discount (NCD) (refer to appendix 5) and the fleet discount. The fleet discount reward is for policyholders with not less than 5 vehicles insured. The motor tariff guideline developed by the National Insurance Commission and the Ghana Insurers Association is used by all nonlife insurance companies in Ghana to determine the minimum motor insurance rate.

The motor tariff guideline however does not employ any actuarial model to properly evaluate risk and hence price them accordingly.

2.6 Credibility Theory

Credibility theory according to Stuart *et al*., (2008), is the set of quantitative tools that allows an insurer to perform prospective experience rating. That is, adjusting future premium based on the past experience and the risk or group of risk. Credibility theory provides the basic analytical framework for pricing nonlife insurance products. The analytical treatment of the subject according to YiuKuen (2009), was started by Hans Buhlman and a lot of work was accomplished by him and his students. According to Stuart *et al*.,, two facts stand out and are considered in answering the question of how credible the policyholders' own experience is given a random variation in the underlying claims experience. They suggested that the more past information the insurer has on a given policyholder, the more credible the policyholder's own experience all else being equal. The other fact that Stuart *et al*., (2008), highlighted in their analysis of the credibility theory is competition. They suggested that competitive environment in the insurance market may force the insurer to give full or nearly full credibility to a given policyholder in order to retain the business. The strength of the credibility theory according to Stuart *et al*., (2008), is what we sacrifice in terms of bias is gained in terms of reducing the average square error. With data from an insured or group of insured available, we can use sample mean or some other unbiased estimator to draw inference about the data but credibility shows that it is optimal to give the remaining weight to an estimator produced from other information hence the reduction of the average square error.

Chapter 3

Methodology

3.1 Introduction

This chapter discusses the methodology of the thesis. Under this section the source of data, type of data as well as the size of data used in the analysis will be discussed. We will also look at the models employed in the analysis, the assumptions made using the models to achieve the research objectives.

3.2 Source and type of data

The research relied extensively on secondary data obtained from the National Insurance Commission (NIC), the body mandated by law to ensure effective administration, supervision, regulation and control of insurance business in Ghana. The data obtained from the commission were reported by the various non-life insurance companies operating in the country. Secondary data often has the advantage of cost saving and overcome some difficulties of reaching wider population associated with gathering primary data. Another advantage of using secondary data is the amount of time needed by the researcher to obtain the needed sample for the research analyses. However the use of secondary data exposes this research to the risk of replicating any defective data reported due to human or system errors. The resources and time available for this research means such errors cannot be eliminated completely. The researcher however finds comfort in using the data from the National Insurance Commission due to the reputation of the commission. The researcher however finds comfort in using

the data from the National Insurance Commission due to the reputation of the commission.

3.3 Target Population

The population considered for this research is motor insurance claim amounts reported by the non-life insurance companies in Ghana to the National Insurance Commission. The claim amounts include amounts paid by the insurance companies to both third party and comprehensive insurance policy holders of motor insurance. The claim amounts are claims made by owners of private and commercial vehicle policy holders as well as claim amounts for special vehicles such as industrial trucks and heavy duty vehicles.

3.4 The Sample data

Out of a total of 26 non-life insurance companies licensed by the National Insurance Commission as at 2014,18 met the defined criteria of operating for a minimum of three years and reported annual claim amounts to the National Insurance Commission. Years of operation in the non-life business in Ghana played a major role in determining which insurance companies to be included in the sample since the proposed model employed for in these research requires knowledge about the variability existing in reported claim amounts within the individual insurance companies and across the insurance industry. Motor insurance business was also critical in deciding the list of companies. The size of motor insurance business in relation to the total non-life portfolio was also considered. Due to the regulatory framework which makes motor insurance compulsory in Ghana, with a minimum requirement of a third party motor insurance cover, all the non-life insurance companies were engaged in taking up the risk of motorist through the sale of both comprehensive and third party motor

insurance and hence had motor insurance policy in their non-life portfolio. This made it easier in identifying which insurance company to sample for the analysis. The researcher considered reported motor insurance claims to the National Insurance Commission from 2011 to 2014. According to Bank of Ghana annual reports on the overview of the economy, annual inflation for years 2011 to 2013 was stable throughout the years. However, inflation pressures were elevated in 2014 pushing the inflation from 13.5 per cent in December 2013 to 17 per cent in December 2014. (BoG, 2014). Using the reported data of motor insurance claim for the period 2011 to 2014 the researcher assumed that inflation contribution to price variation in motor insurance claim is minimal and hence no need to adjust the data for inflation. The last review date of the tariff guide which was April 2, 2010 also informed the choice of the sample period. The tariff guide which determines the minimum chargeable premium was the same throughout the years the sample was collected. In other words, to ensure variability within the reported claim amount was largely due to the associated risks of the motor insurance portfolio, the criteria above used is to reduce the exogenous effects on the amount of claims reported by the insurance company. For the chosen sample period, 9 out of the 18 insurance companies reported 3 data points and the remaining 9 insurance companies had 4 data points for each of the sampling year. The was due to the number of years in operation of the insurance companies, missing data and late reporting of reported claim amount to the NIC.

3.5 Non-Parametric Approach-The Empirical Bayesian Credibility Theory model

The researcher used Empirical Bayesian Credibility Theory (EBCT) model in analyzing as well as predicting the risk premiums for motor insurance

policyholders with the various insurance companies sampled. The Empirical Bayesian Credibility Theory model generally estimates the expected value of X_{N+1} having observed $X_1, X_2, X_3, \ldots, X_N$ aggregate claims in successive years for the risk which in this research is motor insurance claim.

3.5.1 Assumptions of the Empirical Bayesian Credibility Theory model

The distribution of the observed aggregate claim amounts X_j where $j = 1,2,3,\ldots,n_k$ depends on a risk parameter Θ whose value is fixed and the same for all the X_j The Empirical Bayesian Credibility Theory model uses a risk parameter Θ which is a random variable and does not follow any specific statistical distribution. The model also assumes the conditional claim distribution X_j/Θ are independent and identically distributed.

The conditional variables X_j/Θ also do not assume any specific statistical distribution except that the mean $m(\Theta)$ and the variance $s^2(\Theta)$ of X_j/Θ can be expressed as a function of the risk parameter Θ.

That is:

$$m(\Theta) = E(X_j/\Theta), \quad (3.1)$$

$$S^2(\Theta) = Var(X_j/\Theta), \quad (3.2)$$

The Empirical Bayesian Credibility Theory model used in this research to predict the claim premium is linear and of the form:

$$(1 - Z)E(m(\Theta)) + Z\bar{X}_i, \quad (3.3)$$

where

$$\bar{X}_i = \sum_{j=1}^{n_k} \frac{X_j}{n_k}, \quad (3.4)$$

and Z which is the credibility factor is given by

$$Z = \frac{n_k}{n_k + \frac{E(S^2(\Theta))}{Var(m(\Theta))}}, \quad (3.5)$$

k is the number of reported annual claim for each insurance company.
$k = 3,4$

The credibility factor is also known as the weighting factor which is some number between zero and one.

3.5.2 Parameter Estimate Empirical Bayesian Credibility Theory model

The Empirical Bayesian Credibility Theory model makes no assumption about the distribution of the risk parameter Θ. We are required to have data from some other similar risk but not identical to the original risk. In this research, as already discussed, other insurance companies motor insurance claim amounts are used to enable the estimation of the parameters $E[m(\Theta)]$, $Var[m(\Theta)]$ *and* $E[S^2(\Theta)]$

Having obtained our data in the form X_{ij}, in the case of this research, the aggregate motor insurance claim amount, where each insurance company's claim risk is $i = 1,2,3,...,N$, the estimation of the various parameters of interest to enable the researcher use the Empirical Bayesian Credibility Theory model to predict the pure premium are :

The sample mean of the claim data from the insurance company i is $\bar{X}_i$ where

$$\bar{X}_i = \sum_{j=1}^{n_k} \frac{X_{ij}}{n_k} \quad (3.6)$$

The sample mean of the claim data from all the insurance companies used in the research is $\bar{X}$ where

$$\bar{X} = \sum_{i=1}^{N} \frac{X_i}{N}, \tag{3.7}$$

$$E(m(\Theta)) = \bar{X}, \tag{3.8}$$

$$E(S^2(\Theta)) = \frac{1}{N} \sum_{i=1}^{N} \frac{1}{(n_k - 1)} \sum_{j=1}^{n_k} (X_{ij} - \bar{X}_i)^2. \tag{3.9}$$

$$Var(m(\Theta)) = \frac{1}{(N-1)} \sum_{i=1}^{N} (\bar{X}_i - \bar{X})^2 - \frac{1}{N_{nk}} \sum_{i=1}^{N} (n_k - 1)^{-1} \sum_{j=1}^{n_k} (X_{ij} - \bar{X}_i)^2 \tag{3.10}$$

Where $Var[m(\Theta)]$ *and* $E[S^2(\Theta)]$ are non-negative parameters with $Var[m(\Theta)]$ adjusted to zero where a negative estimate is obtained.

$E[m(\Theta)]$, $Var[m(\Theta)]$ *and* $E[S^2(\Theta)]$ are unbiased estimators.

$E[S^2(\Theta)]$ is the average variability of data values from year to year for a given insurance company.

$Var[m(\Theta)]$ is the variability of the average data values for different risks associated with each insurance company. The credibility factor Z in (3.5) is:

- Always between zero and one
- Is an increasing function of the number of years
- Is a decreasing function of $E[S^2(\Theta)]$ relative to $Var[m(\Theta)]$,the risk itself relative to the data from the other risk in the collective
- Z is an increasing function of $Var[m(\Theta)]$. That is the higher the value of $Var[m(\Theta)]$ relative to $E[S^2(\Theta)]$, the more variability there is between the different insurance company risk in the collective and hence less likely it is that the other risks in the

collective will resemble the risk that is of interest and the less reliance should be placed on the data from the other insurance companies.

3.6 Parametric Approach-Bayesian Credibility Theory

The Bayesian approach to credibility theory is used to estimate the motor insurance premium from the sample data. This alternate approach which makes some assumptions about the distribution of the risk parameter is to confirm further the reliability of the estimates of the motor insurance premium obtained using the non-parametric approached which under this study is the Empirical Bayesian Credibility theory.

3.6.1 Description of the Bayesian Credibility

The Bayesian credibility approach used to estimate the risk premium requires assuming that the unknown parameter follows a given distribution which is inferred from the type of sample data we are working with. This is known as the prior distribution. The researcher assumes the prior distribution follows a normal distribution. This assumption of the sample population of claim amount following a normal distribution and this was tested using the Kolmogorov-Smirnov test. The Bayesian credibility also requires the likelihood function which provides a certain probability of incurring the particular pattern of claims given any value of the parameter which is given in the prior distribution. The likelihood function is also assumed to be a normal distribution as well. Using the Bayes formula, the posterior parameter distribution can be obtained by combining the prior parameter distribution with the likelihood function.

3.6.2 Assumptions of the Normal/ Normal Bayesian Credibility Approach

The pure premium estimates for the risk X which under this research is motor insurance is obtained using the following assumptions. The distribution of the motor insurance claim amount X depends on the fixed but unknown value of a parameter Θ. The conditional distribution of the motor insurance claim amount

x given the unknown parameter Θ$N(\Theta,\ \sigma_1^2$is), where$N(\Theta,\ \sigma_1^2)$ is the normal distribution with mean Θ and varianceσ_1^2. The unknown parameter Θ is assumed to be random variable with prior distribution$N(\mu_i,\ \sigma_{2i}^2)$, where$N(\mu_i,\ \sigma_{2i}^2)$ is the normal distribution with mean μ_i and varianceσ_{2i}^2. The values of μ, σ_1 and σ_2 are estimated from the sample data.

3.6.3 The Posterior Distribution of Θ

Let X_j where j = 1,2,3...n_k be the aggregate claim amount which depends on the fixed but unknown value of a parameter Θ.

n_k is the number of years the sample is taken for each insurance company. k is the number of reported annual claim for each insurance company.

The unknown parameter Θ has the prior distribution$N(\mu_i,\ \sigma_{2i}^2)$, where $N(\mu_i,\ \sigma_{2i}^2)$ is the distribution of each insurance company's motor insurance company claim sampled. Each insurance company's claim is normally distributed with parameters $N(\mu_i,\ \sigma_{2i}^2)$ where i = 1,2,...,N represent each insurance company sampled. Having $Y_1, Y_2, ..., Y_N$ as an independent and identically distributed for each sample set for the insurance company. The populations are also normally distributed

with mean$\sum_{i=1}^{N} \mu_i$ and variance$\sum_{i=1}^{N} \sigma_{2i}^2$, where μ_i is the mean of each insurance company's distribution and , σ_{2i}^2 is the variance of each insurance company's distribution.

The probability distribution function of each prior distribution is proportional to

$$\frac{1}{\sigma_{2i}\sqrt{2\pi}} \exp\left[-\frac{1}{2}\left(\frac{\Theta - \mu_i}{\sigma_{2i}}\right)^2\right] \qquad (3.11)$$

The likelihood of the aggregate claim amount given the unknown parameter Θ, that is x_j/Θ is $N(\Theta,\ \sigma_1^2)$. The joint likelihood function for the aggregate claim

amount is proportional to

$$= \left[\frac{1}{\sigma_1\sqrt{2\pi}}\right]^{n_k} \prod_{j=1}^{n_k} \exp\left[-\frac{1}{2}\left(\frac{\Theta - \mu_j}{\sigma_1}\right)^2\right] \qquad (3.12)$$

$$= \exp\left[-\frac{1}{2}\sum_{j=1}^{n_k}\left(\frac{\Theta - \mu_j}{\sigma_1}\right)^2\right] \qquad (3.13)$$

So therefore the posterior distribution is proportional to the product of the likelihood function and their prior distribution

$$= \exp\left[-\frac{1}{2}\left(\frac{\Theta - \mu}{\sigma_2}\right)^2 - \frac{1}{2}\sum_{j=1}^{n_k}\left(\frac{x_j - \Theta}{\sigma_1}\right)^2\right] \qquad (3.14)$$

This is proportional to

$$= \exp\left[-\frac{1}{2}\left(\frac{\Theta - \mu*}{\sigma*}\right)^2\right] \qquad (3.15)$$

which represents the probability distribution function $N(\mu_*, \sigma_*^2)$, a normal distribution of some values of μ_* and σ_*^2.

$$\sigma_*^2 = \frac{\sigma_1^2\sigma_2^2}{\sigma_1^2 + n_k\sigma_2^2} \qquad (3.16)$$

$$\mu_* = \frac{\mu\sigma_1^2 + \sigma_2^2 \sum x_i}{\sigma_1^2 + n\sigma_2^2} \qquad (3.17)$$

Therefore the posterior distribution of the parameter Θ given x_j, j =,1,2,...,n_k and individual distribution for each insurance company is

$$N\left(\frac{\mu\sigma_1^2 + n\sigma_{2i}^2\bar{x}}{\sigma_1^2 + n\sigma_{2i}^2}, \frac{\sigma_1^2\sigma_{2i}^2}{\sigma_1^2 + n\sigma_{2i}^2}\right) \quad (3.18)$$

where $x = \sum_{i=1}^{n_k} \frac{x_i}{n_k}$ and

$$E(\Theta/x) = \frac{\mu\sigma_1^2 + n\sigma_{2i}^2\bar{x}}{\sigma_1^2 + n\sigma_{2i}^2} = \frac{\sigma_1^2}{\sigma_1^2 + n\sigma_{2i}^2}\mu + \frac{n\sigma_{2i}^2}{\sigma_1^2 + n\sigma_{2i}^2}\bar{x} \qquad (3.19)$$

$$= Z_i\bar{x}_i + (1 - Z_i)\mu \qquad (3.20)$$

where

$$Z_i = \frac{n_k}{n_k + \frac{\sigma_1^2}{\sigma_{2i}^2}} \quad (3.21)$$

and $E(\Theta/x)$ is the credibility estimate.

Credit: ActEd Study Material(2013).

The assumption of reported motor insurance claim following a normal distribution is however tested using the Kolmogorov Smirnov test at a significance level of 5 % (alpha = 0.05).

Chapter 4

ANALYSIS AND FINDINGS

4.1 Introduction

This chapter discusses and explains the outcome of the data analysis. The Empirical Bayesian Credibility Theory (EBCT) approach to estimating the pure premium for the insurance companies under review is also presented in this chapter. The descriptive statistics of the claim premiums reported by the insurance companies and well as overview of economic variables for the sample period is discussed in this chapter.

4.2 Descriptive analysis of the claim data

The sample data obtained from the National Insurance Commission for the period 2011 to 2014 include the claims on motor insurance policyholders for 18 non-life insurance companies in Ghana. The descriptive analysis on the sample data is presented in the table below.

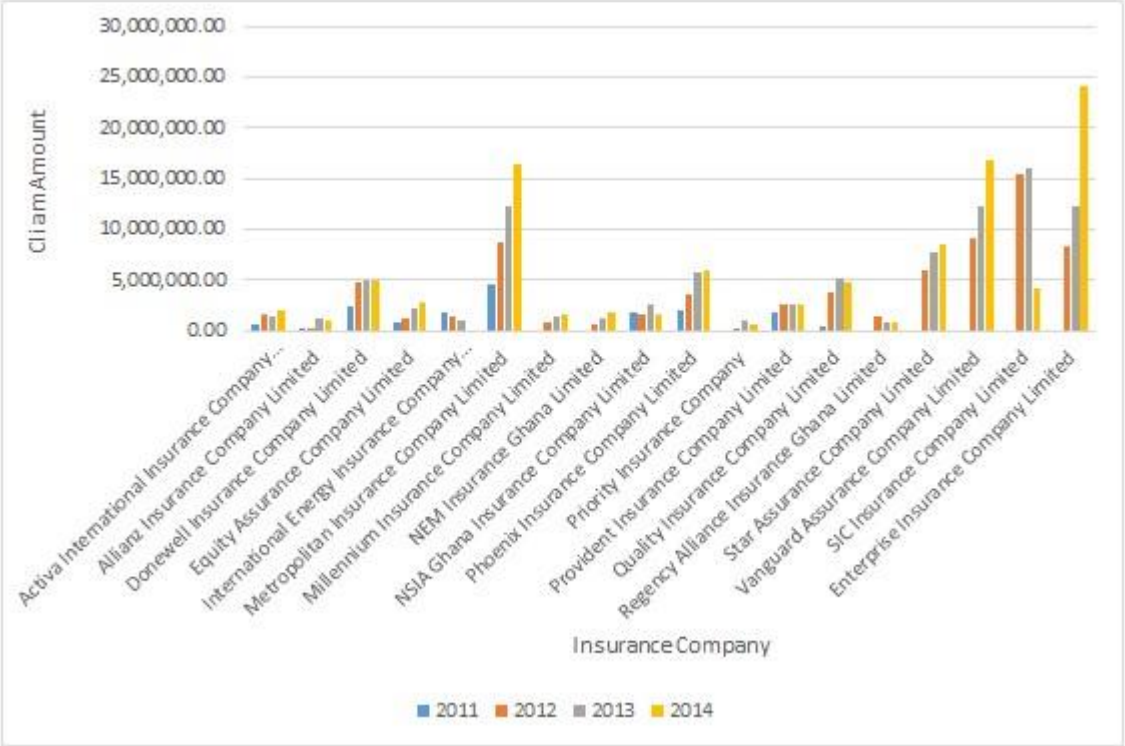
Table4.1:DescriptiveStatisticsforMotorClaimdata

INSURANCECOMPANY	MEAN	Skewness	Kurtosis	MODE	VARIANCE
ActivaInternationalInsuranceCompanyLimited	1,496,115.50	-0.415	-1.849	2,073,302.00	345,480,313,253.67
AllianzInsuranceCompanyLimited	722,698.00	0.074	-2.337	1,247,076.00	227,855,132,733.33
DonewellInsuranceCompanyLimited	4,271,981.50	-0.722	-1.708	5,034,040.00	1,624,958,207,745.67
EquityAssuranceCompanyLimited	1,784,298.00	-0.01	-2.252	2,770,159.00	835,611,054,468.67
InternationalEnergyInsuranceCompanyLimited	1,435,353.00	0.166	-2.333	1,860,816.00	156,800,239,759.00
MetropolitanInsuranceCompanyLimited	10,569,554.75	-0.003	-2.045	16,503,915.00	25,649,450,690,123.60
MillenniumInsuranceCompanyLimited	1,295,596.00	-0.287	-2.333	1,600,482.00	144,681,949,551.00
NEMInsuranceGhanaLimited	1,199,794.33	0.08	-2.333	1,814,263.00	350,647,830,240.33
NSIAGhanaInsuranceCompanyLimited	1,867,151.75	0.666	-1.753	2,597,181.00	246,698,538,058.25
PhoenixInsuranceCompanyLimited	4,358,127.00	-0.242	-2.166	5,934,035.00	3,607,691,064,445.33
PriorityInsuranceCompany	590,870.00	-0.117	-2.333	1,108,757.00	306,750,635,647.00
ProvidentInsuranceCompanyLimited	2,436,270.00	-0.744	-1.691	2,688,466.00	196,989,280,467.33
QualityInsuranceCompanyLimited	3,586,217.50	-0.588	-1.815	5,175,091.00	4,536,715,683,809.00
RegencyAllianceInsuranceGhanaLimited	1,095,830.33	0.36	-2.333	1,486,663.00	116,265,760,361.33
StarAssuranceCompanyLimited	7,420,652.67	-0.194	-2.333	8,630,661.00	1,875,588,177,374.33
VanguardAssuranceCompanyLimited	12,757,400.67	0.127	-2.333	16,814,791.00	14,697,473,081,552.30
SICInsuranceCompanyLimited	11,863,237.67	-0.381	-2.333	16,073,185.00	45,223,695,371,584.30
EnterpriseInsuranceCompanyLimited	14,940,040.33	0.291	-2.333	24,153,621.00	67,427,578,894,121.30
Total	83,691,189.00				167,570,931,905,296.00

Source:ClaimdataformtheNIC

From table 4.1, the skewness which is an indication of the symmetry of the reported claim data is displayed. For each insurance company sampled, the measure of skewness of the claim data is greater than -1.0 and less than 1.0. This suggests that the reported claim

distribution is fairly symmetric which was later confirmed with the K-S normal distribution test. However, the negative Kurtosis obtained across the sampled insurance companies reported claim data indicates a flatter distribution than that of a Gaussian distribution which has a kurtosis of 0.



Source: Claim data form the NIC

Figure 4.1: Cluster Bar Chart of Reported Motor Insurance Claim

The sample data obtained from the National Insurance Commission for the period 2011 to 2014 include the claims on motor insurance policyholders for 18 non–life insurance companies in Ghana. The descriptive analysis on the sample data is presented in the below.

From figure 4.1, Enterprise Insurance company for the period 2011 to 2014 recorded the highest motor insurance claims from policyholders with an average claim amount of GHS14,940,040.33. Enterprise Insurance company doubled the paid claims for motor

insurance in 2014 by increasing total claims from motor insurance policyholders from GHS12,272,329 to GHS24,153,621. Vanguard Assurance Company Ltd, State Insurance Comapany (SIC) and Metropolitan Insurance Company Ltd recorded high claim amount for the period under review with respective claim means GHS12,757,400.67, GHS11,863,237.67 and GHS10,569,554.75. Enterprise Insurance Company paid the highest motor insurance claim in 2014 with a total reported claim amount of GHS24,153,621 paid to motor insurance policyholders in 2014. Following this is Vanguard Assurance Company Ltd with a reported motor insurance claim amount of GHS16,814,791 from policyholders in 2014. The variability within the claim data for the insurance companies will be discussed in subsequent section of this analysis.

A review of the data also indicate that State Insurance Company Ltd recorded the most significant reduction in paid motor insurance claim from 2013 to 2014. The company had a 74% reduction in claim payment from motor insurance policyholders with 2013 figure of GHS16,073,185 reducing to GHS4,107,516 in 2014. Other highlight of the sample data is reported motor insurance claim for Priority

Insurance Company recorded the lowest reduction in motor insurance claim in 2014 with reported claim amount of GHS656,881 which represents 40.76% reduction in the amount paid in 2013.

4.3 Economic Outlook

The strength of the Empirical Credibility Theory approach in estimating pure premium for motor insurance is the use of the variability existing within the reported motor insurance claims of each individual insurance company and across the insurance industry to estimate the credibility factor. There is therefore the need to narrow the variability existing within the reported motor insurance

claim data to the risks associated with the portfolio which in this research is the motor insurance claims. One of such exogenous factor is inflation which influence the size of the claim. Due to the responsiveness of the claim amounts to inflation, further investigation on the economic outlook was conducted to ensure the effect of inflation was negligible for the period of interest. According to the BOG annual report, inflationary figures in Ghana remain stable from 2011 to 2014 (BOG, 2014). The stability in the inflationary figures played a key role in determining the sample period. The rate of inflation is the percentage change in the consumer price index (CPI) over the twelve month period (GSS, 2011). The consumer price index (CPI) measures changes over time in general price level of good and services that household acquire for the purpose of consumption with reference to the price level in 2012, the base year used for this computation which has an index of 100.

According to the Ghana Statistical Service, the inflation rate increased from 14.78% in December 2009 to 17% in December 2014. From 2011 to 2014, the inflation rate reported by the Ghana Statistical Service was averaging around 11.29%. The year on year inflation rates was 8.73% in 2011. This increased slightly to 9.17% in the year 2012 with a further increase to 11.65% in 2013. The average inflation rate for the year 2014 was 15.45% which can be considered to be within a reasonable range taking into consideration the overall inflation rates recorded in previous years in the country. Table 4.2 shows monthly inflation rates in Ghana as captured on the Ghana Statistical Service website reflect the claim made by BOG in the annual report. The assumption of a stable inflation rates in the period 2011 to 2014 was therefore a reason not to adjust the reported motor insurance claims for inflation during the analysis of the data. This assumption however may be waived in other studies with a longer date period.

4.4 The Empirical Bayesian Credibility Theory model Estimates

The Empirical Bayesian Credibility Theory model made no assumption about the type of statistical distribution the risk parameter Θ. It however use the linear combination (3.3) with credibility factor Z to estimate the credibility premium as given (3.5)

4.4.1 The Sample Period

The number of years of the past data used by the researcher is 4 years. The sample period has a direct relationship with the credibility factor Z. In other words, as the number of years of the past data period increases, the credibility factor Z also increases. The more information we have as a result of increase in the sample period from the relevant risk, the more emphasis is put on the particular risk. In this research the risk studied is the claim amount for motor insurance policyholders in Ghana. The stability of the economy played a key role on deciding on the sample period. Ghana's economy recorded relatively low and stable inflationary figures for the period 2011 to 2015 and hence the researchers interest in the period. The number of relevant risks in this research is claim amounts reported by the 18 non-life insurance companies to the National Insurance Commission in Ghana.

4.4.2 The Means of each Risk

The means of each risk x measures the average motor insurance claim for each insurance company in Ghana. This measure of central tendency is the statistical measure that represents an entire data collected for a given risk. The sample

mean $\bar{X}$ is unbiased and therefore a good representation of the data. Reference to table 4.1, the means of each reported motor insurance claims for each insurance company for the sample period is provided in the table below. $E[m(\Theta)]$ is widely accepted notation under Empirical Bayesian Credibility Theory for the overall mean of the claim amounts for the motor insurance policyholders for all the insurance companies.

From (3.8), $E[m(\Theta)] = GHS4{,}649{,}510.50$

4.4.3 Variability within each Risk

$E[S^2(\Theta)]$ is the accepted notation under EBCT for the overall variability within the motor insurance claim amounts reported by each insurance company. In other words, $E[S^2(\Theta)]$ measures the variability within each of the different risks (insurance company) in the group. $E[S^2(\Theta)]$ has been established to have an inverse relationship with the credibility factor Z. As the variability $E[S^2(\Theta)]$ increases, the credibility factor Z decreases. That is, the more variability within the individual risks experience is, the less reliable it is and hence less emphasis is put on each risk data but rather the collateral risk in estimating the risk premium.

From (3.9) ,

$E[S^2(\Theta)] = 9{,}309{,}496{,}216{,}960.88$

4.4.4 Variability between Risks

$Var[m(\Theta)]$ is the accepted notation to measure the variability between the different risks in EBCT. That is, the $Var[m(\Theta)]$ measures the variability across all the insurance company reported motor insurance claim amount. The measure of the variability between the risks $Var[m(\Theta)]$ has a direct relationship with the

credibility factor Z hence as the value for $Var[m(\Theta)]$ increases, the value for the credibility factor Z also increases. The larger the variability between the claim amounts for the various insurance companies, the less relevant the other risks are in assessing the claim premium of the particular risk of interest and therefore want to rely more on the direct data for the estimation of the credibility factor.

From (3.10) ,
$Var[m(\Theta)]$ = 19,822,589,179,225.30

4.4.5 The Credibility Factor

The credibility factor which measures the amount is weight to be assigned to the individual risk as well as the overall group risk is given by the formula (3.5) The accepted notation for the credibility factor Z and it is between 0 and 1. From the sample data n_k is 4 or 3 sample points as already ready discussed in this research. The table 4.3 displays the respective credibility factor for the various insurance companies.

Table 4.2: Empirical Bayesian Credibility factor Estimates for the Insurance Companies

INSURANCE COMPANY	n_k	$E[S^2(\Theta)]/Var(m(\Theta))$	Z
Activa International Insurance Company Limited	4	0.4696407786485090	0.894926505
Allianz Insurance Company Limited	4	0.4696407786485090	0.894926505
Donewell Insurance Company Limited	4	0.4696407786485090	0.894926505
Equity Assurance Company Limited	4	0.4696407786485090	0.894926505
International Energy Insurance Company Limited	3	0.4696407786485090	0.864642824
Metropolitan Insurance Company Limited	4	0.4696407786485090	0.894926505
Millennium Insurance Company Limited	3	0.4696407786485090	0.864642824
NEM Insurance Ghana Limited	3	0.4696407786485090	0.864642824
NSIA Ghana Insurance Company Limited	4	0.4696407786485090	0.894926505
Phoenix Insurance Company Limited	4	0.4696407786485090	0.894926505
Priority Insurance Company	3	0.4696407786485090	0.864642824
Provident Insurance Company Limited	4	0.4696407786485090	0.894926505
Quality Insurance Company Limited	4	0.4696407786485090	0.894926505
Regency Alliance Insurance Ghana Limited	3	0.4696407786485090	0.864642824
Star Assurance Company Limited	3	0.4696407786485090	0.864642824
Vanguard Assurance Company Limited	3	0.4696407786485090	0.864642824
SIC Insurance Company Limited	3	0.4696407786485090	0.864642824

Enterprise Insurance Company Limited	3	0.4696407786485090	0.864642824

4.4.6 Estimating Pure Premium using the EBCT

The credibility factor of Z of 0.89 for insurance company with 4 sample points and 0.864 for insurance companies that had reported claim amounts for 3 years implies that more weight must be given to the data from the individual insurance company than the group data or the overall industry data of motor insurance claim amounts. The estimated credibility premium for all the sampled insurance companies use the linear combination Credibility premium is estimated using the formula (3.3), where $\bar{x}_i$ is the average claim amount for each insurance company. The estimated credibility premium for individual insurance companies for 2015 and provided below.

Table4.3:EstimatedmotorinsurancePremiumfor2015

INSURANCECOMPANYMEANZ1-Z	$E\lceil m(\theta$
ActivaInternationalInsuranceCompanyLimited1,496,115.500.8949265050.1050734954649510.51,827,453.73	
AllianzInsuranceCompanyLimited722,698.000.8949265050.1050734954649510.51,135,301.91	
DonewellInsuranceCompanyLimited4,271,981.500.8949265050.1050734954649510.54,311,649.79	
EquityAssuranceCompanyLimited1,784,298.000.8949265050.1050734954649510.52,085,355.89	
InternationalEnergyInsuranceCompanyLimited1,435,353.000.8646428240.1353571764649510.51,870,412.28	
MetropolitanInsuranceCompanyLimited10,569,554.750.8949265050.1050734954649510.59,947,515.01	
MillenniumInsuranceCompanyLimited1,295,596.000.8646428240.1353571764649510.51,749,572.40	
NEMInsuranceGhanaLimited1,199,794.330.8646428240.1353571764649510.51,666,738.17	
NSIAGhanaInsuranceCompanyLimited1,867,151.750.8949265050.1050734954649510.52,159,503.91	
PhoenixInsuranceCompanyLimited4,358,127.000.8949265050.1050734954649510.54,388,743.68	
PriorityInsuranceCompany590,870.000.8646428240.1353571764649510.51,140,236.12	
ProvidentInsuranceCompanyLimited2,436,270.000.8949265050.1050734954649510.52,668,822.91	
QualityInsuranceCompanyLimited3,586,217.500.8949265050.1050734954649510.53,697,941.41	
RegencyAllianceInsuranceGhanaLimited1,095,830.330.8646428240.1353571764649510.51,576,846.45	
StarAssuranceCompanyLimited7,420,652.670.8646428240.1353571764649510.57,045,558.69	
VanguardAssuranceCompanyLimited12,757,400.670.8646428240.1353571764649510.511,659,939.55	
SICInsuranceCompanyLimited11,863,237.670.8646428240.1353571764649510.510,886,807.93	
EnterpriseInsuranceCompanyLimited14,940,040.330.8646428240.1353571764649510.513,547,143.27	

4.5 Bayesian Credibility Estimates-Parametric Approach

The researcher used the normal/normal Bayesian credibility approach to estimate the pure premium since the claim amount has been established to be consistent with the normal distribution. This generally held assumption of normal distribution of the prior distribution was tested using the Kolmogorov-Smirnov test at significance level of 5%. Let the aggregate annual claim amounts be $X_j, j = 1,2,3,...,n_k$ a random variable. The distribution of X depends on the fixed but unknown value of a parameter Θ. The conditional distribution of X given Θ is $N(\Theta,\sigma^2)$. The prior distribution of Θ is $N(\mu,\sigma^2)$. The posterior distribution of Θ given the aggregate claims $X_1,X_2,X_3,...,X_{nk}$ is

$$N\left(\frac{\mu\sigma_1^2 + n\sigma_{2i}^2\bar{x}}{\sigma_1^2 + n\sigma_{2i}^2}, \frac{\sigma_1^2\sigma_{2i}^2}{\sigma_1^2 + n\sigma_{2i}^2}\right)$$

where $\bar{x} = \sum_{i=1}^{n_k} \frac{x_i}{n_k}$ and

$$E(\Theta/x) = \frac{\mu\sigma_1^2 + n\sigma_2^2\bar{x}}{\sigma_1^2 + n\sigma_2^2} = \frac{\sigma_1^2}{\sigma_1^2 + n\sigma_2^2}\mu + \frac{n\sigma_2^2}{\sigma_1^2 + n\sigma_2^2}\bar{x}$$

$$= Z\bar{x} + (1 - Z)\mu$$

where

$$Z = \frac{n_k}{n_k + \frac{\sigma_1^2}{\sigma_2^2}}$$

4.5.1 Prior Distribution of the Bayesian Credibility

The researcher assumed that reported claim amounts from each of the insurance company follow a normal distribution. Using the Kolmogorov-Smirnov test at

5% significance level, table 4.5 displays the outcome of the test. The table 4.5 displays the Skewness, Kurtosis and the p-value for each insurance company's sample distribution. The Skewness from table 4.5 by observation is between -1 and 1. This can be said to be fairly symmetric as in the case of a normal distribution. However a further statistical test was conducted at 5% significance level with the following hypothesis to confirm this.

H_0: The sample follows a Normal distribution

H_1: The sample does not follow a Normal distribution

Where

H_0 is the null hypothesis and

H_1 is the alternate hypothesis

As the computed p-value for each insurance company is greater than the significance level alpha = 0.05, the researcher cannot reject the null hypothesis H_0 therefore with the confidence level of 5% conclude that the distribution indeed is normal as assumed.

Table 4.4: p-value for Kolmogorov-Smirnov test

INSURANCE COMPANY	P-VALUE
Activa International Insurance Company Limited	0.851
Allianz Insurance Company Limited	0.831
Donewell Insurance Company Limited	0.495
Equity Assurance Company Limited	0.973
International Energy Insurance Company Limited	0.985
Metropolitan Insurance Company Limited	1
Millennium Insurance Company Limited	0.906
NEM Insurance Ghana Limited	0.998
NSIA Ghana Insurance Company Limited	0.666
Phoenix Insurance Company Limited	0.822
Priority Insurance Company	0.995
Provident Insurance Company Limited	0.371
Quality Insurance Company Limited	0.811
Regency Alliance Insurance Ghana Limited	0.757
Star Assurance Company Limited	0.975
Vanguard Assurance Company Limited	0.993
SIC Insurance Company Limited	0.684
Enterprise Insurance Company Limited	0.901

These claim amounts recorded by the insurance companies are also assumed to be independent and identically distributed. With these assumptions, having $Y_1, Y_2, \ldots, Y_m$, the distribution of each insurance company's claim amount as $Y\ N\ (\mu_i, \sigma_i^2)$ where $i = 1,2,\ldots,18$ and the distributions are independent and identically distributed. The prior distribution is $N\ ({}^{P}\mu_i, {}^{P}\sigma_i^2)$

From table table 4.1

$$\sum_{i=1}^{18} \mu_i = 83,691,189$$

$$\sum_{i=1}^{18} \sigma_i^2 = 167,570,931,905,296.00$$

The prior distribution has a normal distribution with parameters

Mean = 83,691,189, *V ariance* = 167,570,931,905,296

4.5.2 The Likelihood Distribution

The researcher also assumed that the likelihood of claim amount for each insurance company given an unknown parameter Θ is normally distributed with parameter $N(\Theta,\sigma_i^2)$. Table 4.1 displays the variance of each insurance company given the unknown parameter.

4.5.3 The Credibility Factor

The credibility factor which indicates the weight to be given to each insurance company's data in computing the credibility premium is given by formula (3.21). That is

$$Z = \frac{n_k}{n_k + \frac{\sigma_{1i}^2}{\sigma_2^2}} \quad (4.1)$$

Where n_k is the number of sample data for each insurance company σ_{1i}^2 is the variance of the individual insurance claim data σ_2^2 is the variance of the insurance industry. This is the variance of the prior distribution The respective credibility factor for each insurance company is provided in the table 4.5 below

Table4.5:BayesianCredibilityfactorestimatesfortheInsurancecompanies

INSURANCECOMPANY	n_k	α_2^2	α_{1t}^2	CREDIBILITYFACTOR
ActivaInternationalInsuranceCompanyLimited	4	167,570,931,905,296.00	345,480,313,253.67	0.99948484153513400000
AllianzInsuranceCompanyLimited	4	167,570,931,905,296.00	227,855,132,733.33	0.99966017718620500000
DonewellInsuranceCompanyLimited	4	167,570,931,905,296.00	1,624,958,207,745.67	0.99758157880376100000
EquityAssuranceCompanyLimited	4	167,570,931,905,296.00	835,611,054,468.67	0.99875489945481600000
InternationalEnergyInsuranceCompanyLimited	3	167,570,931,905,296.00	156,800,239,759.00	0.99968818906328800000
MetropolitanInsuranceCompanyLimited	4	167,570,931,905,296.00	25,649,450,690,123.60	0.96314380246626200000
MillenniumInsuranceCompanyLimited	3	167,570,931,905,296.00	144,681,949,551.00	0.99971228040552800000
NEMInsuranceGhanaLimited	3	167,570,931,905,296.00	350,647,830,240.33	0.99930297493340300000
NSIAGhanaInsuranceCompanyLimited	4	167,570,931,905,296.00	246,698,538,058.25	0.99963208449843000000
PhoenixInsuranceCompanyLimited	4	167,570,931,905,296.00	3,607,691,064,445.33	0.99464648018299200000
PriorityInsuranceCompany	3	167,570,931,905,296.00	306,750,635,647.00	0.99939018147928500000
ProvidentInsuranceCompanyLimited	4	167,570,931,905,296.00	196,989,280,467.33	0.99970619694869400000
QualityInsuranceCompanyLimited	4	167,570,931,905,296.00	4,536,715,683,809.00	0.99327715138327700000
RegencyAllianceInsuranceGhanaLimited	3	167,570,931,905,296.00	116,265,760,361.33	0.99976877676874900000
StarAssuranceCompanyLimited	3	167,570,931,905,296.00	1,875,588,177,374.33	0.99628293429408200000
VanguardAssuranceCompanyLimited	3	167,570,931,905,296.00	14,697,473,081,552.30	0.97159416044116800000
SICInsuranceCompanyLimited	3	167,570,931,905,296.00	45,223,695,371,584.30	0.91746544333663500000
EnterpriseInsuranceCompanyLimited	3	167,570,931,905,296.00	67,427,578,894,121.30	0.88173512717768200000

4.5.4 The Bayesian Credibility Estimates of Premium

The credibility premium estimate for 2015 for each of the insurance company using the Bayesian parametric approach is

$$Z_i\bar{X}_i + (1 - Z_i)\mu$$

Where $\bar{X}_i$ is the mean claim amount of the i_{th} insurance companies.

μ is the mean of the i_{th} insurance company

The estimated claim amounts using the Bayesian Credibility approach is provided in the table below

Table4.6:BayesianCredibilityEstimatesfor2015

INSURANCECOMPANYMEANZ1-Z	$E[m(\theta$
ActivaInternationalInsuranceCompanyLimited1496115.50.9994848420.000515158836911891,538,458.99	
AllianzInsuranceCompanyLimited7226980.9996601770.00033982383691189750,892.59	
DonewellInsuranceCompanyLimited4271981.50.9975815790.002418421836911894,464,050.59	
EquityAssuranceCompanyLimited17842980.9987548990.001245101836911891,886,280.31	
InternationalEnergyInsuranceCompanyLimited14353530.9996881890.000311811836911891,461,001.27	
MetropolitanInsuranceCompanyLimited10569554.750.9631438020.0368561988369118913,264,540.15	
MillenniumInsuranceCompanyLimited12955960.999712280.00028772836911891,319,302.83	
NEMInsuranceGhanaLimited1199794.3330.9993029750.000697025836911891,257,292.90	
NSIAGhanaInsuranceCompanyLimited1867151.750.9996320840.000367916836911891,897,256.08	
PhoenixInsuranceCompanyLimited43581270.994646480.00535352836911894,782,838.12	
PriorityInsuranceCompany5908700.9993901810.00060981983691189641,546.11	
ProvidentInsuranceCompanyLimited24362700.9997061970.000293803836911892,460,142.94	
QualityInsuranceCompanyLimited3586217.50.9932771510.006722849836911894,124,751.10	
RegencyAllianceInsuranceGhanaLimited1095830.3330.9997687770.000231223836911891,114,928.30	
StarAssuranceCompanyLimited7420652.6670.9962829340.003717066836911897,704,155.26	
VanguardAssuranceCompanyLimited12757400.670.971594160.028405848369118914,772,334.48	
SICInsuranceCompanyLimited11863237.670.9174654430.0825345578369118917,791,525.79	
EnterpriseInsuranceCompanyLimited14940040.330.8817351270.1182648738369118923,070,886.19	

4.6 Comparing Parametric and Non Parametric Premium Estimates for 2015

Comparing the estimated premium using the EBCT from table 4.4 and the Bayesian Credibility from table 4.7, it can be concluded through observation that the

use of both approaches indeed provides estimates fairly similar for each insurance company. It can be observed that out of the estimated claims for 2015 for the 18 insurance companies, 15 of the estimates using the parametric approach gave outcome which is less that 20% deviation from the estimates obtained using the Empirical Bayesian Credibility theory.

The researcher however conducted a further t-test at significance level of 5% to ascertain if there is a significant difference between the pure premium estimates obtained through the use of the Empirical

Table4.7:ComparingtheestimatesfromtheEBCTandtheBayesiancredibilityestimates

INSURANCECOMPANY	VARINACEEBCTESTIMATESBAYESIANESTIMATES
ActivaInternationalInsuranceCompanyLimited	4345,480,313,253.671,827,453.731,538,458.99
AllianzInsuranceCompanyLimited	4227,855,132,733.331,135,301.91750,892.59
DonewellInsuranceCompanyLimited	41,624,958,207,745.674,311,649.794,464,050.59
EquityAssuranceCompanyLimited	4835,611,054,468.672,085,355.891,886,280.31
InternationalEnergyInsuranceCompanyLimited	3156,800,239,759.001,870,412.281,461,001.27
MetropolitanInsuranceCompanyLimited	425,649,450,690,123.609,947,515.0113,264,540.15
MillenniumInsuranceCompanyLimited	3144,681,949,551.001,749,572.401,319,302.83
NEMInsuranceGhanaLimited	3350,647,830,240.331,666,738.171,257,292.90
NSIAGhanaInsuranceCompanyLimited	4246,698,538,058.252,159,503.911,897,256.08
PhoenixInsuranceCompanyLimited	43,607,691,064,445.334,388,743.684,782,838.12
PriorityInsuranceCompany	3306,750,635,647.001,140,236.12641,546.11
ProvidentInsuranceCompanyLimited	4196,989,280,467.332,668,822.912,460,142.94
QualityInsuranceCompanyLimited	44,536,715,683,809.003,697,941.414,124,751.10
RegencyAllianceInsuranceGhanaLimited	3116,265,760,361.331,576,846.451,114,928.30
StarAssuranceCompanyLimited	31,875,588,177,374.337,045,558.697,704,155.26
VanguardAssuranceCompanyLimited	314,697,473,081,552.3011,659,939.5514,772,334.48
SICInsuranceCompanyLimited	345,223,695,371,584.3010,886,807.9317,791,525.79
EnterpriseInsuranceCompanyLimited	367,427,578,894,121.3013,547,143.2723,070,886.19

Credibility Theory and the Bayesian credibility approach. The researcher used use the hypothesis below

H_0: The difference between the means is equal to 0.

H_1: The difference between the means is different from 0.

Where

H_0 is the null hypothesis and

H_1 is the alternate hypothesis

Using the two tailed test at significance level of 0.05, the p value from table 4.9 is 0.537 which means the researcher cannot reject the null hypothesis and conclude that difference between the means is equal to zero. This result therefore further supports the claim that estimated outcomes using the Empirical Bayesian Credibility model and the Bayesian credibility approach are the same.

Table 4.8: Outcome of t-test on estimated claims using EBCT and Bayesian

t (Observed value)	-0.623
$\|t\|$ (Critical value)	2.032
DF	34
p-value (Two-tailed)	0.537
alpha	0.05

The various risk units produced large variances making the data very sensitive. A further test using a non-parametric approach was conducted to confirm the similarity or otherwise of the estimates of pure premium obtained using the parametric and non-parametric approach. The Wilcoxon sign-rank test was used with

5% level of confidence to test the hypothesis:

H_0: The two samples follow the same distribution.
H_1: The distributions of the two samples are different.

Where

H_0 is the null hypothesis and

H_0 is the alternate hypothesis

At significance level of 0.05, the p value from table 4.9 is 0.601 which means the researcher cannot reject the null hypothesis and conclude that the two samples follow the same distribution. The outcome of this addition test means the estimates of pure premium using the Empirical Bayesian Credibility model and the Bayesian credibility approach come be said to have significantly similar.

Table 4.9: Outcome on Wilcoxon sign-rank test on estimated claims using EBCT and Bayesian

Expected value	85.500
Variance (V)	527.250
p-value (Two-tailed)	0.601
alpha	0.05

4.7 Accuracy of the Estimation

According to Stuart *et al*., (2008), there is no perfect model in estimating claims for non-life risks. Some have however suggested that an improved version of the Empirical Bayesian Credibility Theory model by using the risk volumes of the business for each insurance company in estimating the credibility premium. In other words, the aggregate claims in the year are standardized to remove the effect of different levels of business in different years. The researcher assumed the number of business for the year is 1. The parameter estimation using this additional information does not vary from what was used in this research. With a high credibility factor of approximately 0.89, we can ignore the data from other insurance companies and rely on the data from each insurance company to estimate the credibility premium. Another observation is the variability measure within the report claim amount for each insurance company and the variability between the reported claim amounts among the insurance companies. It was observed that there exists larger variability between the reported amounts for the insurance companies than there is within each individual risk. This indication supports the large credibility factor obtained and hence heavy dependence on the data within each given risk in predicting the estimated pure premium.

To establish the accuracy of the premium estimates obtained using the Empirical Bayesian Credibility theory, the Bayesian credibility theorem which assumes the reported motor insurance claim data follows a normal distribution to estimate the claim premium was also used on the same reported motor insurance claim data to estimate the pure premium for motor insurance. The outcome of which the earlier claim is confirmed that indeed insurance companies can base their projection and make future business decision using estimates computed using the

Empirical Bayesian Credibility Theory.

Chapter 5

Conclusion and Recommendations

5.1 Conclusion

The researchers concluded that the use of an actuarial tool to calculate pure premium for motor insurance in Ghana can be relied upon. The use of an actuarial tool as in the case of this research, the Empirical Bayesian Credibility Theory can be said to be more scientific and a better predictive tool of what will happen in future using what already exist. The consistency established in the estimations of pure premium using EBCT and the Bayesian credibility for each risk unit in this research for the various insurance companies means the use of an actuarial tool across the non-life industry will be the way to go. Large variability existed within each non-life insurance company claim data and across the industry signifying very sensitive sector responsive to changes. Despite the number of risk units used in this research and the large variance existing across the industry, the credibility factor which determines the amount of weighting to be given to data from each insurance company when estimating the motor insurance pure premium was very high in both the parametric and non-parametric approach. The heavy dependence on past claim data for the insurance companies in estimating the future pure premium for motor insurance means each insurance company have within their control the amount of risk they wish to carry for the motor insurance business.

The main objective of this research is to estimate the risk premium of motor insurance in Ghana using an actuarial model. The EBCT and the Bayesian Credibility approach

which assumed reported motor insurance claim follow a normal distribution and was confirmed using the Kolmogorov-Smirnov test. From table 4.5 reported motor insurance claim for Metropolitan Insurance Company Limited produced skewness of -0.003 which can be said to be fairly symmetric. At 5 % level of confidence, the K-S test for normal distribution conducted for the 18 insurance companies reported motor insurance claim produced the largest p-value of 1 for the reported data from Metropolitan Insurance Company Limited and the smallest p-value of 0.371 for reported motor insurance claim data from Provident Insurance Company Limited. From Table 4.5 it is revealed that reported motor insurance claim in Ghana follow a normal distribution. The confirmation that the distribution of reported motor insurance claims follow a normal distribution means with the mean and variance obtained, the probability of an insurance company in Ghana recording a given claim amount can be computed. This information can be extended to establishing the confidence interval for the motor insurance claim amount for insurance companies in Ghana as well as expected

profit.

From table 4.8 the estimated risk premium for motor insurance for Donewell Insurance Company using EBCT is GHS4,311,649.79 and the Bayesian Credibility estimate of motor insurance claim for Donewell insurance Company Limited is GHS4,464,050.59. However, the estimated motor insurance claims for Enterprise Insurance Company using the EBCT and Bayesian Credibility theory are GHS13,858,778.40 and GHS23,070,886.19 respectively. From the table 4.8, the estimated motor insurance claim for 2015 using the EBCT and the Bayesian Credibility theory can be said to be the same. However, the large variance existing within the reported motor insurance claim data for Enterprise Insurance and Metropolitan Insurance Company Limited accounted for the large variation between the estimation using the EBCT and the Bayesian Credibility theory.

From the analysis and results displayed in table 4.8, it is established that motor insurance claims can be estimated using an actuarial tool as confirmed by the results from the analysis.

According to table 4.7, the credibility factor used in estimating the motor insurance pure premium is 0.9994848 for Activa International Insurance Company and 0.881735127 for Enterprise Insurance Company. The large credibility factors obtained across all the sampled insurance companies' reported claim data as displayed in table 4.6 and table 4.7 suggest heavy reliance on the data within the individual insurance companies in estimating the pure premium as compared to the overall industry data. The heavy reliance on each insurance company's reported data as confirmed by the credibility factors in estimating the pure premium means the external variability in estimating the pure premium of motor insurance in Ghana is minimal ensuring stability in the estimated claims

The use of EBCT and the Bayesian Credibility theory in estimating the motor insurance pure premium arrived at the same outcome. From table 4.9, the t test produced a p-value of 0.537. In conclusion the consistency in estimation using both the EBCT and the Bayesian Credibility theory confirms the strength of actuarial tools in estimating the pure premium of motor insurance claims in Ghana.

5.2 Recommendation

To arrive at the various research objective, some assumptions were made to enable the researcher carry out the analysis. The assumption of the distribution of the reported motor insurance claim amount, the use of EBCT and the adjustment or otherwise of the reported motor insurance claim amount for

inflation are not universal and hence the insurance companies can make the appropriate assumptions in carrying out further analysis which may lead to different conclusion.

The highly sensitive nature of the reported claim data for motor insurance in Ghana due to the large variance within the reported claim amount of each insurance company requires a further research to establish the source of this variability since that is a risk in the using of estimation obtained from the data in decision making. This large variance as a source of risk in computing risk premium can however be minimized if regular analysis is conducted and estimations adjusted as and when it is required.

The researcher used both reported motor insurance claim amount for third party and comprehensive motor insurance reported to the NIC in the analysis. Even though this crude approach did not significantly affect the outcome of the research, it is recommended that further classification such as the type of cars, type of policy, the part of the country where the vehicle is operated or any other criterion to obtain a more homogenous data which will produce as more representative estimation and reduce the variability to those associated to the policy holders in the portfolio. Further analysis using the number of claims as well as the claim amount will be useful in determining the accuracy of the use of actuarial tool in estimating motor insurance premium.

The effect of the exogenous factors on the overall insurance industry cannot be discounted as this can be said to have a direct effect on the outcome of the estimates. The need for a stable economic environment can be said to be key in predicting the accuracy of the estimates and therefore the economic variables such as inflation do impact on the amount that is paid out as claims. The use of tariff guide as against a more scientific and a robust way of estimating premium

does not afford the insurance companies the needed flexibility to price their risks and estimate their potential profit from the motor insurance business.

Both parametric and non-parametric approach to estimating the pure premium were used by the researcher opening up for further research using any of several loss models in computing the risk premium. The many assumptions made in this research such as stable inflation in the country can be relaxed and further investigation done under the new conditions.

The insurance Act (Act 724) making at least third party motor insurance compulsory for every vehicle owner is one of the many ways to ensure the public is guaranteed some fallback should the unfortunate happen. The researcher recommends that the National Insurance Commission should collaborate with the appropriate state organizations like the Customs Exercise and Preventive Services (CEPS), the Insurance companies, DVLA and other bodies involved in activities relating to vehicles to establish a database to help monitor uninsured vehicles. The on the spot checks by the police MTTU for insurance may soon not be effective considering the number of vehicles that are brought into the country every year. This database will also assist the Insurance Companies to know the market potential and design appropriate product to penetrate further.

Risk indeed is an opportunity but the benefits that can be accrued from risk can only be realized when the risk is known and properly managed. The business of motor insurance is an age long product and therefore several experiences have evolved around this product. The researcher recommends that Insurance Companies in Ghana engage qualified actuaries to manage their risk and properly price their motor insurance business. The use of a technical expert on vehicles by the insurance companies during the product pricing stage of their motor insurance business may also go a long way to guarantee a healthy motor insurance portfolio and this the researcher recommends.

REFERENCES

ActEd-Study-Manual (2013). C t 6-p c-13 combined material pack and examination subject ct6.

Ayuso, M., Montserrat, G., and Miguel, S. (2007). Individual prediction of automobile bodily injury claims liabilities.

Ayuso, M. and Santolino, M. (2007). Predicting automobile claims bodily injury severity with sequential ordered logit models. *Insurance Mathematics and Economics*.

Batsirai, W. M. and Chiduza, T. (2013). The use of statistical distributions to model claims in motor insurance.

Bell, P. (2006). The social construction of bodily injury. *The Geneva Papers on Risk and Insurance-Issues and Practice*.

Bermudez, L. M. (2009). A priori ratemaking using bivariate poisson regression models.

BoG (2014). *https* : *//www.bog.gov.gh/index.php?option = com*$_c$*ontent&view = article&id* = 113 : *annual – reports&catid* = 102 : *annual – reports&Itemid* = 172.

Borscheid, P. and Haueter, N. V. (2012). The evolution of a global risk network. World Insurance.

Butler, P. (1993). Cost-based pricing of individual automobile risk transfer: Carmile exposure unit analysis. Journal of Actuarial Practice.

CEA (2010). The european motor insurance market "cea statistics no 38 ".

http://www.insuranceeuroe.eu/facts-figures/statistics-publications/motor.

Cohen, A. and Dehejia, R. (2004). The effect of automobile insurance and acident laws on traffic fatalities. The Harvard John M. Olin Discussion Paper Series.

Coroama, V. and Langheinrich, M. (2006). Personalized vehicle insurance ratesa case for client-side personalization in ubiquitous computing.

EC (2003). Committee on legal affairs and the internal market 2003/2130 (ini), draft report with recommendation to the commission on a european disability rating scale.

Edward, W. F. and Emiliano, A. V. (2008). Hierarchical insurance claims modeling. Journal of the American Statistical Association.

Faure, M. G. (2006). Economic criteria for compulsory insurance. The Geneva Papers.

Fredrik, T. (2012). A credibility method for profitable cross-selling of insurance products. Annals of Actuarial Science.

Gangopadhyay, A. and Gau, W. (2007). Bayesian nonparametric approach to credibility modelling. Annals of Actuarial Science.

GSS (2011). Ghana-statistical-service newsletter consumer price index (cpi).

GSS.a (2011). Ghana statistical service.

Hoffer, G. E. and Miller, E. G. (1991). Protecting consumers from uninsured motorists. An Alternative Financing Mechanism.

Jason, B. and Pascal, N. (2008). Pay-as-you-drive auto insurance: A simple way to reduce harms and increase equity. Hamilton Project Discussion Paper.

Jean-Philippe, B. (2007). Credibility premium for the zero-inflated poisson model and new hunger for bonus interpretation.

Keneley, M. and McDonald, T. (2007). The nature and development of the general insurance industry in australia.

Lawrence, B. (2001). Significant developments in motor insurance in thailand. Risk Management and Insurance Review.

Lili, B. and Zhengyu, G. (2014). A study of the deficit of the third party liability compulsory insurance of motor vehicle.

Litman, T. (2011a). Distance-based vehicle insurance feasibility, cost and benefits. Victoria Transport Policy Institute.

Litman, T. (2011b). Pay-as-you-drive pricing for insurance affordability. Victoria Transport Policy Institute.

Lookman, S. H. and Balasubramanian (2013). Survey of insurance fraud detection using data mining techniques.

Miguel, S. and Jean-Philippe, B. (2009). Modeling the disability severity score in motor insurance claims: An application to the spanish case.

Miller, S. L. (2001). Regulatory negotiation in automobile insurance reform. Risk Management and Insurance review.

Ming-hua, Y. (2011). Insurance fraud identification research based on the bp neurological network-with china motor insurance claim as an example.

Morata, B. L. (2009).A priori ratemaking using bivariate poisson regression models.

NIC (2010). National insurance commission motor tariff implementation guide-lines.

NIC (2011). National insurance commission annual report.

NIC (2014). http://www.nicgh.org/live/en/news.php?pg=125&pp=93&n=news&view=267.

NIC (2015). http://www.nicgh.org/live/en/?pg=103&pp=93.

Sharon, T. and Salsas-Forn, P. (2002). Claims auditing in automobile insurance: Fraud detection and deterrence objectives.

Stefano, B. and Gisella, F. (2001). Insurance fraud evaluation: A fuzzy expert system.

Stuart, K. A., Panjer, H. H., and Willmot, G. E. (2008). The loss models. from data to decision.

Vladimir, K. K., Nielsen, J. P., and Fredrik, T. (2012). Optimal customer selection for cross-selling of financial service products.

Yip, K. C. H. and Yau, K. K. W. (2005). On modeling claim frequency data in general insurance with extra zeros.

Yiu-Kuen, T. (2009). Nonlife actuarial models, theory, methods and evaluation.

Zantema, J., van Amelsfort, D. H., Bliemer, M. C. J., and Bovy, P. H. L.

(2009). Pay-as-you-drive strategy, case study of safety and accessibility effects. Transportation Research Board of the National Academies.

Appendix

Figure

A

5.1: Year 2002 Motor Tariff [Third Party]

RISK	BASIC PREMIUM	EXTRA SEAT LOADING COST PER SEAT	ADDITIONAL PERILS	NIC	P.A. BENEFIT 5 MILLION	EMERGENCY TREATMENT 300,000 LIMIT	OFFICE PREMIUM
X.1	330,000	10,000	100,000	15,000	50,000	3,000 Per Seat	
X.4	354,500	"	N/A	"	N/A	"	
TAXI	555,000	N/A	"	"	50,000	3,000 Per Seat	
HIRING CARS	445,000	6,000	"	"	"	"	
MINI BUS	568,800	8,000	"	"	"	"	
MAXI BUS	637,250	6,000 5,000	N/A	"	"	"	
AMBULANCE /HEARSE	437,500	5,000	"	"	"	"	
Z.301 Above 3.00CC	600,000 700,250	N/A	"	"	"	"	
ART/TANKER	796,500	N/A	"	"	"	"	
Z.300 Above 3.00CC	450,000 591,200	N/A	"	"	"	"	
Z.802 [SITE]	325,000	N/A	"	"		"	
Z.802[ROAD]	490,000	N/A	"	"	"	"	
GWI-CLASSI	367,000	N/A	"	"	N/A	"	
CLASSII	407,500	N/A	"	"	N/A	"	
CLASSIII	475,000	N/A	"	"	N/A	"	
Y.3	90,000	N/A	"	"	N/A	"	

⇨ No Discounts Are Allowed Here ⇦

B

5.2: Agreed Third Party Premiums-2010

Appendix

Figure

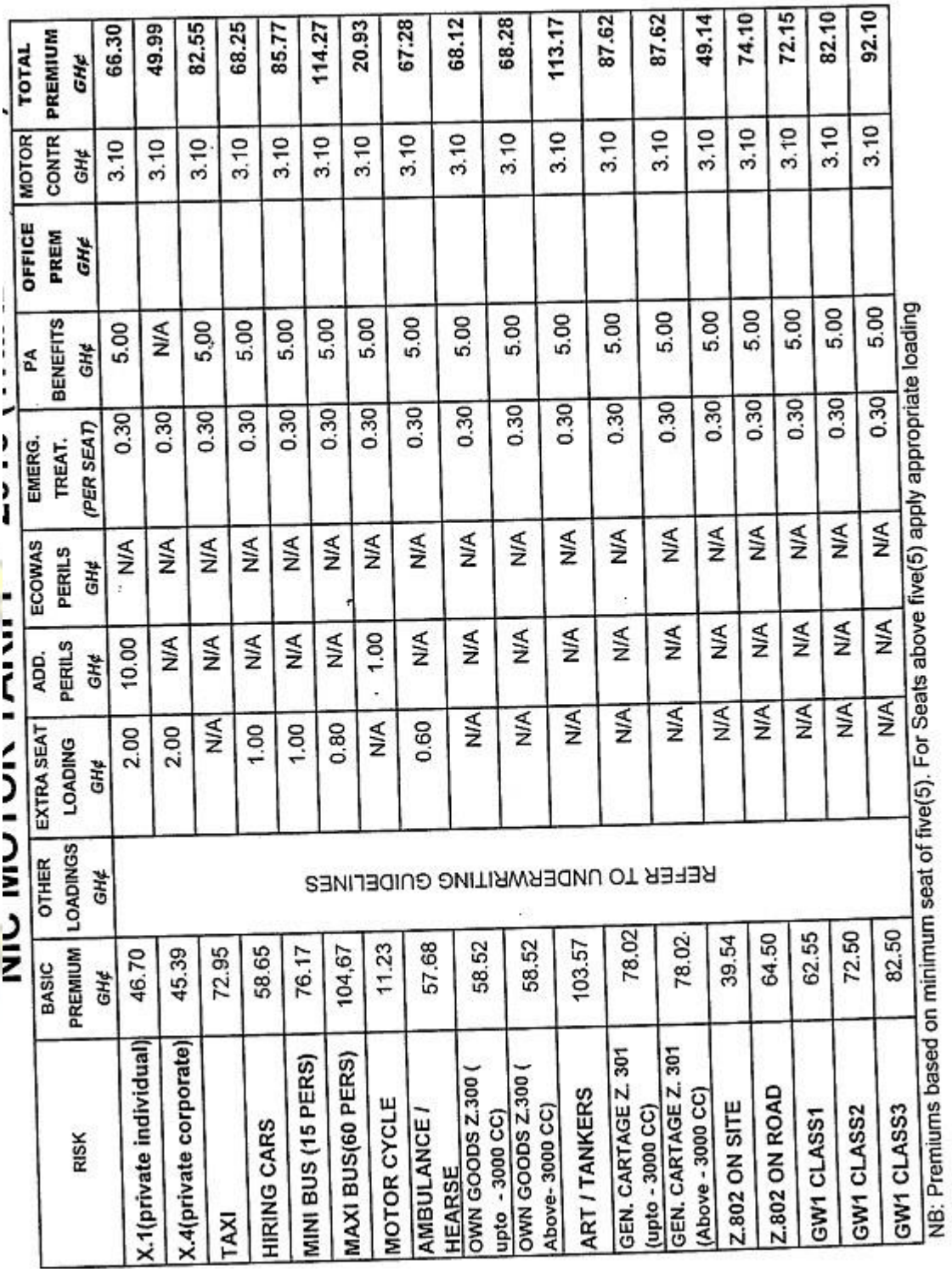
RISK	2002 OFFICE PREMIUMS	AGREED 30% INCREASE	AGREED 2010 PREMIUMS
X.1 (Private Individual)	51.00	15.30	66.30
X.4 (Private Corporate)	38.45	11.54	49.99
TAXI	63.50	19.05	82.55
HIRING	52.50	15.75	68.25
MINI BUS	65.98	19.79	85.77
MAXI BUS	87.90	26.37	114.27
MOTOR CYCLE	16.10	4.83	20.93
AMBULANCE / HEARSE	51.75	15.53	67.28
OWN GOODS Z.300	52.40	15.72	68.12
GEN. CART.	67.40	20.22	87.62
ART / TANKERS	87.05	26.12	113.17
SPECIAL TYPE - SITE (Z802)	37.80	11.34	49.14
SPECIAL TYPE - ROAD (Z802)	57.00	17.10	74.10
TRADE PLATE	55.50	16.65	72.15

Appendix

Figure C

Appendix

Figure 5.3: NIC Motor Tariff-2010 [Third Party]



NIC MOTOR TARIFF

RISK	BASIC PREMIUM GH¢	OTHER LOADINGS GH¢	EXTRA SEAT LOADING GH¢	ADD. PERILS GH¢	ECOWAS PERILS GH¢	EMERG. TREAT. (PER SEAT)	PA BENEFITS GH¢	OFFICE PREM GH¢	MOTOR CONTR GH¢	TOTAL PREMIUM GH¢
X.1(private individual)	46.70	REFER TO UNDERWRITING GUIDELINES	2.00	10.00	N/A	0.30	5.00		3.10	66.30
X.4(private corporate)	45.39		2.00	N/A	N/A	0.30	N/A		3.10	49.99
TAXI	72.95		N/A	N/A	N/A	0.30	5.00		3.10	82.55
HIRING CARS	58.65		1.00	N/A	N/A	0.30	5.00		3.10	68.25
MINI BUS (15 PERS)	76.17		1.00	N/A	N/A	0.30	5.00		3.10	85.77
MAXI BUS(60 PERS)	104,67		0.80	N/A	N/A	0.30	5.00		3.10	114.27
MOTOR CYCLE	11.23		N/A	1.00	N/A	0.30	5.00		3.10	20.93
AMBULANCE / HEARSE	57.68		0.60	N/A	N/A	0.30	5.00		3.10	67.28
OWN GOODS Z.300 (upto - 3000 CC)	58.52		N/A	N/A	N/A	0.30	5.00		3.10	68.12
OWN GOODS Z.300 (Above- 3000 CC)	58.52		N/A	N/A	N/A	0.30	5.00		3.10	68.28
ART / TANKERS	103.57		N/A	N/A	N/A	0.30	5.00		3.10	113.17
GEN. CARTAGE Z. 301 (upto - 3000 CC)	78.02		N/A	N/A	N/A	0.30	5.00		3.10	87.62
GEN. CARTAGE Z. 301 (Above - 3000 CC)	78.02.		N/A	N/A	N/A	0.30	5.00		3.10	87.62
Z.802 ON SITE	39.54		N/A	N/A	N/A	0.30	5.00		3.10	49.14
Z.802 ON ROAD	64.50		N/A	N/A	N/A	0.30	5.00		3.10	74.10
GW1 CLASS1	62.55		N/A	N/A	N/A	0.30	5.00		3.10	72.15
GW1 CLASS2	72.50		N/A	N/A	N/A	0.30	5.00		3.10	82.10
GW1 CLASS3	82.50		N/A	N/A	N/A	0.30	5.00		3.10	92.10

NB: Premiums based on minimum seat of five(5). For Seats above five(5) apply appropriate loading

Appendix D

Appendix

Figure 5.4: Worked example For NIC Motor Contribution Returns

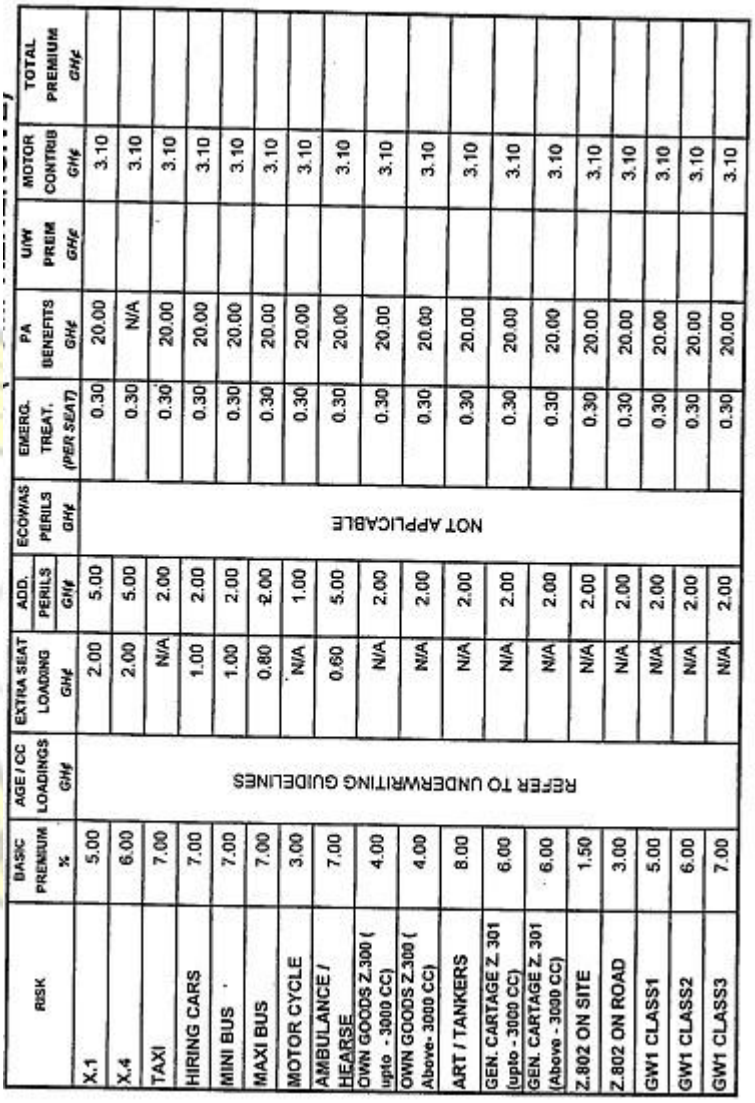
STICKER BOOKLETS		COMPENSATION FUND		NIC		MOTOR CONTRIB.	REMARKS		
	QTY	QTY	AMT(GHC1.00)	QTY	AMT(GHC1.00)	(GHC1.10)	O	C	R
3210401 - 3210450	50	49	49.00	49	49.00	53.90		1	
	50	50	50.00	50	50.00	55.00			
	50	49	49.00	49	49.00	53.90			1
	50	50	50.00	50	50.00	55.00			
	50	50	50.00	50	50.00	55.00			
	50	50	50.00	50	50.00	55.00			
	50	49	49.00	49	49.00	53.90	1		
	50	49	49.00	49	49.00	53.90	1		
	50	50	50.00	50	50.00	55.00			
	50	50	50.00	50	50.00	55.00			
	50	50	50.00	50	50.00	55.00			
	50	50	50.00	50	50.00	55.00			
	50	50	50.00	50	50.00	55.00			
TOTAL			646.00		646.00	710.60	2	1	1

Summary:	GH¢
NIC:	646.00
Compensation Fund:.....	646.00
Sub-Total:	1,292.00
Add:	
Contributions	710.60
Grand Total:	**2002.60**

Appendix E

Appendix

Figure 5.5: NIC Approved Motor Tariff-2010 [Comprehensive]



RISK	BASIC PREMIUM %	AGE / CC LOADINGS GH¢	EXTRA SEAT LOADING GH¢	ADD. PERILS GH¢	ECOWAS PERILS GH¢	EMERG. TREAT. (PER SEAT)	PA BENEFITS GH¢	UW PREM GH¢	MOTOR CONTRIB GH¢	TOTAL PREMIUM GH¢
X.1	5.00	REFER TO UNDERWRITING GUIDELINES	2.00	5.00	NOT APPLICABLE	0.30	20.00		3.10	
X.4	6.00		2.00	5.00		0.30	N/A		3.10	
TAXI	7.00		N/A	2.00		0.30	20.00		3.10	
HIRING CARS	7.00		1.00	2.00		0.30	20.00		3.10	
MINI BUS	7.00		1.00	2.00		0.30	20.00		3.10	
MAXI BUS	7.00		0.80	2.00		0.30	20.00		3.10	
MOTOR CYCLE	3.00		N/A	1.00		0.30	20.00		3.10	
AMBULANCE / HEARSE	7.00		0.60	5.00		0.30	20.00		3.10	
OWN GOODS Z.300 (upto - 3000 CC)	4.00		N/A	2.00		0.30	20.00		3.10	
OWN GOODS Z.300 (Above- 3000 CC)	4.00		N/A	2.00		0.30	20.00		3.10	
ART / TANKERS	8.00		N/A	2.00		0.30	20.00		3.10	
GEN. CARTAGE Z. 301 (upto - 3000 CC)	6.00		N/A	2.00		0.30	20.00		3.10	
GEN. CARTAGE Z. 301 (Above - 3000 CC)	6.00		N/A	2.00		0.30	20.00		3.10	
Z.802 ON SITE	1.50		N/A	2.00		0.30	20.00		3.10	
Z.802 ON ROAD	3.00		N/A	2.00		0.30	20.00		3.10	
GW1 CLASS1	5.00		N/A	2.00		0.30	20.00		3.10	
GW1 CLASS2	6.00		N/A	2.00		0.30	20.00		3.10	
GW1 CLASS3	7.00		N/A	2.00		0.30	20.00		3.10	

Appendix F

Figure 5.6: Extra seat loading

X1 and X4	GHC2 per seat above 5 seats
Hiring	GHC 1 per seat above 5 seats
Vehicles up to 20 seats	GHC 1 per seat above 5 seats
Vehicles above 33 seats	GHC 0.80 per seat above 5 seats
Vehicle above 50 seats	GHC 0.60 per seat above 5 seats
Source:NIC Motor Tariff 2010	

Figure 5.7: Age of Vehicle

1 to 5 years	Free
5 to10 years	5%
Above 10 years	7.50%
Source: NIC Motor Tariff 2010	

Figure 5.8: Cubic Capacity Loading

Up to 1600	Free
1600 to 2000	5%
Above 2000	10%
Source: NIC Motor Tariff 2010	

Appendix

Figure 5.9: No Claim Discount

Years	Private	Commercial	Motor Cycle
1	25	15	10
2	30	20	10
3	35	25	10
4	45	25	10
5	50	25	10
Source: NIC Motor Tariff 2010			