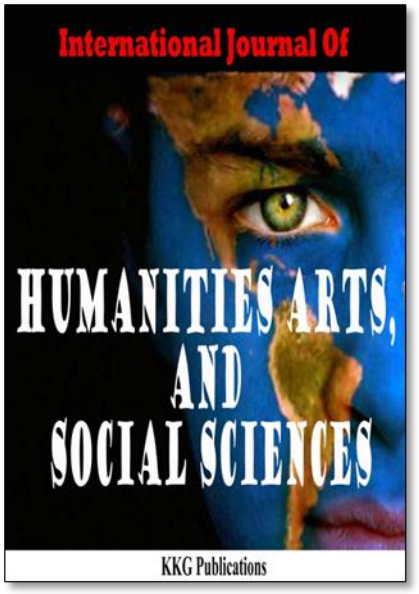

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FACTORS AFFECTING THE NUMBER OF REGISTERED AUTOMOBILE INSURANCE IN MYANMAR BASED ON BAYESIAN MODELING USING THE MCMC PROCEDURE

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Abstract. Insurance plays a vital role in financial sector. Myanmar economy is dramatically developed under new nominally civilian government's policies. This paper presents how government policy changing in other factors affects automobile insurance premium by using MCMC methods which is developed from Bayesian inference. The annual secondary data of registered vehicles, Gross Domestic Product (GDP), Population, premium of Third Party Liability Motor Insurance and Comprehensive Motor Insurance over the period of 1994 to 2014 were used in this study. The Metropolis-Hastings algorithm and Gibbs sampling are applied in this study. Raftery and Lewis convergence diagnostic are computed for MCMC sampler output to determine accuracy and probability of the parameter within a specified quantile to estimate if the parameters are convergent or not. The results show that there is a positive relationship between automobile insurance and other factors such as GDP, registered vehicles and population. However, the number of registered vehicles has no impact on automobile insurance although there is a mandatory motor insurance law in Myanmar.

INTRODUCTION

The international insurers are increasingly turning their interest to Southeast Asia as Western economies get slow and Asian economies become developed and saturated. Among Southeast Asian countries, Myanmar is one of the most potential countries to launch international insurance companies for many reasons. First of all, recently, Myanmar is the political and economic transition country with a young and large population of 53.3 million, the 5th most populous country in ASEAN, so the demand for insurance is also high. Secondly, according to the International Monetary Fund, it is expected to post real GDP growth of around 6% over the next five years. On the other hand, by geographical aspect, Myanmar is strategically located and is also blessed with natural resources that it can be the major artery connection with one third of the global population. Moreover, Myanmar has the border trades with China, India, Laos, Thailand and Bangladesh. Historically, in 1963, before nationalization, there were nearly 80 foreign insurers. Trajectory of the Myanmar's economy is growing and the international relations are expanding, many foreign companies will enter the country, and big international insurance firms also see the huge potential growth amidst economic reforms, and, thus they are eager to get in on the action.

Insurance, the risk-transfer mechanism which is socially valuable, is a vital sector of financial services industry. The concept of general insurance is not only to protect human beings but also secure personal property from unexpected risk. Furthermore, the products and services provided by insurance industry have a lot of obvious benefits for both individuals and the society. Briefly, there are two major divisions in insurance: life insurance and non-life insurance. Life insurance protects policyholders from financial loss due to premature death, sickness or diseases. Non-life insurance, property and casualty insurance, provides businesses and individuals security from financial and physical losses.

Insurance is one of the best known and the most valuable ways of protecting against the risks that are associated with daily life. Meanwhile only a small proportion of Myanmar people is aware of the benefits of affecting the insurance cover for protection of loss potentials in their daily business transactions. In Myanmar, there has not been private insurance for more than 50 years; therefore most of the people do not have the knowledge of insurance advantages. That's why their interest in insurance is very low. In Myanmar, the Insurance system started as an aftermath of the wake of the First Anglo- Myanmar War, and 18 insurance companies landed in 1945. In 1963, before the former military government launched a sweeping nationalization, there were more than 70 private insurance companies which were operating in Myanmar. Since 1952, Myanmar Insurance Enterprise (MIE) stood as the sole insurer in Myanmar. After five decades of monopoly by the state-owned Myanmar Insurance Enterprise (MIE), underdeveloped insurance market of Myanmar was liberalized in 2013. Admittedly, Myanmar insurance sector

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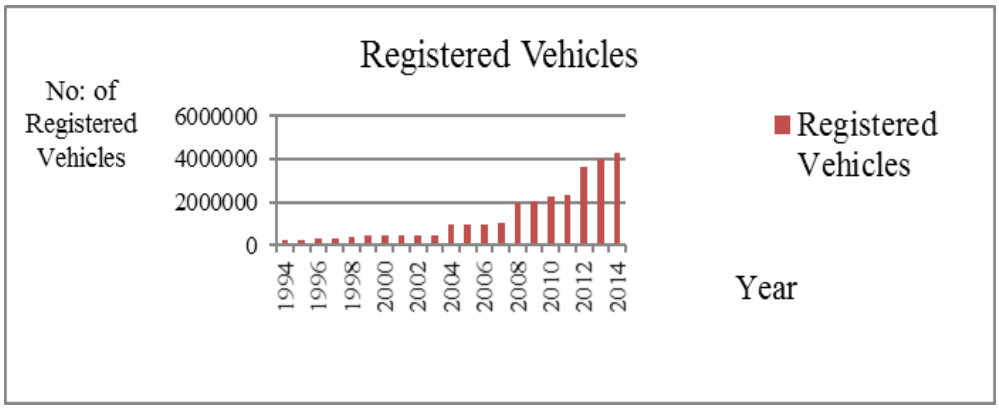
had a long and eventful history and furthermore, accordingly to the Asia Insurance Review, Myanmar insurance has a potential trend to become one of the huge insurance markets in ASEAN.

Following the 2010 general election, the former military government was officially dissolved in 2011 and then a new nominally civilian government was installed. The new government strongly emphasized not only on the expanding of country's infrastructure but also on the economic transition. Myanmar insurance is one of the obvious economic transition changings under the new government. Myanmar Insurance Industry has seen setbacks in September 2012; following that the government announced that monopoly would be broken and to become a well-functioning market economy, government also invited both local and international private insurance companies to enter insurance industry. As Myanmar opens to the world, insurance sector is also growing pressure to upgrade and expand.

Myanmar Insurance mainly sells seventeen insurance products in Myanmar. Overall, there are different kinds of products in Insurance Market of Myanmar, this research will focus on the automobile insurance sector because this sector has the most dramatic effect under the civilian government's reform and new policies such as the privatization of the insurance industry and especially the policy changing in the automotive industry of Myanmar. Significant changings of new administration's performances of the release of car import regulations and an old-age car substitution program have strongly affected the automobile insurance of Myanmar. During 2010-2011, after the period of election, the new government released vehicles import regulations. In September 2011, an old-age car substitution program was launched in Myanmar. Under the recent government policy, 10 years old poor cars are qualified for the old-age car substitution program. Before the policy change in Myanmar, only 20 years old vehicles were able to receive import permission slips to trade into new car. After changing the vehicle import policy, the government granted more licenses to the country's car production factories with the hopes of increasing demand for local vehicle manufacturing. Under the previous military government, car prices in Myanmar were the highest among the world due to import restrictions. Because of the current quasi-civilian government, restrictions have eased and car prices have fallen dramatically.

Figure 1 shows the number of registered vehicles which represents the development of automobile industry over the period of 1994 to 2014. From the figure, it can be clearly seen that the number of registered vehicles keeps rising from 2 hundred thousand to over 4 million since the policy changed.

FIGURE 1
Numbers of Registered Vehicles



Source: Ministry of Commerce, Myanmar

Government of Myanmar changed a lot of policies on automobile setor over 70 years. The following tabel shows the bief history of changing policy on automobile sector.

Thanks to the potential growth of automobile industry, motor insurance sector in Myanmar expands and has an interest of policyholders. Policyholders in Myanmar can buy two types of automobile insurance: third party liability automobile insurance and comprehensive motor insurance. Third party liability motor insurance is the mandatory insurance for all registered vehicles in Myanmar under Third Party Liability Insurance Rules of 2nd May 2003. According to this law, all vehicles not only from foreign countries entering or crossing Myanmar but also the vehicles which are produced in domestic confines have to buy Third Party Liability Insurance. The cover consists of death, bodily injury, or property damage to a third party (or) insured caused by motor vehicles. The Third Party Liability only policy covers the motor vehicles user's or owner's liability for death or bodily injury to third party, loss or damage to the property owned by third party. Vehicle owners can also buy additional covers for other perils by payment of extra premium: Flood, Wind storm, earthquake, strike, riot and civil commotion, and theft. Comprehensive Motor Insurance is voluntary insurance which includes both third party

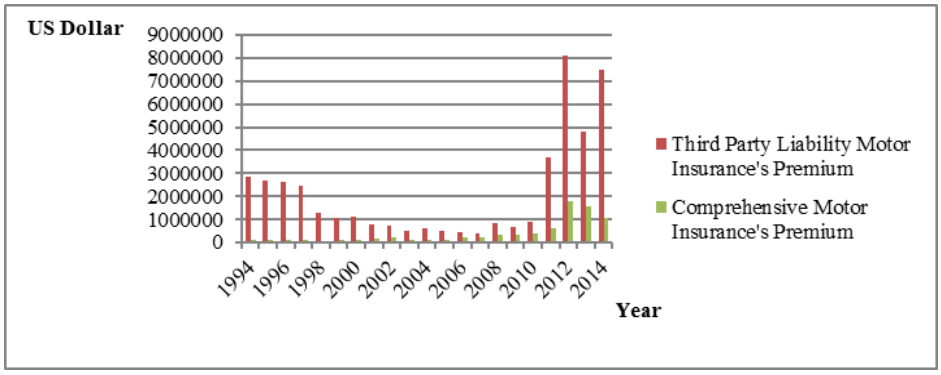
liability and own damage cover. The comprehensive policy includes compensation for loss of or damage to the insured vehicle caused by: accidental collision, overturning, fire or lightning, malicious act, and impact damage caused by falling object.

In order to understand more clearly about insurance economics especially in automobile insurance premium and the effect of the change in government policy, figure 2 shows the total volume of the premium rate of automobile insurance in Myanmar during 20 years which represent the demand of automobile insurance in Myanmar. Myanmar Insurance Enterprise sells two products of automobile insurance in Myanmar. They are Third Party Liability Motor Insurance and Comprehensive Motor Insurance. Policyholders can buy all types of motor insurance with both Myanmar currency and US dollar. However, in order to make all the variables used in this study, to be in harmony with each other, all financial data are converted into US dollar term by using the real exchange rate announced by the IMF. Until 1st April 2012, fixed exchange rate was denoted over 35 years in Myanmar. Therefore, this study uses IMF based exchange rate rather than Government Base Exchange Rate.

The following figure 2 shows the amounts of automobile premium over the period of 1994 to 1996 which represents the demand of motor insurance in Myanmar. The volume of insurance premium increased as rapidly as the number of registered vehicles since 2011 after government policy changed on car import policy. Noticeably, 2012 shows the highest amount of premium in Third Party Liability Motor Insurance during 20 years because government liberalized car permit regulations and allowed every Myanmar citizen who had legal age to import car under their name. In 2013, the premium amount had fallen because of the frequent import policy changes. Unstable policies have been controversial because of their dramatic impact on prices. Many dealers have been left with stock that is worth far less than what they paid to import it, while thousands of cars have even been abandoned at Yangon port because the taxes owed are higher than their sale price. People are afraid to buy or import car on unstable condition.

On 13th May 2014, the minister for commerce promised not to change car policy anymore. Because the government authorized officer granted that not to change import policy again, the premium rate of Third Party Liability rose again after that announcement. On the other hand, the number of comprehensive motor insurance had slightly fall because since August 5, 2013, Myanmar Insurance allowed private insurance companies to sell non-life insurance products. Therefore, people started buying comprehensive motor insurance from other private insurance companies.

FIGURE 2
The Volume of Automobile Insurance Premium



Source: Myanma Insurance

This study examines the factors that affect the premium of automobile insurance in Myanmar. From the effect of government policies and reform, shown in above figures is a total effect of all factors, furthermore, there is still need to know which factor is the most effective factor affecting automobile insurance premium and the net impact of each factor. Thus, in order to investigate the factor affecting the number of registered automobile insurance of Myanmar during the period 1994-2014, the technique used for estimation is based on Bayesian modeling using the MCMC procedure. There are many reasons to select Markov chain Monte Carlo (MCMC) simulation for this study. One of the main reasons is the shortage of observations which were used in this study. MCMC methods are one of the branches of Bayesian inference which apply in many fields of economic research such as marketing research and financial econometrics. The strong point of Bayesian approach using MCMC is that on the unobserved variables, one only has to consider the likelihood function conditional. Secondly, MCMC method is a class of algorithms for sampling from probability distributions in a special way and it is a subclass of Monte Carlo simulation. Monte Carlo simulation is one of the greatest common techniques for propagating the uncertainty in the various aspects of a system to the predicted

performance. The entire system is simulated a large number of times. Each result is separate, independent and represents possibility of future realization for the system. In the whole methodology part, Augmented Dickey-Fuller unit root test, Phillips-Perron unit root test and Markov Chain stimulation are included. This paper can be said to be the first research to study the automobile insurance in Myanmar.

Theory

Solow's neoclassical growth theory (1956) showed that countries which have well- functioned financial systems get stable and show faster economic growth. Theoretical studies and empirical evidence proved that there is significant positive relationship between better-developed financial markets and total factor productivity. Insurance sector links into other financial sectors such as banking, stock exchange and it plays a vital role in financial sectors.

Insurance plays a significant role in the economy by mobilizing domestic savings. It enables not only to reduce loss and financial instability but also improves economic activities and development. Moreover, basic principle of insurance is that it transfers risk from the policyholders to the insurer. The insurers earn funds by collecting premium from insurer. Furthermore, insurance promotes industrial development of a country by generating investment between financial institutions and consumers (Insurance, 2015).

The rapid growth of total insurance premiums is directly related with GDP growth. The main function of insurance is to pass risk through insurer. The insured pays a premium and makes a contractual agreement with insurance companies to secure against a specific uncertainty. The amount of insurance premiums is directly related to GDP. Risk diversification and loss minimization are the aims of insurance. However, policyholder needs to pay in advance to take protective coverage from insurance products. Therefore (Beenstock, Dickinson & Khajuria, 1988) suggest that GDP is one of the significant factors in study in the consumption of non-life insurance.

The rapid growth in population and economic activities can increase the growth of registered vehicles (Goel & Sachdeva, 2014). According to the From Cities on the Move report of World Bank on 2002, in developing countries, urban populations are growing annually more than 6 percent. Therefore, rapid urbanization in developing countries presents tremendous challenges to the transportation systems of expanded cities not only to meet the accessibility but also sustainability of safety and healthy environment.

In 21st century, non-life insurance protects not only a vehicle which is a financial asset of policyholders but also ensures life safety of insurer. According to the Ernst & Young estimate's Year 2011 report of Motor insurance: Asia's growth engine,

"Motor insurance is a high volume, low unit risk business."

Automobile insurance is an agreement contract between policyholders and the insurers that protects against financial loss of insured. Depending on the type of automobile insurance, the coverage is different. Consumers can buy automobile insurance policies depending on the needs of their preference.

Motor insurance is the strongest class of non-life insurance product in terms of premium volume. Motor insurance industry is dominated by fierce competition for market share in some developing countries (Gönülal, 2009).

Non-life insurance development is linked to GDP (Beenstock et al., 1988). The rapid population growth and increasing economic activities have resulted in tremendous growth of motor vehicles. At the same time, the number of accidents happened increases with the number of motor vehicles. The severity of accident depends upon the type of vehicle involved in the accident (Goel & Sachdeva, 2014).

LITERATURE REVIEW

Stephens, Crowder and Dellaportas (2004) Quantification of automobile insurance liability: a Bayesian failure time approach. The main goal of this research work is to make a new modeling approach to the prediction of outstanding claims of an insurance company. In this paper, they used a three-stage hierarchical model, and in that model the number of claims made per year, the settlement process in each year, and the claim settlement amounts are included. In this study, researchers used Failure time modeling, Automobile insurance liability, Bayesian inference and Markov Chain Monte Carlo (MCMC). Researchers assumed that data of "reported-but-not-settled" records of (1989-1995) outstanding claims and in which the year of notification is the same as the accident year and there were no partial payments. At Bayesian inference: notation and model: A Poisson regression model for number of claims; A discrete failure time model for settlement times and Hazard parameterization, hazard likelihood, Hazard prior and Hazard posterior are tested; Marginal likelihood under the non-parametric model; A Gamma model for claim amount. In Bayesian inference and prediction, likelihood construction is tested with three stages and then prior distributions are presented. The Bayesian computation via MCMC model in this paper consisted of a series of either Gibbs or Metropolis-Hastings updating steps which are so called a Metropolis-within-Gibbs algorithm. The main advantage of applying the new modeling approach is that it can predict the future outstanding claims via a failure time approach.

Gschlößl and Czado (2007) Spatial Modeling of Claim Frequency and Claim Size in Non-life Insurance in German. This paper mainly used two models: Compound Poisson model and spatial regression models. Under these main models, MCMC based on Bayesian inference and Poisson Regression Model and Gamma model were used. The data set of this study is based on full comprehensive car insurance in Germany within the year 2000 with 350000 observations. The variables used in this paper were policyholders with full comprehensive car insurance premiums,

claims caused by traffic accidents, age, gender, kilometers driven per year, type of car and age of car. There are three main objectives in this study; (a) Does the inclusion of spatial effects, improve the model fit after having adjusted for covariate information and can it be observed as a spatial pattern for the expected number of claims and the expected claim sizes? (b)Are there significant numbers of claims effects in the models for claim size? (c) To what extent the inclusion of spatial and claim number effects influence the total claim sizes from (a) and (b)? For the methodology, Poisson regression model with spatial effects is applied for claim frequency. And then MCMC model based on Bayesian inference is used as measures for comparing model based on related posterior predictive distribution. According to the result, the inclusion of spatial effects leads to a significantly improved model fit not only for claim frequency but also for claim size and more accurate predictions of the total claim sizes are obtained. Furthermore, effects for the number of claims are significant in the claim size models and there is a negative relationship between number of claims and the average claim size. The expected average claim size is inversely related to the number of claims caused by policyholder.

Yu (2015) Hierarchical Bayesian Modeling of Health Insurance Claims. The main objective of the study is to propose using Bayesian framework for health insurance total claim amounts classified by age group, region of residence and time horizon of the insured population. The insured population, number of claims and amount of claims were used as the variables of this study. For the methodology, generalized exponential growth model (GEGM) is applied for the insured population growth which consists of the random effects in age, region and time classifications. The number of claims for each classified group is assumed Poisson distributed and independent of the size of the individual claims. Markov chain Monte Carlo (MCMC) is used to test the effectiveness of modeling and estimation. Four premium principles and two risk measures are used based on the predicted values to estimate the premium. Bayes and posterior regret gamma minimax premium computation, and Bayes and posterior regret gamma minimax prediction of a future claim size under the general entropy loss were applied in methodology of the study. This study used robust Bayes methodology under the asymmetric general entropy loss function in insurance. This paper also compared the prequential analysis and the performance of posterior regret gamma minimax predictors against the Bayes predictors. Two major objectives of this study are (1) computing premiums, and (2) predicting a future claim size. According to the result, based on the predicted claim amounts, under various premium principles the premiums can be calculated. The premium to charge per policyholder can also be obtained easily by dividing the total premiums over the predicted insured population.

Gao, Li and Guo (2011) Automobile Insurance Pricing with Bayesian General Linear Model. In this study, researchers compared two methods: General Linear model and MCMC method based on Bayesian theory for pricing automobile insurance and examining the best method among them. The variables used in this study are vehicle type, vehicle age, geographic zone and vehicle insurance claim amount. According to the result, Bayesian General Linear Model is the best one for pricing automobile insurance. General Linear Model cannot fully integrate prior information and has too much trust in Data and moreover it is rather broad when price of Vehicle insurance is considered. While pricing based on Bayesian method can fully integrate experiential opinions of actuaries and shortage of data can also apply with this model and is able to make vehicle insurance rate more comprehensively and reasonably. It can be easily applied to other vehicle insurance pricing models.

Karimnezhad and Parisan (2014) Robust Bayesian methodology with Applications in Credibility Premium Derivation and Future Claim Size Prediction. Major concerns of this paper are the two problems in Bayesian framework (a) estimation of a risk premium and (b) prediction of a future claim size. Robust Bayesian method is applied which deals with the problem of explaining uncertainty of the inputs such as the prior, the model, and the loss function and provides a break-through way to take into account the input's variation. In this paper, researchers were motivated to utilize robust Bayes methodology under the asymmetric general entropy loss function in insurance and pursue two major purposes: (1) computing premium, and (2) predicting a future claim size. Some classes of priors and concern with (a) Bayes and posterior regret gamma minimax premium computation, and (b) Bayes and posterior regret gamma minimax prediction of a future claim size under the general entropy loss are used in this paper. The outcomes of the research are (1) estimate average prediction risk (EAPR) values have a negative relationship with times (n), and (2) posterior regret gamma minimax (PRGM) predictors act much better than the Bayes predictor.

Literature Review Regarding Myanmar's Case

Aung (1998) Insurance, An Essential Element in the Economy. This study broadly explained about general benefits of insurance, contribution of insurance to economy, risk management, role of insurance in Myanmar Economy, and the liberalization of Insurance by descriptive statistics. This paper also examined about the Insurance Liberalization in Thailand and Indonesia, and also analyzed the relationship between inflation and insurance premium. He presented that high inflation is a definite obstacle to the development of insurance, and to life insurance in particular. Moreover, the volume of premium revenue in the insurance sector is highly sensitive to the insurance factor. Researcher also presented about consumers' lack of familiarity with insurance products in life insurance and underdeveloped domestic financial market of Myanmar. This research also forecasted about the future competition in the liberalization of Insurance Market and also estimated about the future trend of Insurance Industry in

Myanmar.

Thant (2010) studied Insurance Market Development in Myanmar. This paper explored the background of Myanmar Insurance Industry and overviews the risk and insurance and people's consciousness how insurance can cure the losses that they may face in the courses of their daily lives and its trend over the period (1989-2006). Also, the need of life insurance for the public in Myanmar was assessed. This paper divided Myanmar Insurance Market into two periods: before 1988 and after 1988. The part of Myanmar Insurance Market Development before 1988 is examined into 3 eras: (1) Colonial Period, (2) Parliamentary Democracy Period and (3) Centrally Planned Economy Period, and after, 1988 is presented about the era of Market Economy Period. Secondly, it analyzed the situation of life insurance in Myanmar Insurance. In this part, this study pointed out about the requirements of life insurance product distribution and technologies. This paper recommended that the requirements of Life Insurance in Myanmar economy can be easily created by the government in the manners of a sound but flexible system of regulation and supervision, incentives to save for the long term rather than consume, encouraging better understanding of personal saving and financial planning through education.

THEORETICAL FRAMEWORK

This paper tests about the statistical relationship between automobile insurance premium and other related factors' effects on it. The MCMC method will be applied to achieve the objective of the study. The adopted model for the demand function of the study can be expressed as follows:

$$NRV_t = f(TPL_t, CMI_t, PoP_t, GDP_t)$$

Where,

NRV_t = Numbers of Registered Vehicles

history of global insurance industry. In this study, it analyzed with descriptive statistics method to evaluate the relationship between insurance and economic growth which may attribute the

TPL_t = Third Party Liability Motor Insurance in US dollars

CMI_t = Comprehensive Motor Insurance's premium in US Dollars

PoP_t = Population of Myanmar

GDP = Gross Domestic Product of Myanmar in US Dollars

The above equation can explain why these variables influence the volume of automobile insurance in Myanmar.

The major hypothesis of this model is registered vehicle , non-life insurance development is linked to GDP (Beenstock et al., 1988). The rapid population growth and increasing economic activities have resulted in tremendous growth of motor vehicles. As number of registered vehicles increased, the demand of motor insurances also rose.

However, as this paper focuses only on the relationship between foreign trade and economic growth, the first three variables are not included in the model. As the VAR estimation and Granger causality test are used to investigate the relationship among all three variables, all of these three variables are endogenous variables and put on the right hand sides in three equations.

The variables used in this study consist of endogenous variables such as the growth rate of GDP, Export income and Import expenses of Myanmar. The following table shows the design of the variables and measurements used in this study.

TABLE 1
Design of the Variables

Concept	Variables	Measures	Symbols
Number of registered vehicles in term of growth rate	Number of registered vehicles	{(Present year NRV- Previous year NRV)/Present Year NRV}*100	NRV_t
Third Party Liability Motor Insurance's premium in terms of growth rate	Third Party Liability Motor Insurance's premium	{(Present year TPL_t- Previous year TPL_t)/Present Year TPL_t}*100	TPL_t
Comprehensive Motor Insurance's premium in terms of growth rate	Comprehensive Motor Insurance's premium in Dollars	{(Present year CMI_t- Previous year CMI_t)/Present Year CMI_t }*100	CMI_t
Population of Myanmar in terms of growth rate	Population of Myanmar	{(Present year PoP_t- Previous year PoP_t)/Present Year PoP_t}*100	PoP_t
Gross Domestic Product of Myanmar in terms of growth rate	Gross Domestic Product of Myanmar	{(Present year GDP - Previous year GDP)/Present Year GDP}*100	GDP_t

RESEARCH METHODOLOGY

Bayesian Theorem

In this section, theories will be emphasized about the relationship between the premium amount of automobile insurances and the

number of cars registered and the other related factors in Myanmar: multi regression model based on Bayesian Theorem.

Bayesian Data Analysis

Bayesian approach is formulated by Rev. Thomas Bayes (1702-1761) (Holland, 1962). There are three steps to Bayesian data analysis.

1. Set up of a full joint probability distribution for both observable, y and parameters, θ, $\mathrm{p}(y,\theta) = \mathrm{p}(\mathrm{y} \mid \theta)\,\mathrm{p}(\theta)$
2. Conditioning on data, p (y,θ)
3. Model checking

In Bayesian data analysis, almost all inference is made by using probability statements, regarding $\theta \mid y$ or $\tilde{y} \mid y$, for future unobserved $\tilde{y}$.

Most classical models can be casted in a Bayesian framework such as normal linear regression, ARMA, GLMs, etc.

Markov Chain Monte Carlo

Markov Chain Monte Carlo (MCMC) model can be called as the revolution of Bayesian statistics. It was popularized by a paper of (Gelfand & Smith, 1990). Gelfand and Smith (1990) is one of the top three most cited papers in mathematics in the last 20 years. Before Gelfand and Smith (1990), there also had been other statisticians who were using MCMC such as Ripley, Besag, Tanner and Geman.

Markov Chain Monte Carlo (MCMC) methods are a class of algorithms to simulate samples from a posterior distribution to get the desired true posterior distribution at stationary level. (Kristoffer Sahlin, 2011). The first major MCMC algorithm was devised by Metropolis et. al (1953), the so called Random Walk Metropolis algorithm. In Monte Carlo methods, the samples are assumed as independent.

MCMC is a general method which simultaneously solves inference of

$$\{p(\theta \mid y), p(\theta_i \mid y), p(\tilde{y} \mid y)\}$$

The requirement of the evaluation of joint distribution is

$$p(\mathrm{y},\theta)\alpha\, p(y \mid \theta)\, p(\theta) \qquad , \theta \in \Theta$$

MCMC methods construct a Markov Chain on the state space, $\theta \in \Theta$, whose steady state distribution is the posterior distribution of interest $p(\theta \mid y)$. MCMC simulation approximates the true posterior density by using a bag of samples drawn from the density.

MCMC is a powerful simulation technique for inference that is especially used when there is non-conjugacy; it means that when the combination of prior and sampling distributions does not lead to a standard form for the posterior, $p(y \mid \theta)$. Furthermore, MCMC works by stimulating a discrete-time Markov chain and it produces a dependent sequence (a chain) of random variables with approximate distribution. The chain is initialized with a user defined starting value, $\theta^{(0)}$. MCMC produces a set of dependent samples.

There are two main general procedures for MCMC stimulation from a target distribution: (1) Metropolis-Hastings, and (2) Gibbs sampler. The Metropolis-Hastings algorithm is a general approach to sampling from a target density. The Gibbs sampler, Gibbs sampling of Geman and Geman (1984) and Gelfad and Smith (1990), the most popular MCMC method, is a special case of the Metropolis-Hastings algorithm using the order sub-updates.

This study uses MCMC algorithms based on Raftery-Lewis convergence diagnostic which was designed to test the number of iterations and burn-in needed by first running and testing shorter pilot chain. Raftery and Lewis's diagnostic is a run length control diagnostic based on a criterion of accuracy of estimation of the quantile q. It is deliberated for use on a short pilot run of a Markov chain. The number of iterations required to estimate the quantile (q) within an accuracy of positive or negative value of (*r*) with probability *p* is calculated. Separate calculations are performed for each variable within each chain.

The lack of dependence on the past is called the Markov property and allows Markov chains to simplify complex problems. In the MCMC pack, M refers to number of burn-ins necessary, N means number of iterations necessary in the Markov chain, Nmin is minimum number of iterations for the "pilot" sampler, and I represents dependence factor, which is interpreted as the proportional increase in the number of iterations attributable to serial dependence. If high dependence factors were greater than 5, that will be worrisome and may be due to influential starting values, high correlations between coefficients, or poor mixing. There are four main steps in MCMC algorithms, 1) Burn-in period, 2) Thinning, 3) Effective Sample Size, and 4) Convergence.

ADF Unit Root Test

Augmented Dickey Fuller (ADF) unit root test is an argument version of Dickey fuller (DF) test. It is used to provide some form of the serial correlation. There are three versions of ADF unit root test that can be applied to analyze whether property of a series is stationary or non-stationary.

(1) Test for a unit root

$$\Delta y_t = \varphi^* y_{t-1} + \sum_{i=1}^{p-1} \varphi_i y_{t-i} + \varepsilon_t$$

(2)Test for a unit root with a constant

$$\Delta y_t = \beta_o + \varphi^* y_{t-1} + \sum_{i=1}^{p-1} \varphi_i y_{t-i} + \varepsilon_t$$

(3)Test for a unit with a constant and deterministic time trend

$$\Delta y_t = \beta_o + \beta_1 t + \varphi * y_{t-1} + \sum_{i=1}^{p-1} \varphi_i y_{t-i} + \varepsilon_t$$

Where,

y_t = value of variable at time "t"

y_{t-1} = value of variable at time "t-1"

Δy_t = the difference between y_t and y_{t-1} (y_t - y_{t-1})

β = constant term

t = time

ε_t = an error term

To get the presence of unit root test, T statistics is needed to compute to compare the corresponding critical value at different significance level. (Xu, 2012)

The formula of T statistics is:

$$\tau = \frac{\delta^*}{\sqrt{\text{var}(\delta^*)}}$$

Data of the Study

This study examines the relationship between the number of registered vehicles, population and the amount of motor insurance's premium in Myanmar over the period of (2000-2014) financial years. This study used the secondary data using annual year data for five variables, and all the data used in this study are taken from the Myanmar Insurance, International Monetary Fund (IMF), The World Bank, and Myanmar Road Transportation Administration Department.

In respect to methodology selection, motor insurance premiums, population, GDP, number of accidents, and number of registered vehicles are used to run the multi-regression model based on Bayesian approach. Data processing is a vital role of the whole study. As a result, all data were analyzed quantitatively with the help of R version 3.2.0 in order to attain the objective of the study.

The data description and statistics are shown in Table 2. As shown in the table, the mean values of all variables are positive.

TABLE 2
Data Description and Statistics

Variables	Observations	Mean	Standard Deviation	Minimum Value	Maximum Value
Growth rate of Gross Domestic Products					
GDP	20	13.19874	19.95621	-27.26477	54.44317
Growth rate of Population					
PoP	20	0.957809	0.246006	0.653254	1.336925
Growth rate of Number of Registered Vehicles					
NRV	20	18.74043	29.54255	1.333031	29.54255
Growth rate of Third Party Liability Motor Insurance					
TPL	20	20.44691	80.83269	-48.66103	304.2462
Growth rate of Comprehensive Motor Insurance					
CMI	20	20.51174	54.34461	-49.29846	191.8724

Empirical Analysis

The relationship between the economic growth and foreign trade is examined in two ways: exploratory data analysis and descriptive analysis. The first section deals with the data running and data analyzing by using VAR model to find out the relationship between economic growth and foreign trade in growth rate terms. The facts that how GDP growth affected the foreign trade, how imports growth and exports related each other and how foreign trade had impacts on GDP growth are discussed based on the empirical results. In the second section, the relationship between the economic growth and foreign trade is discussed by using descriptive statistics.

Exploratory Data Analysis

Firstly, the Augmented Dickey-Fuller (ADF) unit root test is applied to check the stationary condition of the data set in order to put the MCMC algorithms of Bayesian analysis. In this study, all data are time-series and have to be stationary at level in Augmented Dickey-Fuller (ADF) unit root test. After making sure that all the data are stationary at level, MCMC stimulations are conducted as the second step of the analysis to examine the relationship between automobile insurance premium and other five variables.

Augmented Dickey-Fuller (ADF) Unit Root Tests

Augmented Dickey-Fuller (ADF) unit root test is applied to check the stationary quality of the time series variables in order to use MCMC stimulation method based on Bayesian Theorem of Multi-regression model. According to the Augmented Dickey-Fuller (ADF) unit root test, if the test statistics is less than 5% , the null hypothesis can be rejected and the data is time-series stationary. Table 4.1 shows the ADF unit root tests results of the variable. As shown in Table 3, all variables are stationary at level in testing with intercept.

TABLE 3
Augmented Dickey-Fuller Unit Root Tests Results

Variables	ADF Test statistics	5% Critical value	10% Critical value	Deterministic Regresses	Lags	Results
GDP	-3.860804	-3.029970	-2.655194	Intercept	4	Stationary
PoP	-3.629942	-3.065585	-2.673459	Intercept	4	Stationary
NRV	-5.246777	-3.029970	-2.655194	Intercept	4	Stationary
TPL	-3.231428	-3.029970	-2.655194	Intercept	4	Stationary
CMI	-4.448392	-3.029970	-2.655194	Intercept	4	Stationary

As shown in Table 4.1, except GDP, the rest of the two variables, EXP and IMP, are stationary at level in testing with intercept and trend. However, in testing with neither intercept nor trend, null hypothesis can be rejected for all three time-series, which means that all the variables are stationary at level in testing with neither intercept nor trend. The time-series data of GDP are significance at 10% critical level.

MCMC Procedure Based on Bayesian Multi-Regression Model

Markov chains can serve as a crucial alternative analytical tool for the construction of computer algorithms for the Markov Chain Monte Carlo simulation (MCMC) of the mathematical models under consideration.

Markov Chain Monte Carlo (MCMC) is a computationally intensive simulation method to replace the exact integrals which were developed in the 1980s which made it possible to tackle more complex and realistic problems. Creating a stationary distribution of Markov process which is specified, $p(\theta \mid y)$ and running the long sufficient stimulation is the key of MCMC.

$$NRV_t = \varepsilon + \beta_1 TPL_{\$t} + \beta_2 CMI_{\$_t} + \beta_3 PoP_t + \beta_4 GDP \quad ,$$

$$\varepsilon \sim n(0, \sigma^2 I)$$

Where,

NRV_t = number of registered vehicle

TPL_t = Third Party Liability Motor Insurance's premium

CMI_t = Comprehensive Motor Insurance's premium

PoP_t = Population of Myanmar

GDP_t = Gross Domestic Product of Myanmar

Here

$Y = NRV = (\text{nrv}_1, ..., \text{nrv}_n)^T$

and TPL_t, $CMIK_t$, GDP_t and PoP_t are dependent variables (X),

$X = [1, X_1, ..., X_k]_{n\times(k+1)}$, with $X_j = (X_{j1}, ..., X_{jn})^T$,

$\beta = (\beta_0, ..., \beta_k)^T$, $\varepsilon = (\varepsilon_1, ..., \varepsilon_n)^T$

Conjugate priors:

$$\beta \sim N(\beta_0, A_0), \sigma^2 \sim IG(\frac{\upsilon_0}{2}, \frac{\delta_0}{2})$$

Where β and σ^2 are assumed a priori independent.

The likelihood function:

$$\text{L(Y}; \beta, \sigma^2) = (2\pi\sigma)^{-\frac{n}{2}} \exp\left\{-\frac{(Y - X\beta)^T (Y - X\beta)}{2\sigma^2}\right\}$$

Conditional posterior distributions:

$$\beta \mid Y, \sigma^2 \sim N(\widehat{\beta}, \widehat{A})$$

After the model has converged, samples from the conditional distributions are used to summarize the posterior distribution of parameters of interest, in this case β and σ^2. Convergence refers to the idea that MCMC technique will eventually reach a stationary distribution.

FIGURE 3
The Trace Plots and Histograms of All MCMC Iterations for All Parameters

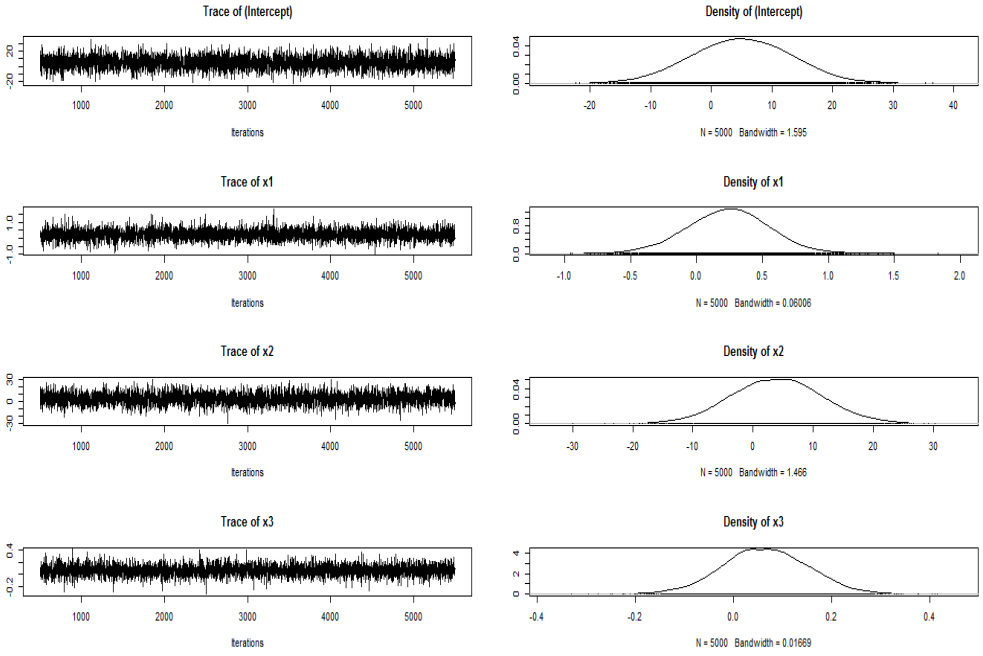
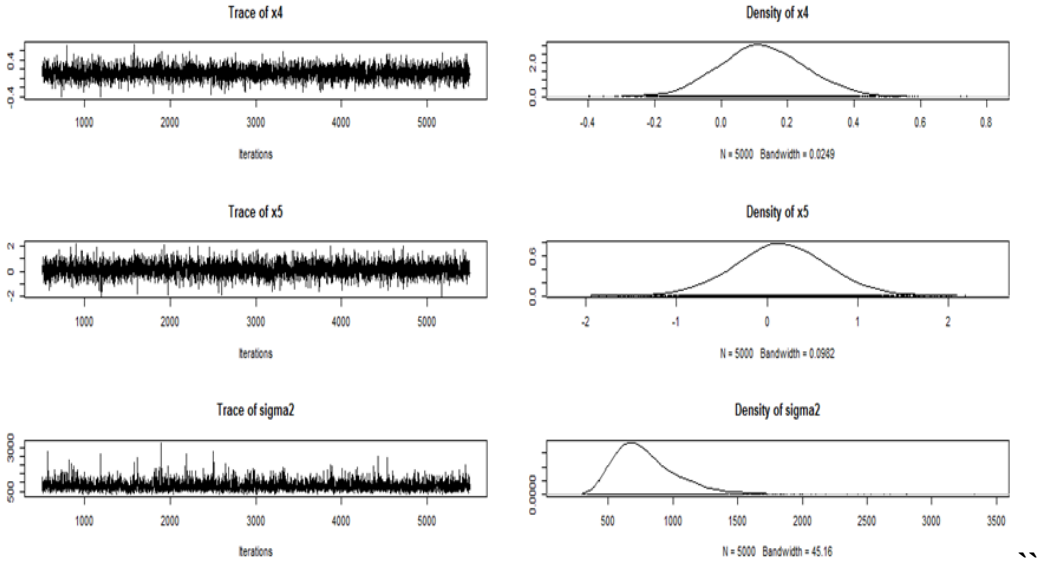


FIGURE 4
The Trace Plots and Histograms of All MCMC Iterations for All Parameters



Above figures show that the trajectory of the chain is consistent over time which is important to approximate the stationary distribution adequately, and that its distribution looks appropriately normal. Moreover, the traceplots of the study indicate that the chains are mixing well. Therefore, the traces and distributions of all variables are reasonable. According to the Markov chains theory, the chains are eventually converging to the stationary distribution of target distribution. It is easily seen that $f(TPL_t, CMI_t, PoP_t, GDP_t)$ is a stationary distribution for this Markov chain. Therefore, if the conditions of the ergodic theorem are satisfied, then $f(TPL_t, CMI_t, PoP_t, GDP_t)$ is a limiting distribution of this chain. Therefore if we run the chain a long time (burn it in), the observations we get will have this distribution.

TABLE 4
Summary (Posterior)

	Burn-in (M)	Total (N)	Lower bound (Nmin)	Dependence factor (I)
(Intercept)	2	3803	3746	1.02
X1	2	3803	3746	1.02
X2	2	3803	3746	1.02
X3	3	4062	3746	1.08
X4	2	3995	3746	1.07
Sigma2	2	3803	3746	1.02

Quantile (q) = 0.025, Accuracy (r) = +/- 0.005, Probability (s) = 0.95

For the parameter of GDP (x1), and population (x2), the results suggest that a total of 3803 samples be generated of which the first 2 be discarded as a burn-in sequence. The results of the parameter of Third Party Liability Motor Insurance (x3), and Comprehensive Motor Insurance (x4) show that a total of 4062 and 3995 samples be generated at the first 2 be discarded as a burn-in sequence. Thinning interval indicates that every (1) sample, after the burn-in sequence, be retained for posterior inference due to serial autocorrelation.

According to the lower bound results, the number Dependence Factor is simply the total number of iterations divided by the lower bound. It measures the sample size increase due to autocorrelation. Dependence factors less than 5.0 indicate that there are perfect convergences (Smith, 2007). Hence, the results of autocorrelation show that residuals are not correlated with each other, meaning that there is no autocorrelation in residuals. Since, the model is stable and has no autocorrelation in residuals; simple regression model would only be suited for this study.

TABLE 5
Quantiles for Each Parameter, Quantiles for each Variable

	2.5%	25%	50%	75%	97.5%
(Intercept)	-11.0982	-0.580456	5.02595	10.7052	21.0837
X1	-0.3902	0.029923	0.24318	0.4469	0.8666
X2	-10.7645	-1.151572	3.98378	9.0313	19.2315
X3	-0.1095	0.006432	0.06429	0.1223	0.2369
X4	-0.1285	0.038570	0.12058	0.2114	0.3894
Sigma2	438.0215	615.644001	749.97186	929.2459	1475.8915

According to the multi-regression theory based on Bayesian model, GDP, Third Party Liability Motor Insurance premium, and Comprehensive Motor Insurance's premium have positive impact on the number of registered vehicles starting from 25% quantiles whereas population got 50% quantiles. In the findings of MCMC pack expressed in figure 4.4, all parameters have a positive effect on the dependent variable of registered vehicles. As the result, starting from 50% quantiles is the best quantiles for all factors to convergence except population(x2) parameter.

Moreover, at 50% quantiles, GDP has 24% impact on registered vehicles while population has dramatic impact on registered vehicles. Although population has strong positive relationship with registered vehicles, the income distribution of Myanmar is significantly gaped. Third Party Liability Motor Insurance has 12% effect and Comprehensive Motor insurance has 15% effect on registered vehicles. However, as this study mainly focues on motor insurance, 97.5% quantiles is the best situation because at that point, GDP has 87% impact on registered vehicles and motor insurances have 24% and 39% respectively. According to the

result, number of registered vehicles is not significantly impact on motor insurance although GDP dramatically impacts registered vehicles.

Briefly, as shown in table, the GDP of Myanmar has positive impact on the registered vehicles and consequently it will lift the demand of motor insurance in Myanmar while population has a continuous effect on them.

CONCLUSION

This paper studied about the factors affecting the number of automobile insurance premium of Myanmar based on Bayesian modeling using the MCMC procedure over the period of 1994 to 2014. Secondary data of annual Gross Domestic Product (GDP), Population, Number of Accident, Number of Registered Vehicles, Third Party Liability Motor Insurance's Premium, and Comprehensive Motor Insurance's Premium are applied in this research. All these six variables are converted into growth rate terms.

This study applied two main methodological approaches in order to find out the appropriate answers for the research problem: econometric approach and descriptive analysis. In econometric Methods, Augmented Dickey-Fuller (ADF) unit root test, and Regression model based on Bayesian theorm by using MCMC approach are applied. In this study, empirical results are mainly based on the above econometric methods. Secondly, the history of Myanmar Insurance Sector during the period of 1994-2014 is analyzed by using descriptive analysis.

Insurance plays a vital role in financial sector. Myanmar economy is dramatically developed under new nominally civilian government's policies. This paper presents how government policy changing in other factors affects automobile insurance premium by using MCMC methods which is developed from Bayesian inference. The annual secondary data of registered vehicles, number of accident, Gross Domestic Product (GDP), Population, premium of Third Party Liability Motor Insurance and Comprehensive Motor Insurance over the period of 1994 to 2014 were used in this study. The Metropolis-Hastings algorithm and Gibbs sampling are applied in this study. Raftery and Lewis convergence diagnostic are computed for MCMC sampler output to determine accuracy and probability of the parameters within a specified quantile to estimate if parameters are convergent or not. The results showed that how long iterations need to burn-in to reach satisfied equilibrium. As the dependent factor result is less than one, and it indicates there is no autocorrelation between consecutive iterates in the BUGS output and all factors used in this sector are accuracy and coverage. According to the multi-regression theory based on Bayesian model, GDP, Third Party Liability Motor Insurance premium, and Comprehensive Motor Insurance's premium have positive impact on the number of registered vehicles starting from 25% quantiles whereas population and number of accidents got accuracy when quantiles at 50%. The result shows that all parameters have positive impact on number of registered automobile and number of registered vehicles is directly affected by the premium of automobile insurance.

As this is the first research of the automobile insurance in Myanmar, the result might be useful information for the public and private partners to make decision of the automobile insurance. According to the result, the policy makers can figure out a better policy to upgrade automotive industry which consequently affects insurance industry, and business firms can make right investment in automobile insurance sector.

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— This article does not have any appendix. —