

KWAME NKRUMAH UNIVERSITY OF SCIENCE AND
TECHNOLOGY, KUMASI

COLLEGE OF SCIENCE

DEPARTMENT OF MATHEMATICS



ACTUARIAL MODELING OF HEALTH INSURANCE CLAIM RESERVES USING THE
CHAINLADDER

BY GENEVIEVE OPOKU

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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 acknowledgement had been made in the text.

Genevieve Opoku (PG7045216)

Student

Signature

Date

Certified by:

Dr. Gabriel Asare Okyere

Supervisor

Signature

Date

Certified by:

Prof. Mrs. A.O. Adebajji

Head of Department

Signature

Date

Dedication

This study is dedicated to the Opoku family, especially my father Mr. Paul Opoku for their love and support throughout my study of this degree programme.

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My sincere appreciation goes to the Almighty God for His immeasurable protection and guidance throughout my study of this programme.

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Abstract

The preparation for outstanding claims is one of the main factors of technical provisions of Insurance company's liabilities. Minimising the digression of the true amount of reserves from its estimation is one of the major actuarial challenges. Though the NHIA request the use of Chain Ladder method amidst the various actuarial models for reserve, most health insurance companies default in settling their claims on time leading to the pullout of some healthcare service providers in providing services to customers under the defaulters' schemes.

This thesis summarizes the salient techniques typically used for the estimation of outstanding claims reserves in non-life insurance specifically health insurance, including those to estimate the claims development. This research goes for estimation of health claim reserves in Ghana utilizing Inflation-adjusted chain ladder, Mack chain ladder and Bootstrap chain ladder technique. Claim data on Nationwide Medical Insurance Co. Ltd for my examination ranges from January 2008 to December 2017. Results indicate the Inflation-adjusted Chain Ladder had a superior reserve estimate than that of Mack Chain ladder and Bootstrap Chain Ladder methods.

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Chapter 1

Introduction

1.1 Background of Study

The financial health of business organizations which is measured by solvency and liquidity ratios is highly dependent on the adequacy of loss reserves of the organizations.

In the insurance industry, adequate Incurred But Not Reported (IBNR) and Reported But Not Settled (RBNS) reserves is needed to improve the financial sustainability and boost public interest in insurance. Incurred But Not Reported (IBNR) “is a type of reserve account used in the insurance industry as a provision for claims and/or events that have transpired, but not yet been reported to an insurance company”. This reserve account holds funds for estimated probable loss by an insurance company which is estimated by an actuary based on reserve and claim data for a period of time. An overstatement or understatement of such reserves affect the profitability and solvency of the insurance company due to the high correlation between profitability and solvency and IBNR reserves.

According to Iryna, Teresa, Mirosław(2015), a prudent insurance company ensures that adequate IBNR reserves are kept to indemnify an insured on a catastrophic insured event and this consequently improves the performance of the insurance company and preventions of bankruptcy. These reserves can eventually serve as a source of investment income for the insurance companies. Insurance in Ghana is regulated and supervised by National Insurance Commission (NIC) and National Health Insurance Authority (NHIA). The NIC emerge in 2006 by the insurance Act, 2006 (Act 724) and its main aim is to register, supervise, regulate, monitor and control the activities of all insurance companies other than health insurance companies.

Among the regulation and supervision role of the NIC and NHIA is the establishment of regulatory outstanding claims reserves for insurance companies which includes IBNR reserves and RBNS reserves.

There are distinct categories in insurance; life insurance and non-life insurance. Claim reserving methodologies for these two categories differ due to their complexity in premium allocation and length of entitlement of claims for policyholders. Non-life insurance policies usually pay one time premium which is valid for a period of one year upon whereas the frequency of payment of life insurance premium may be more frequent and validity of the insurance policy can elapse for more years. Thus, claim reserving for non-life insurance is a short term provision whereas that of life insurance is long-term provision.

Insurers are usually confronted by the delay in claims reporting, and then a further delay before they are paid or settled. Claim reserving is the backbone of every insurance industry and a pivot in the future lifetime of the industry. Insurance is simply a device whereby many people contribute to a pool, so that a few who suffer a loss may be compensated (Chapman, 2011). It is a guarantee of repayment on account of a loss; paid to individuals or organisations so worried about risks that they have made prepayments to an insurance agency. This form of protection approach may likewise be extensively characterised as an agreement under which the insurer concurs, as an end-result of a premium, to repay the guaranteed for the shortfall endured because of the event of indicated occasions which cause the annihilation, deficit or loss of something in which the insured has an interest in.

Essvle (2009) clarifies insurance as a form of peril control predominantly used to hedge against the danger of unforeseen, questionable loss or the equitable transfer of the risk of a loss, from an entity to another, in return for compensation. Ordinarily, policyholders who suffer losses form a small percentage as compared to those who do not. Their losses are paid out of the premiums as 'claims' collected from the pool of policyholders. Premiums paid by the policyholder are also the monetary amount the insured pays the insurer (usually

an insurance company) for covering a specified risk. For insurers to maintain sufficient capital to pay claims or losses and to efficiently price their insurance products they have to be accurate with their loss reserves (England Verrall, 2002).

The insurance policy that pays for medical and surgical losses incurred by a policyholder(insured) refers to as Health insurance. The health insurance policy coverage includes refunding the policyholder for losses incurred from illness or injury, or paying the health-care service provider directly. Health insurance is currently usually included in employer benefit packages as a means of attracting quality recruits (Investopedia). With Health Insurance policy, policyholder pays premium in advance and expects all claims within the coverage limits to be met once the loss occurred within the policy year.

Health insurance claims complaints are numerous suggesting that claims behaviour of insurance be investigated to minimize operating losses and ensure operational excellence. The estimation of outstanding liabilities for claims that on or before the valuation date is termed loss reserve (Schmidt, 2006).

The largest liability in insurers' annual statement is the loss reserve. Loss reserves have a great impact on insurers' solvency and profitability. The ability to accurately estimate the outstanding claims liabilities is therefore extremely important for insurers companies (England Verrall, 2002).

The primary problem that confronts insurers is often the delay in submitting the claims to the insurer and a further delay in vetting them before they are paid or settled. Claim reserving is the backbone of every insurance industry and a pivot in the future lifetime of the industry. The credibility, prestige and survival of every insurance industry is situated in their claim reserving models.

1.2 Problem Statement

Health insurance in Ghana is rising with the influx of many private health insurance companies. Ghanaians are gradually becoming conscious of the need to insure against their health (both national and private health insurance). Notwithstanding the importance of insurance to the individual, there has always been a growing complaint from the part of the insured and the Health Service Providers (HSPs) on the longevity of the insurer to pay claims since they have huge claims piled from year to year. This challenge is not oblivious to the insurance companies in the market. To solve this, insurance companies in the first place, should have enough capital reserves so as to be able to serve claimants anytime a claim is made.

The preparation for outstanding claims is one of the main factors of technical provisions of Insurance company's liabilities. Measuring the digression of the true amount of reserves from its estimation is one of the major actuarial challenges. Shareholders, senior managers, insurance regulators and rating agencies all have interest in knowing the order of magnitude of these potential variations (reserve uncertainty) since companies with large potential deviations need higher capital or reinsurance.

Insurance companies are always responsible to respond to any claim when it is made since that is the principal objective of the deed on the part of the insurer. In health insurance, claims are usually paid within one year after reporting. When the insured visit an HSP, there may be delay in reporting claims to the insurer. That is, the occurrence of an accident or incident to the insurer may be quickly reported. However, the extent to which the client is liable or the determination of the exact cost the insurer is obliged to pay may take some procedures and a lot of time.

It is imperative for an insurance company to know what to set aside in reserves at regular intervals so as to handle claims when they arise. In order to live by this, Insurance

companies are always supposed to leave sufficient amount of money from the insurance packages customers have bought into. This is to help guide the company against insolvency.

Claim reserving is therefore the way to go, in order to make funds available always, and in order to be able to pay any eventual claim. Claims reserves are future obligations of an insurance company.

There are a number of actuarial models through which claims could be reserved. Unfortunately, irrespective of how beneficial these models are, they are still used by only a handful of practitioners in Ghana. Though the NHIA request the use of Chain Ladder, it is silence on which of the methods of Chain Ladder. This could be as a result of the general lack of understanding of the methods, lack of flexibility and variability in some methods. One of the most known methods of reserving used is called Chain-Ladder

1.3 Objectives

The main aim of the study is to model health claim reserves in Ghana using the Inflation adjusted chain ladder, Mack chain ladder and Bootstrap Chain ladder methods. The specific objectives set to achieve the aim of the study are:

- 1) To evaluate the total claims for each particular incident year using Inflation adjusted chain ladder, Mack chain ladder and Bootstrap Chain ladder models.
- 2) To estimate the outstanding health claim liability for each development year using the Inflation adjusted chain ladder, Mack chain ladder and Bootstrap Chain ladder models.

1.4 Methodology

This section explains in details the steps that were used in the modeling process by using Inflation adjusted chain ladder, Mack chain ladder and Bootstrap Chain ladder methods and

also to select the best model to estimate claims reserves of health claims. The method or model was then used in calculating the outstanding reserves or liabilities for each development year and incident year respectively. Inflation rate was employed in all Chain Ladder methods. The overall total outstanding reserves or liabilities of health claims were then determined by summing all the individual outstanding liabilities of each future development years. The Statistical tools used for the analysis were the Microsoft Excel and R.

1.5 Significance of Study

The study is intended to:

- 1) Derive a model will be determined to always estimate the amount of claims; which will then be used to forecast future claims.
- 2) This research will also help health insurance companies reduce the burden of piled claims which exerts a lot of pressure on the financial position of the company.
- 3) Policyholders will also benefit from this work since the usage of the model by the insurance company will help to always make sufficient funds available so that if there is a claim it could be treated swift enough, because the company would have enough capital reserves. Inclusion of inflation in the model would guide against the loss of value of the money a claimant is supposed to receive.

1.6 Scope of the study

In order to achieve the objectives, the study has been focused on private health insurance in Ghana. The private health Insurance companies offer a full-range of insurance products covering medical Insurance. The study has been restricted to only health claims data in from Nationwide Medical Insurance.

1.7 Limitations of Study

There are a number of factors that inhibited the success of this work. The most predominant setback was access to data or relevant information. Insurance companies are unwilling to give out or disclose information about their claims. Claims Department Officers in charge of the claims data were hesitant to provide or disclose information which may lead to their dismissal. Amongst the many prevailing setbacks were the lack of readily available mathematical, actuarial and statistical software for data analysis.

1.8 Organisation of the Study

The Chapter One talks about the background, problem statement, objectives, methodology, significance, scope and limitation of the study as well as the organization of the study. The chapter Two discusses the relevant literature of this study. It also reviews the methods other researchers used and its limitations. The chapter Three deals with the detailed methodology used by the researcher in solving the problem at hand. It further discusses the actuarial models used in the analysis. The chapter four has to do with the analysis of the data obtained from modeling of the data and the interpretation thereof. The chapter five is the summary of the piece of work done by the researcher. It also gives recommendation to areas that can be researched in the near future by other researchers and some techniques that can help others to do good work in the same or similar area of research.

Chapter 2

Literature Review

2.1 History of Insurance

Ancient World

At first individuals used to offer merchandise in their own particular towns and get-together society. Be that as it may, with the progression of time, they swung to adjacent towns to offer. Moreover, in the 1300s and mid-1400s, the European brokers used to offer their products over the world and to support the risk of burglary or extortion by the Capitan or team otherwise called *Risicum Gentium*. Notwithstanding, they understood that offering along these lines, includes not just the risk of misfortune (i.e. harmed, robbery or life of dealer too) yet in addition they can't cover the more extensive market. In this way, the pattern of enlisting authorized base operators crosswise over various markets developed. The dealers sent their products to the operators who were able to sell as a result of their brokers. Sending merchandise to the specialists by street or ocean includes diverse risks i.e. ocean storms, privateer assault; merchandise might be harmed because of poor dealing with while stacking and emptying, and so on. Dealers misused distinctive measures to support the risk engaged with the sending out. Rather than sending every one of the merchandises on a truck to convey products over vessels to maintain a strategic distance from the shipment aggregate loss. Insurance is the most established strategy for exchanging exposure, that is created to relieve exchange. Insurance for marine is critical in worldwide exchanging and makes expansive business exchange conceivable (Petersson, 2010). As indicated by Kingstons (2011) the supporting instruments of risk our precursors used to moderate risk were ocean (*Mutuum*) loans, bill of trades, and commenda contract. In 1972, Nelli featured that contract of commenda at the time was the nearest marine insurance alternative. Moreover, he called attention for 50 years.

In 1400s, word arrangement for contract in insurance wound up institutionalized. By the 1500s, insurance was normal among Holland and England also. The idea of guaranteeing the nation's outskirts rose in the 1600s because of lessened exchange or higher cost of insurance in local nation. In 2011, Kingston indicated the Lloyd's Coffee-House was the

conspicuous insurance in marine commercial center in England amid 1700s and western dealers utilized this commercial center to guarantee their movements. In the event of question, approach author picked 1 judge and picked a 3rd fair-minded mediator and gatherings will undoubtedly acknowledge the choice made by the lion's share. In view of the powerlessness of this casual court (referee) to uphold their choices, in the sixteenth century, brokers swung to formal courts to determine their debate. Unique courts explained the question of insurance in marine on who refused to comply with the Church's forbiddances in the late 1300s. In the early 1400s, Barcelona law passed, deeming it compulsory for merchants to swing to "courts" in the event of question on insurance. In the early 1500s, the commercial Genoa court was supplanted by more particular court "Rota" which takes after the shipper's traditions as well as joined the lawful laws in it.

The Chinese and Babylonian dealers in the third and second centuries BC, individually rehearsed the primary techniques for exchanging or conveying risk in a money related economy. To restrain the misfortune of any single vessel's upsetting, the Chinese dealers voyaging slippery stream rapids would redistribute their products crosswise over numerous vessels . The Babylonians built up a framework that was recorded in the popular Code of Hammurabi, c. 1750 BC, and drilled by early Mediterranean cruising dealers. In the event that a trader got a loan to finance his shipment, he would pay the bank an extra aggregate in return for the moneylender's certification to drop the loan should the shipment be stolen or lost adrift. Yearly endowments were given from the different ethnic gatherings to the Achaemenian rulers they were under in Ancient Persia. This worked as an early type of political insurance, and formally bound the Persian ruler to shield the gathering from hurt.

Eventually, the tenants of Rhodes made the 'general normal' in the first thousand years BC. This enabled a gathering of vendors to settle or pay to guarantee their merchandise sent collectively. The pooled premiums would be utilized to repay any vendor

whose merchandise were casted off amid transport, regardless of whether because of sinkage.

Olden Athenian spurred money for travels with settlements dropped in case ship was missing. During 4th century Before Christ, the loans rates varied by protected or perilous occasions of year, suggesting an instinctive pricing of risk with an impact like insurance.

The Greeks and Romans presented the causes of wellbeing and disaster protection c. 600 BC when they made organizations called "kindhearted societies, which watched over the groups of expired individuals, and paying memorial service costs of individuals. Societies in the Middle Ages served a comparative reason. The Jewish Talmud additionally manages a few parts of guaranteeing merchandise. Before insurance was set up in the late seventeenth century, "friendly societies" existed in England, in which individuals gave measures of cash to a general aggregate that could be utilized for crises.

Modern Insurance

Property Insurance

Ground sirloin sandwich Feuerkasse happens to be the essential formally settled fire insurance institution on the planet, and the most settled existing insurance institution available to individuals in general, having started in 1676.

It as we most likely mindful of currently can be referred to the London's Great Fire, which in 1600s consumed over thirteen thousand houses. The stunning consequences of the flame changed over the progression of insurance. Different flame insurance plans came to no avail, anyway in 1681, monetary authority Barbon and 11 accomplices developed the principle insurance association to ensure square and packaging homes. At initial, five thousand homes were defended by the insurance

association .

This method was a little while later revealed as awfully blemished, as enemy units as often as possible neglected replicating structures once they found that it had no insurance approach with their association. Unavoidably, an answer was settled on for all the associations in insurance would provide equipment and money to a city master blamed for situating fire shirking assets and firemen likewise around the city to respond to all flares. This did not deal with the issue through and through, as the separations still would in general help saving ensured structures to those with no insurance by any stretch of the creative ability.

The primary insurance association that ensured flame insurance in Colonial America was encircled in Charles Town in the 1700s. Benjamin Franklin progressed and made basic the demonstration of insurance to widen the danger of fire mishap. In the mid 1700s, he set up a fire association. The association made duties to fire neutralizing activity. Also, the association alerted against flame threats, it declined to secure certain structures where fire danger was too much, for instance, each and every wooden house.

Business Insurance

Meanwhile, the essential insurance plans for the ensuring of business meanders ended up open. Prior to the completion of the 1600s, London's creating criticalness as a center for trade was extending enthusiasm for insurance in marine. In the 1600s, Lloyd started a bistro in London. A little while later transformed into an outstanding continuous for convey owners, vendors, and vessels' administrators, and along these lines a dependable transportation news.

It transformed into the social occasion environment for gatherings in the conveyance business opening up to ensure ships, and those anxious to underwrite such

endeavors. These beginnings provoked the insurance establishment. In late 1700s, after Edward's going, the sharing people from the insurance strategy encircled a board.

Life Insurance

Life incorporation strategies which seem essential were omitted in the mid 1700. The essential relationship to offer life consideration was the A.S for a P.A.O, developed in England in the early eighteen century by Talbot and Sir Allen. The basic game-plan of disaster security was that each part paid a settled yearly bit for every thought on from one to three thoughts with thought to age of the general population being twelve to fifty-five. Near the year's end a bit of the "all around arranged obligation" was partitioned among the mates and family of kicked the bucket individuals and it was in degree to the extent of offers the beneficiaries ensured. Kindhearted Association began with 2000 individuals.

Halley around 1693 formed the essential life table, yet only during the seventeen fifty's the basic numerical including quantifiable gadgets being set up provided improvement in present day debacle assurance. James Dodson, a mathematician and analyst, tried to set up another association that issued premiums went for precisely adjusting the dangers of whole deal life confirmation approaches, consequent to being denied permit into the A.L.A.S due to his era. Dodson could not be ineffective with undertakings at verifying an agreement with the A.L.A.S prior destruction during seventeen fifty-seven.

James Dodson's adherent, Mores was at last prepared near the set up of S.E.A.L.S during seventeen sixty-two. That being the globe's first normal back up plan and it led age build premiums based as for death estimate position "structure in favour of legitimate cover performance as well as improvement" including "reason behind present day living attestation whereupon entire living affirmation plans are therefore founded".

He further established focal expert considerably known as analyst, thus most prompt alluded near reference to the circumstance around commerce entity. Morgan was the then chief current analyst. In the mid-1700s the Society did the fundamental statistical loss estimation including consequently passing on primary setback reward as well as between time compensate amid people. Standard estimation were used to change fighting interests and the society attempted to treat its people unbiasedly. So directors ensured that the contributors got a sensible benefit for their different ventures.

The idea of catastrophe security in the States begun in the late 1760s. The Episcopalian pastors made a comparable help support in the late 1700s. Some place in the scope of 1787 and 1837 more than two dozen fiasco security associations were started, anyway not exactly around six endure.

Accident Insurance

In the 1800s, "insurance in accident" began to end up its availability. In the mid-1800s in England, the principle association offered mishap insurance, molded to protect against the fatalities on the early railroad system. It was enrolled as the U.C.C.C to permit confirmations on individuals lives.

The association could accomplish a simultaneousness with the railroad associations, whereby fundamental mishap insurance would be sold as a group deal close by set out tickets to clients. The association charged high premiums for 2nd and below average class set out as a result of the higher danger of harm in the roofless carriages.

National Insurance

By the 1800s, governments began the national insurance programs against torment and development. Germany dependent on a custom of welfare programs in Prussia and Saxony

that began as in front of timetable as during the 1840s. In the nineteenth century, Chancellor Otto von Bismarck introduced development annuities, mishap insurance and restorative consideration that formed the explanation behind Germany's welfare state. His paternalistic undertakings won the assistance of German industry since its destinations were to win the assistance of the normal laborers for the Empire and decrease the overflowing of transients to America, where pay was higher anyway welfare did not exist.

All experts who earned under £160 a year were expected to pay 4 pence seven days to the arrangement; the business paid 3 pence, and general assessment accumulation paid 2 pence. In this way, experts could take cleared out leave and be paid 10 shillings for each week for the underlying 13 weeks and 5 shillings consistently for the accompanying 13 weeks. Pros furthermore gotten to free treatment for tuberculosis, and the weakened were met all requirements for treatment by a board authority. The National Insurance Act in like manner gave maternity benefits. Time-obliged joblessness advantage relied upon actuarial gauges and it was organized that it would be upheld by a settled total each from workers, organizations, and natives. It was limited to explicit endeavors, rehashing/infrequent endeavors like advancement of water crafts, and neither made any course of action for wards. By the twentieth century, around two million were ensured under the arrangement for joblessness advantage and practically fifteen million shielded for disease advantage.

In the U.S.A, the moment that the section of the S.S.A in the 1930s, the legislature didn't direct any kind of insurance on the country. The new program broadened the thought and affirmation of insurance as an approach to achieve financial protection. That advancement experienced impacted expeditiously after the World War 2. In the midst of the 1900s, there was furthermore the G.I-life inclusion system that was proposed to encourage the heaviness of. military hardships on the normal resident masses.

Health Insurance

The authentic scenery of medical coverage has grown all around. Movement of restorative consideration, particularly in industrialized countries, isn't any more conned to the ofces of essential consideration doctors. As therapeutic developments end up being logically cutting-edge, intense and basic consideration would now have the capacity to treat shocking, perpetual, complex, and genuine conditions and wounds that used to be fatal or debilitating. While the improvement of new prescriptions that can restore working and moreover grow life is respecting, the costs of these intercessions and going with medical clinic stays can be prohibitively high for certain people. The WHO (2013) demonstrates that 150 million people overall suffer nancial fiasco consistently because of out-of-pocket costs for their social insurance needs. Distinctive countries have been utilizing diverse insurance models and financing plans to pay for restorative administrations in perspective on their different budgetary substances and social settings. These plans of insurance have assorted fragments and installment essentials depending upon the possibility of the insurance plan and the administrations being verified. A few plans of insurance anticipate that people should pay premium costs for choosing in the program and have diverse dimensions of out-of-pocket installments, e.g, deductibles, co-installments, or coinsurance. They may in like manner require prior endorsement from insurance associations to start inclusion for explicit procedures or may constrain inclusion limits for enrollees. Some insurance associations may similarly utilize installment capitation for medicinal services suppliers to control costs by motivating suppliers to give simply required administrations and to all detriment setting.

2.2 Concept of Claim

Claim is a privilege of insured to get the sum anchored under the arrangement of insurance contract guaranteed by Insurer. Insurance Claim is the demand of the insured arrangement policyholder from the insurance firm for budgetary repayment at whatever point he or she endures loss of the insured property or life and so forth. Insurer settles the claim in the wake

of fulfilling himself that every one of the conditions and necessities for settlement of claim have been accumulated with.

2.3 Claim Conditions

The claims in general happen under two conditions:

- 1) **Maturity Claim:** This sort of claim needs settlement once the policy finishes the term chosen. The arrangements like the endowment, cash back or child products fall under this. It is also paid out for the most part on endowment educational product whose span has been lapsed.
- 2) **Death Claim:** This happens if there should arise an occurrence of death of the policyholder amid the term of the policy. The demise could either be because of sickness or accidental. The term policy is the greatest illustration.

2.3.1 Health Claim Conditions

- 1) **Cashless claims:** The insure settles all the bills with the Healthcare Service Provider directly after the insured or policyholder has visited the them for medical care. The Healthcare Service Providers should be a member of the insurers networked service providers.
- 2) **Reimbursement claims:** The insured pays for the service upfront and request the insurer to reimburse. The Healthcare Service Providers could be both a member or non-member of the insurers network of providers.

2.4 Process for Claim Settlement

Regularly it takes quite a while until the point that a claim is finally settled. The principle reasons are:

1. Notification delay: time interval between announcing date and accident date.
2. Settlement delay: time lag between announcing date and settlement.
3. Re-openings as a result of sudden development of claims.

2.5 Loss Reserving Methods

Amid the most recent decades, actuaries have proposed a myriad loss reserving technique in light of run-off triangles. In each of these techniques, it is accepted that all related claims are settled within a number of development years and furthermore, the development of cumulative losses from a similar number of origin years is known up to the present year with the end goal that the losses can be displayed in a run-off triangle.

The most admired and most popular of these methods are surely the chain-ladder and the Bornhuetter-Ferguson (B-F) techniques. It shows up that the fundamental thought of the chain-ladder technique was at that point known to Tarbell (1934) while the B-F technique was first depicted right around forty years after the fact in the paper by Bornhuetter and Ferguson (1972).

At the primary look, the two methods have extremely little in like manner:

- 1) The CL method proposes indicators of a cumulative (ultimate) losses and each indicator is acquired consecutively by duplicating the cumulative (current) loss by the chain ladder factors which are sure development factors derived from the run-off triangle.

- 2) The B-F method proposes indicators of the outstanding losses and each indicator is gotten by multiplying an estimator of the expected cumulative (ultimate) loss by an estimator of the level of the outstanding loss with respect to the ultimate one.

The way that these methods go for various target amounts can be ignored since indicators of ultimate losses can be changed over into indicators of outstanding losses, and the other way around. In any case, a significant distinction lies in the way that the CL method continues from current losses while the B-F method is based on the normal ultimate losses, and this distinction is associated with the data sources which are considered:

- 1) The CL method depends totally on the information contained in the run-off triangle.
- 2) The B-F method limits the utilization of the run-off triangle to the estimation of the level of the outstanding loss and utilizes the result of the earned premium and a normal loss proportion to evaluate the normal ultimate loss.

The point of this paper is to estimate outstanding reserves or liabilities using inflation adjusted chain ladder and Bornhuetter Ferguson models.

Chapter 3

Methodology

3.1 Introduction

This chapter explains in details steps that were used in the modeling process by using Inflation adjusted chain ladder, Mack chain ladder and Bootstrap Chain ladder methods and also to select the best model to estimate claims reserves of health claims.

The Statistical tools used for the analysis were the Microsoft Excel and R.

3.2 Claims Data

There are a few different ways of displaying claims data, which stress different data aspects. Here they will be displayed as a triangle, which is the most usually utilized technique. The year in which the occurrence happened and the insurer was on hazard is known as the origin (accident) year. The quantity of years until an installment is made is known as the delayed (development) period. The claims data are divided up by the origin (accident) year and delayed (development) period.

3.3 Run-Off Triangle

The run-off triangle's general form is given by:

Table 3.1: Incremental Losses

Origin Years	Delayed (development) years					
	1	2	3	k	N-1	N
1	$C_{1,1}$	$C_{1,2}$	$C_{1,3}$	$C_{1,k}$	$C_{1,N-1}$	$C_{1,N}$
2	$C_{2,1}$	$C_{2,2}$	$C_{2,3}$	$C_{2,k}$	$C_{2,N-1}$	$C_{2,N}$
...						
j	$C_{j,1}$	$C_{j,2}$	$C_{j,3}$	$C_{j,k}$		
...						
N	$C_{N,1}$					

Each triangle row denotes origin (accident) year which characterizes a claims cohort. The "1" row incorporates all claims identifying with accidents that happened amid the "1" year. The columns represent delayed years, which indicates how the claims cohort identifying with a specific accident year "develop" over a period. Column "1" depicts the year in which the accident happened. Column "2" depicts the year after the accident happened and so on.

Each entry in the table can be characterized by its accident year (row) and its delayed year (column). For example; $C_{1,3}$ is for Accident Year "1", Delayed (development) Year "3", Note that since it is a cumulative table, this figure incorporates payments made in years "1", "2" and "3". Development year "1" is the only year with payments reported and rest are incurred but not reported.

We look attentively at risks portfolios and we suppose that each portfolio claim is cleared either in the origin year or in the preceding k delayed years where $k = \{1, 2, \dots, N\}$. The incremental or cumulative losses may be utilized in modeling the portfolio.

3.3.1 Incremental and Cumulative Losses

In modeling a portfolio with incremental, we look attentively at a group of random variables $\{C_{j,k}\}_{j,k \in \{1, 2, \dots, N\}}$ and we interpret $C_{j,k}$ as the origin year loss "j" which is cleared with delayed years "k" and hence in year k and year j + k. We allude to $C_{j,k}$ as the incremental loss of origin year j and delayed year k.

In modeling a portfolio with cumulative, we look attentively at a group of random variables $\{S_{j,k}\}_{j,k \in \{1, 2, \dots, N\}}$ and we interpret $S_{j,k}$ as the origin year loss "j" which is cleared with delayed years of at most "k" and hence no later than delayed year k .

We allude to $S_{j,k}$ as the cumulative loss of origin year "j" and delayed year k.

3.4 Chain Ladder

The technique depends on the assumption that proportionate connections between values in back to back delayed years will rehash, later on, i.e. the sections in the runoff triangle are corresponding and subsequently, it is conceivable to get estimates of extreme claims in light of the watched information, where 'extreme' means the most recent postpone year

so far watched, and does exclude any tail factor. The chain ladder technique expect that every outer factor, for example, inflation of claim costs, change in the blend of business, change in the rate of claims settlement, can viably be disregarded and the model expects the form:

$$C_{j,k} = x_j y_k + \varepsilon_{j,k} \text{ where } j, k = \{1, 2, \dots, N\},$$

where $C_{j,k}$ signifies the incremental claims measure being delayed year k in regard to origin year j .

x_j is the parameter fluctuating by origin year, representing exposure, for instance, the claims quantity brought about in the origin year j .

y_k is the development factor for the year k , representing the ratio of aggregate payment made before the delayed year k ends. $\varepsilon_{j,k}$ is the error term.

Without the outer components, the distribution of delays between the occurrence offering ascend to a claim and the payments made in regard to that claim remain generally stable after some time. The method accepts that the components y_k are consistent for all long accident periods

Under the basic chain ladder method development factor is utilized to assess reserves. On the off chance that b_k speaks to the proportion of the aggregate payment made before the finish of year $k + 1$ to the normal estimation of the total payment made before year k ends, and b_k is the development factor that will be utilized to duplicate the current payments at delayed year k to get the future risk at year $k+1$. The chain-ladder method's development factors referred to likewise as age-to-age factors or connection proportions, are meant by $b_k, k = \{1, 2, \dots, N - 1\}$ and it is estimated by utilizing the total loss from the triangle. In the event that $S_{j,k} = \sum_{z=1}^N C_{j,z}$

, $k = \{1, 2, \dots, N\}$ is the combined loss acquire from the values of incremental loss, the development factor b_k is given as;

$$b_k = \sum_{j=1}^{N-k} \left(\frac{S_{j,k+1}}{S_{j,k}} \right)$$

The b_k factors are consequently figured by summing every section in the run-off triangle and taking the proportion to the past segment add up to except the last entry. On the off chance that the result of all the b_k 's for assessing the last reserve liability of the triangle is B_k . At that point it is given by:

$$B_k = \prod_{k=1}^{N-1} b_k \text{ where } k = 1, 2, \dots, N - 1.$$

The outstanding liability forecast cumulative claims in development year $k + 1$ is given by $S_{j,k+1} = S_{j,k} \cdot b_k$ where $j = \{1, 2, \dots, N\}$ and $k = \{1, 2, \dots, N\}$. The outstanding claim reserves for every origin year j and delayed year k can be evaluated from forecast cumulative claims as $S_{j,k+1} - S_{j,k}$. These estimates would then be able to be utilized to the run-off end of the later origin years up to the point for which past experience is available.

3.5 Mack Chain Ladder

There exist development factors f_k and variance parameters σ_k^2 such that the cumulative payments

$$C_{i,k} = \sum_{j=0}^k S_{i,j} \quad (3.1)$$

Assumes

$$E[C_{i,k+1} | B_{i,k}] = f_k C_{i,k} \quad (3.2)$$

$$Var[C_{i,k+1} | B_{i,k}] = \sigma_k^2 C_{i,k} \quad (3.3)$$

and $\{C_{i1}, \dots, C_{in}\}, \{C_{j1}, \dots, C_{jn}\}$, accident periods are independent of origin.

If the assumptions hold then the method gives an unbiased estimator for claim reserves.

$C_{i,r} \dots$ ultimate claims amount.

$$R_i = C_{i,n} - C_{i,n+1} \text{ Outstanding Claims Reserve} \quad (3.4)$$

3.6 Bootstrap Chain Ladder

The bootstrap technique is a particular re-sample distribution method used to estimate, in a consistent way, the variability of a parameter. This re-sampling method replaces theoretical deductions in statistical analysis by repeatedly re-sampling the “original” data and making inferences from the re-sample.

Examples of Bootstrap;

- 1) random sampling with replacement from the original dataset for $b = 1, \dots, B$ resample from $X_1, \dots, X_n$ with replacement and obtain $X_{1,b}^*, \dots, X_{n,b}^*$

Chapter 4

Analysis

4.1 Introduction

The aim of this chapter is to present and look into the study's findings. The chapter is divided into three sections; we start with Inflation adjusted chain ladder approach.

The second section explains the Mack Chain Ladder method of computing reserves.

The third section is the Bootstrap approach.

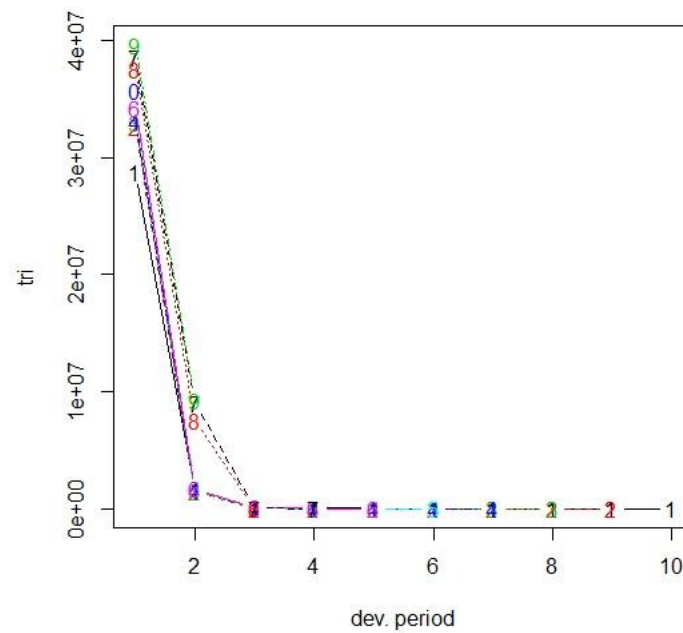
4.2 Inflation-adjusted Chain Ladder

The run-off triangle (Table 4.1) indicates the health claims incremental losses from Nationwide Medical Insurance record file from 2008 to 2017. The figure is run-off to 2017 due to the overall health claims in 2008 all being paid off in 2017. Once the raw information for claims losses settled is gathered and sectioned as in the table above, the insurer is prepared to estimate the values in the future.

Table 4.1: Incremental losses

Origin years	Development years									
	0	1	2	3	4	5	6	7	8	9
2008	9186149	621313.4	29105.11	18336.22	8297.775	6213.134	3209.926	1382.963	1189.348	746.8
2009	12443636	614415.2	22977.58	11625.62	6231.171	6108.991	4807.81	3556.054	2405.3	
2010	13924007	672281.8	22520.81	12037.22	10408.55	8326.836	7986.136	5211.427		
2011	15166396	838030.4	47293.7	14565.43	4655.836	2706.881	1557.445			
2012	17166907	963735	21667	4876.763	2689.51	1147.777				
2013	19137811	1109488	72762.78	20062.04	2426.25					
2014	24887271	6826836	27354.26	13362.78						
2015	28416342	6722818	18612.24							
2016	35270688	9311449								
2017	35764389									

Figure 4.1: Graph of Incremental losses



The International Monetary Fund (IMF) inflation rates from 2008 to 2017 over 12 months period in Ghana is shown in Table 4.2. This table was then taken in account for transforming the incremental losses to current real losses for the future reserves determination.

Table 4.2: Inflation rate

Origin Years	Inflation Rate (%)
2008	
2009	19.30%
2010	10.70%
2011	8.70%
2012	9.20%
2013	11.60%
2014	15.50%
2015	17.20%
2016	17.50%
2017	12.40%

Table 4.3: Adjusted incremental claim values

origin years	Development years									
	0	1	2	3	4	5	6	7	8	9
2008	28731064	1628878	68928.59	39949.42	16555.4	11107.71	4968.518	1826.479	1336.827	746.8
2009	32623087	1455098	50061.62	23194.98	11139.95	9455.865	6349.675	3997.004	2405.3	
2010	32975729	1464711	44932.64	21519.89	16110.98	10997.25	8976.416	5211.427		
2011	33043268	1672006	84550.68	22545.25	6148.962	3042.535	1557.445			
2012	34250744	1722945	33537.5	6440.74	3023.009	1147.777				
2013	34214171	1717333	96097.8	22549.73	2426.25					
2014	38522022	9016202	30746.19	13362.78						
2015	37529463	7556447	18612.24							
2016	39644253	9311449								
2017	35764389									

4.2.1 Adjustment for Inflation

This method depends on adjusting the generalized model by presenting an assumed rate. The past values are brought to current nancial values by changing them with past ination rate. Incremental claims along the same diagonal emerge from that year and thus a similar ination rate value is applied to them. Table 4.3 demonstrates the adjusted incremental claim values.

4.2.2 Future Cumulative Liabilities Estimation

To create forecasts of future values of cumulative claims in year $k+1$ we have to apply development factors to the most recent cumulative claims in each line, that is $S_{j,k+1}$ or S_j, N must be gotten by increasing $S_{j,k+1}$ or $S_{j,N-1}$ by b_k , where b_k is the development factor for all $k = \{1, 2, \dots, N - 1\}$.

Table 4.4: Cumulative reserves and Development factors

origin years	Development years									
	0	1	2	3	4	5	6	7	8	9
2008	28731063.72	30359941.38	30428869.98	30468819.39	30485374.79	30496482.5	30501451.02	30503277.5	30504614.32	30505361.12
2009	32623087.29	34078184.91	34128246.52	34151441.51	34162581.46	34172037.33	34178387	34182384.01	34184789.31	34185626.2
2010	32975728.53	34440439.48	34485372.13	34506892.02	34523003	34534000.25	34542976.67	34548188.09	34550186.74	34551032.58
2011	33043268.18	34715273.83	34799824.51	34822369.76	34828518.73	34831561.26	34833118.7	34836992.62	34839007.97	34839860.88
2012	34250744.33	35973689.23	36007226.73	36013667.47	36016690.47	36017838.25	36023710.37	36027716.69	36029800.93	36030682.99
2013	34214171.38	35931504.15	36027601.95	36050151.69	36052577.94	36060159.1	36066038.12	36070049.15	36072135.83	36073018.93
2014	38522021.71	47538224.01	47568970.2	47582332.98	47595129.62	47605137.96	47612899.2	47618194.39	47620949.15	47622114.98
2015	37529462.64	45085909.55	45104521.79	45131138.72	45143276.14	45152768.9	45160130.32	45165152.73	45167765.58	45168871.36
2016	39644253.46	48955702.36	49025898.04	49054829.05	49068021.69	49078339.75	49086341.17	49091800.23	49094640.24	49095842.15
2017	35764388.86	39844997.82	39902130.02	39925676.94	39936414.42	39944812.28	39951324.63	39955767.75	39958079.23	39959057.46
Development Ratio		1.114096986	1.001433861	1.000590117	1.000268937	1.000210281	1.000163034	1.000111213	1.000057851	1.000024448

Table 4.5: Unadjusted projections

origin years	Development years									
	0	1	2	3	4	5	6	7	8	9
2008										
2009										836.9
2010									1998.646	845.84
2011								3873.911	2015.353	852.91
2012							5872.117	4006.321	2084.238	882.06
2013						7581.165	5879.016	4011.028	2086.687	883.1
2014					12796.636	10008.34	7761.235	5295.194	2754.758	1165.83
2015				26616.934	12137.42	9492.765	7361.417	5022.413	2612.847	1105.78
2016			70195.685	28931.004	13192.644	10318.064	8001.417	5459.061	2840.008	1201.91
2017	4080608.965	57132.199	23546.915	10737.48	8397.862	6512.345	4443.124	2311.479		978.24

4.2.3 Future Outstanding Liabilities

The outstanding forecast value of cumulative claims in delayed year $k + 1$ is $S_{j,k+1} = S_{j,k} \cdot b_k$ where $j = k = \{1, 2, \dots, N\}$.

The unadjusted outstanding reserves in Table 4.5 above were then adjusted by 2017 annual inflation rate to arrive at the inflationary adjusted outstanding reserves shown in Table 4.6. We assume that inflation rate (12.4%) for 2017 would not change for the future years.

From Table 4.6, the future outstanding liabilities of 2017 were obtained by adding the diagonal of claim liabilities marked asterisk (*). That is GHS 4,732,468.19 with a standard error 846.611908026.

The total future liabilities were obtained by adding the claim liabilities boldly written. That is GHS 5,161,413.06.

Figure 4.2: Graph of cumulative losses

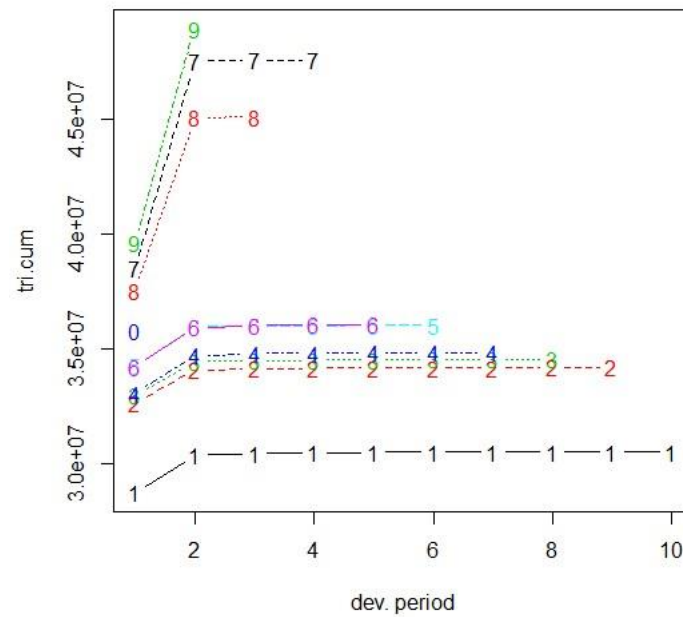


Table 4.6: Adjusted projections

origin years	Development years									
	0	1	2	3	4	5	6	7	8	9
2008										
2009										940.67*
2010									2246.478*	1068.62
2011								4354.276*	2546.149	1211.17
2012							6600.259*	5061.489	2959.69	1407.88
2013						8521.230*	7427.408	5695.799	3330.6	1584.32
2014					14383.419*	36206.92	11021.223	8451.76	4942.14	2350.9
2015				29917.434*	15334.125	13480.055	11749.697	9010.399	5268.802	2506.29
2016			78899.950*	36550.736	18734.012	16468.856	14354.843	11008.187	6437.002	3061.99
2017	4586604.476*	72179.449	33437.435	17138.295	15066.08	13132.133	10070.537	5888.715	2801.17	

Table 4.7: Standard error

Years	Dev't Years	Actual Claims
2008	0	28731063.7249641
	1	30359941.3840306
	2	30428869.9789462
	3	30468819.3945828
	4	30485374.792466
	5	30496482.500833
	6	30501451.0187945
	7	30503277.4973683
	8	30504614.3242393
	9	30505361.12
2009	0	32623087.289409
	1	34078184.9089607
	2	34128246.5248111
	3	34151441.5067866
	4	34162581.461641
	5	34172037.3268938
	6	34178387.0015608
	7	34182384.006032
	8	34184789.306432
2010	0	32975728.5251244
	1	34440439.4827373
	2	34485372.1275516
	3	34506892.0209723
	4	34523002.9963733
	5	34534000.2492068
	6	34542976.6655088
	7	34548188.0927088
2011	0	33043268.1789885
	1	34715273.8343335
	2	34799824.5100594
	3	34822369.762675
	4	34828518.7250636
	5	34831561.2596448
	6	34833118.7046448

Years	Dev't Years	Actual Claims
2012	0	34250744.3333934
	1	35973689.2291343
	2	36007226.7253742
	3	36013667.465608
	4	36016690.474848
	5	36017838.252048
2013	0	34214171.3776141
	1	35931504.1492683
	2	36027601.9528143
	3	36050151.6857743
	4	36052577.9357743
2014	0	38522021.7093265
	1	47538224.0145265
	2	47568970.2027665
	3	47582332.9827665
2015	0	37529462.641674
	1	45085909.545394
	2	45104521.785394
2016	0	39644253.45812
	1	48955702.35812

Standard Deviation	4670111.08508
Sample Size	54
Square Root of the Sample Size	5516.236
Standard Error (Mean)	846.61190802569

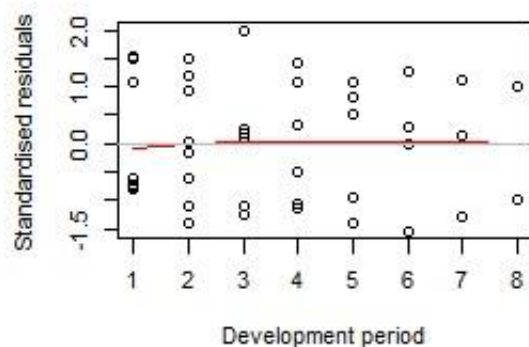
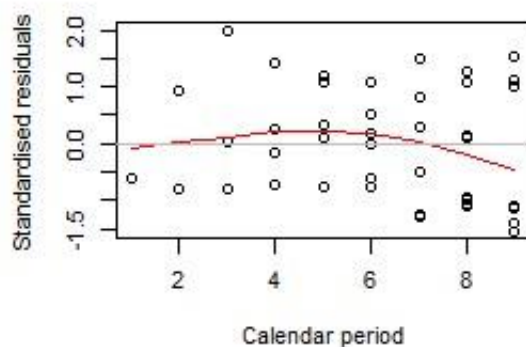
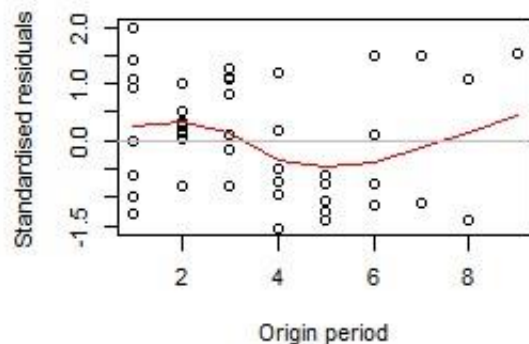
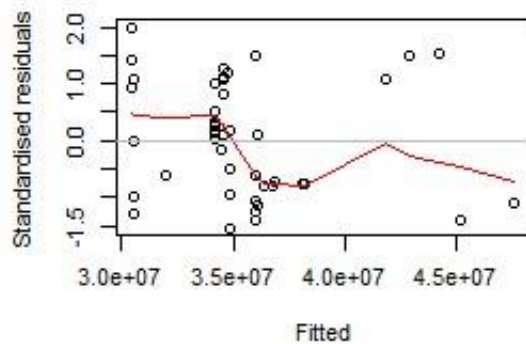
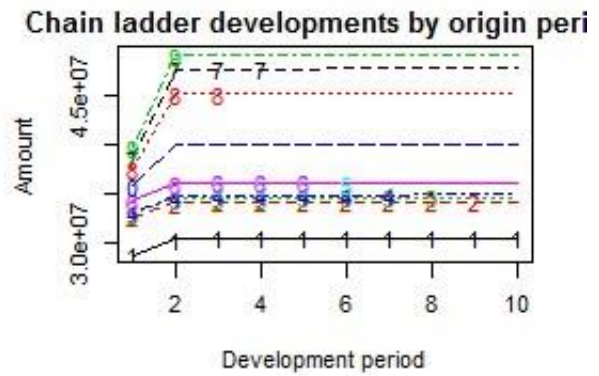
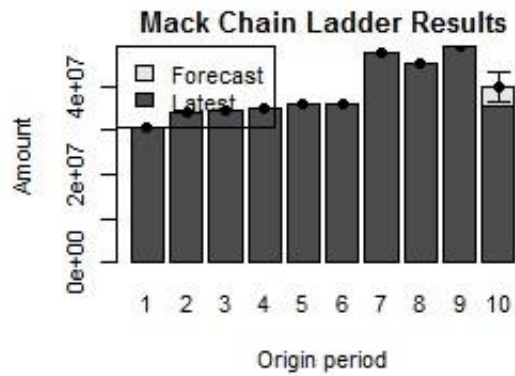
4.3 The Mack Chain-Ladder Method

	Latest	<u>Dev.To.Date</u>	Ultimate	<u>IBNR</u>	<u>Mack.S.E</u>	<u>CV(IBNR)</u>
1	30,505,361	1.000	30,505,361	0	0	NaN
2	34,184,789	1.000	34,185,626	837	371	0.443
3	34,548,188	1.000	34,551,033	2,844	861	0.303
4	34,833,119	1.000	34,839,861	6,742	1,987	0.295
5	36,017,838	1.000	36,030,683	12,845	4,094	0.319
6	36,052,578	0.999	36,073,019	20,441	7,004	0.343
7	47,582,333	0.999	47,622,115	39,782	12,166	0.306
8	45,104,522	0.999	45,168,871	64,350	19,453	0.302
9	48,955,702	0.997	49,095,842	140,140	45,056	0.322
10	35,764,389	0.895	39,959,057	4,194,669	3,353,226	0.799

Totals

Latest: 383,548,819.40
Dev: 0.99
 Ultimate: 388,031,468.67
IBNR: 4,482,649.27
Mack.S.E 3,353,780.25
CV(IBNR): 0.75

The above table shows the summary of the mack chainladder. The summary statistics consist of the Latest mean, ultimate mean and IBNR per year. From above, the outstanding liabilities for year 2017 is GHS4,482,649.27 with a standard error of 3,353,780.25.



The residual plots show the standardised residuals against fitted values, origin period, calendar period and development period.

All residual plot should show no pattern or direction for Mack's method to be applicable.

Pattern in any direction can be the result of trends and require further investigations.

4.4 The Bootstrap Chain-Ladder Method

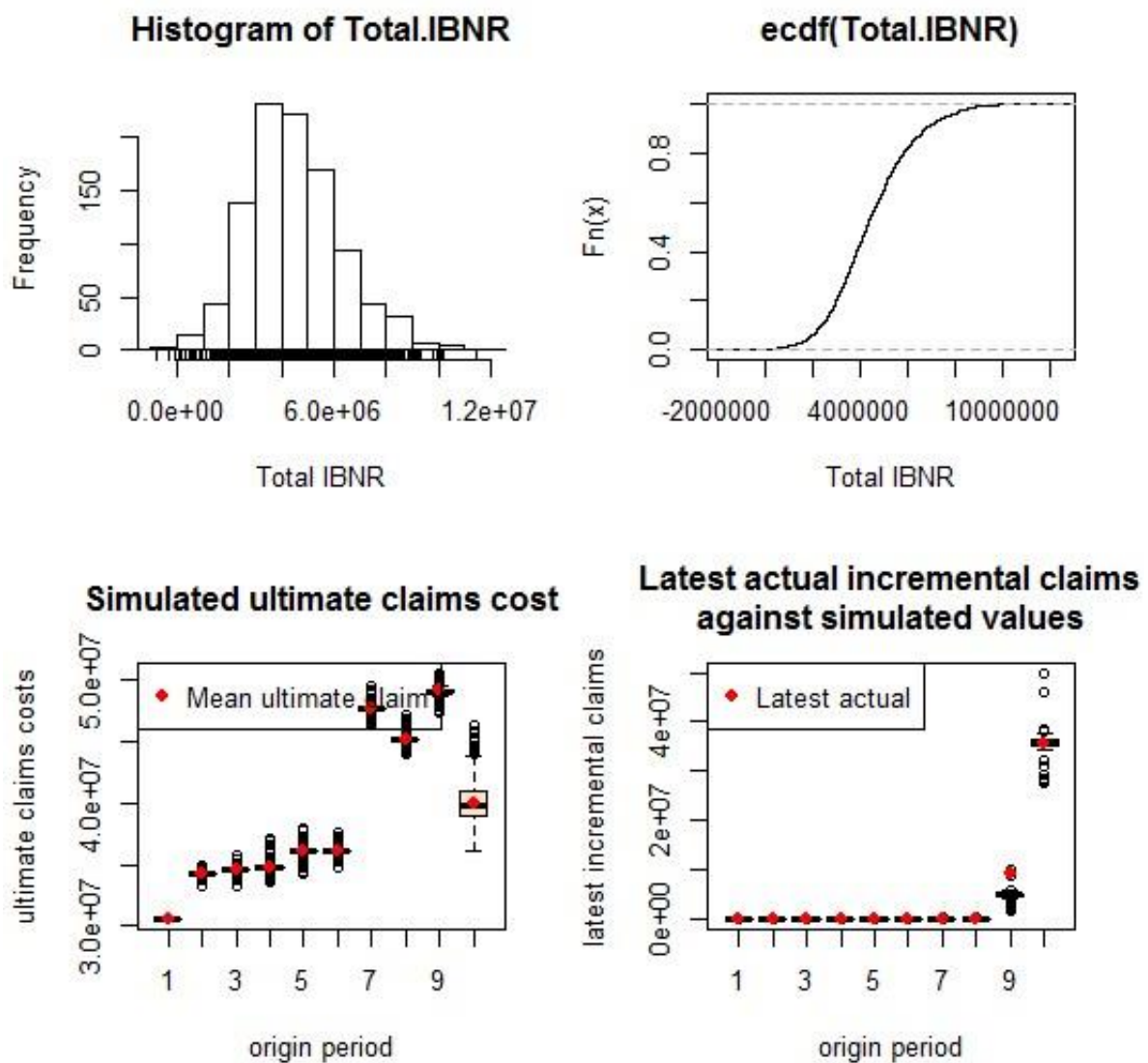
	Latest	Mean Ultimate	Mean IBNR	IBNR.S.E	IBNR 75%	IBNR 95%
1	30,505,361	30,505,361	0	0 0.00e+00	0	
2	34,184,789	34,187,004	2,215	84,404 6.30e-19	612	
3	34,548,188	34,549,948	1,760	118,345 2.45e-02	53,141	
4	34,833,119	34,839,371	6,252	141,775 9.62e+01	137,173	
5	36,017,838	36,024,661	6,823	191,481 4.81e+03	236,320	
6	36,052,578	36,056,221	3,643	217,960 9.46e+03	275,267	
7	47,582,333	47,615,519	33,186	271,057 5.42e+04	411,304	
8	45,104,522	45,156,518	51,996	298,110 8.90e+04	515,065	
9	48,955,702	49,086,096	130,393	375,914 2.11e+05	800,243	
10	35,764,389	39,918,877	4,154,488	1,526,641 5.18e+06	6,715,945	

Totals

Latest: 3.84e+08
 Mean Ultimate: 3.88e+08
 Mean IBNR: 4.39e+06
 IBNR.S.E 1.72e+06
 Total IBNR 75%: 5.50e+06
 Total IBNR 95%: 7.47e+06

The set of reserves obtained in this way forms the predictive distribution, from which summary statistics such as mean, prediction error or quantiles can be derived.

The mean and standard error of 1000 bootstrap iterations is shown above, together with the chain-ladder reserve estimates, prediction error and quantiles for the over-dispersed gamma chain-ladder model. The IBNR (Incurred but not reported)/ outstanding liabilities for 2017 is GHS 4,390,000 with a standard error 1,720,000



The graphs above indicates the histogram of simulated total IBNR, Empirical distribution of total IBNR, Box-whisker plot of simulated ultimate claims cost by origin period and Test if latest actual incremental loss could come from simulated distribution of claims cost.

Chapter 5

Conclusion

5.1 Introduction

This chapter presents the summary of findings, conclusions and recommendations of this work.

5.2 Summary of Findings

1) Table 4.1 depicts the health insurance claims' incremental losses got from Nationwide Medical Insurance record file from 2008 to 2017. The run-off triangle's incremental claims for any year of development as indicated in the Table 4.1 shows oddness, each claim do not follow a routine from the previous. In 2017 accident year, the highest incremental claim amount was recorded and that is GHS 35764388.86.

Also, in origin year 2013, the minimum claim amount was recorded and that is GHS 746.8.

2) In the Inflation-adjusted chain ladder method, the future outstanding liabilities of 2017 were obtained by adding the diagonal of claim liabilities marked asterisk (*). That is GHS 4,732,468.19 with a standard error of 846.61190806. The total future liabilities were obtained by adding the claim liabilities boldly written. That is GHS 5,161,413.06. In the Mack Chain-Ladder method, the outstanding liabilities for year 2017 is GHS 4,482,649.27 with a standard error of 3,353,780.25. In the Bootstrap Chain-Ladder method, The IBNR (Incurred but not reported) or outstanding liabilities for 2017 is GHS 4,390,000. with a standard error 1,720,000 3) The Inflation-adjusted chain ladder method is the best estimate for claim reserving since it has the lowest or least standard error.

5.3 Recommendation

It is recommended that further research ought to be directed to dig into additional fitting models that give the best estimate and changeability of claim reserves. The models created here does not utilize any data from claim numbers. We prescribe that if these were accessible, distinctive actuarial models could be considered to consider such parameters.



References

- Cipra, T. (2010). "Classical Non-Life Insurance, Financial and Insurance Formulas".
- De Alba, E. (2002a). "Bayesian estimation of Outstanding Claim Reserves, North American Actuarial Journal", 6(4):1-20
- Essvale (2009). "Business Knowledge of I.T. in Insurance, Essvale Cooperation Ltd, London".
- Gasper, D. (2010). "The idea of human security".
- Gould, I. L. (2008). "Stochastic chain - ladder models in non - life insurance". Halliwell, L. J. (2009). "Modelling paid and incurred loss together. In CAS E- forum spring".
- International Monetary Fund, "World Economic Outlook Database (2018). Retrieved from <http://indexmundi.com/ghana/economy/profile.html>"
- Irukwu, J. O. (1977). "Insurance Management in Africa. The Caxton press (West Africa)" Ltd, Ibadan, 13-20.
- Mack, T. (1991). "A Simple Parametric Model for Rating Automobile Insurance or Estimating IBNR Claims Reserves". ASTIN Bulletin, 21(1): 95 - 105
- Mack, T. (1993). "Distribution - free Calculation of the Standard error of Chain - Ladder reserve Estimates". ASTIN Bulletin, 23:201 - 225
- Mack, T. (1994). "Which Stochastic model is Underlying the Chain Ladder method? Insurance; Mathematics and Economics", 15:133-138

Mack, T. (1999). "The Standard Error of Chain Ladder Reserve Estimates: Recursive Calculation and Inclusion of a Tail Factor". ASTIN Bulletin, 29:360 - 365

Mack, T. (2006). "Parameter Estimation for Bornhuetter-Ferguson. CAS Forum Fall", 141 - 157

Mack, T. (2008). "The prediction error of Bornhuetter Ferguson . ASTIN Bulletin38(1)":87-103

Owusu -Boakye Kwadwo Nyame (2018). Understanding Actuarial Reserves. Unpublished report.

Paul Owusu-Sekyere. "Modeling Motor Insurance Claim Reserves in Ghana using Bornhuetter Ferguson and Inflation Adjusted Chain Ladder".

