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CLAIM RESERVES ESTIMATION USING CHAIN LADDER METHOD IN CASUALTY INSURANCE FOR THE PERIOD 2010 - 2019

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ABSTRACT

In a work environment, the presence of risk or unforeseeable events is inevitable, as employees certainly seek to get a sense of security in doing work. Therefore, insurance is responsibility to provide sense of security to employees by providing protection in the form of claim payments to employees who get accidents. To meet the claim payment, insurance companies need to prepare funds. With the chain ladder method, insurance companies can estimate how much funds must be prepared to make claim payments. This study used the secondary data from general insurance companies in the United States published by the *National Association of Insurance Commissioners* under the title "*Statistical Compilation of Annual Statement Information for Property/Casualty Insurance Companies in 2019*". Data in the form of cumulative run-off triangle with accident period 2010-2019. Through this calculation, claim reserves that must be prepared by insurance companies for 2020 amounted to USD 1,553,906.

1. INTRODUCTION

Human life will not be separated from the possibility of risks that can endanger themselves or personal property. Risks are often unpredictable when and where they will occur and can cause material and non-material losses. One of the treatments that can be chosen is through insurance. Casualty insurance is a type of insurance coverage that provides financial protection to individuals from liabilities. It is designed to cover the costs associated with legal claims that result from accidents or unexpected incidents. The arrival of an unpredictable disaster when makes the insurance company have to prepare funds if at any time the insured party asks for a claim to the insurance, these funds are called claim reserves. A claim reserve is an amount of money prepared by an insurance company to meet future payments related to claims that have already occurred but have not been paid or settled by a certain date (Maher, 1992).

Payment of claims made by insurance companies sometimes requires a long processing time. This causes some of the insured parties to delay reporting to the insurance even though the risk has occurred (Alaeddin et al., 2018). This is what causes the terms Incurred But Not Reported (IBNR) and Reported But Not Settled (RBNS). Incurred But Not Reported (IBNR) is an event that has occurred but has not been reported to an insurance company, while Reported But Not Settled (RBNS) is an event that has been reported but whose payment has not been resolved (Hossack et al., 1999).

If the claim data is arranged based on the time of the event as a column and the delay time as a row, then a distribution of upper triangle data is formed called the run-off triangle data matrix. This run-off triangle contains incremental data information from the claim reserve, the increment data can be calculated in cumulative form which will later become the main material for actuaries to calculate claim reserves, thus several methods for calculating claim reserves such as the Chain Ladder (CL) were born. The Chain Ladder (CL) method is one of the methods of calculating claim reserve estimates that is widely used in practice because of its simplicity and good results, this method assumes that the cumulative increase in claims from

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one increase in years to the average of other actions such as accidents that occurred in the previous year (Thomas & Colloquium, 2013).

Numerous studies have investigated methods to estimate claim reserves of the insurance company. (Adam, 2018) used Chain Ladder method to create claim reserves estimation in general insurance. The result show that the company should prepared fund USD 20,109.82 for outstanding claims in 2013. Another research (Pertiwi et al., 2023) was using Chain Ladder method to estimate claim reserves of vehicle insurance. The result showed that the insurance company must set aside 48699 to pay all claims that unpredictability occurred (Mulyaningrum, 2019), used Bornhuetter Ferguson method to estimate claim reserves of casualty insurance. The result show that insurance company should prepared fund USD 360,857,397 for outstanding claims of 2011-2019 in 2028. Therefore, establishing an accurate estimation of claim reserves is essential to insurance company.

2. Literature Review

Insurance companies are required to hold liabilities on their accounting books. For insurers, those liabilities include unpaid costs of claims. Statutory accounting requires the insurer to reflect the amount the insurance company expects to pay for all unpaid claims (Liability, 2011; Mursyid, 2019). IBNR (Incurred But Not Reported) refers to the amount of insurance claims that have occurred, but not yet reported as of the accounting date (Marbun, 2016). Insurance companies use actuarial methods and historical claims data to estimate the value of potential claims that have occurred but are still unreported. Accurate estimation of IBNR reserves is important aspects for managing liabilities, company valuation, and premium pricing (Amini & Hikmah, 2022).

Run-off triangles are two-dimensional matrices set of claims that are based on accident period and development period. The accident or policy years indicate the periods in which the claims occurred, while the development periods represent the time intervals from the initial reporting of the claims to their final settlement. Data run-off triangle refers to claims amount or number of claims, which are shown in incremental or cumulative data. Suppose $X_{i,j}$ denotes a stochastic variable that expresses the size of the claim in the run-off triangle data as incremental data with an event period of $1 \le i \le n$, a development period of $1 \le j \le n$, and terms $i + j \le n + 1$. This data is dataset that will observe as the basis for estimating outstanding claim reserves (Mutaqin et al., 2008).

Table 1. Run-off Triangle Data in the Form of Incremental Data

Claim Data		Development Year				
		1	…	j	…	n
Accident Year	1	$C_{1,1}$	…	$C_{1,j}$	…	$C_{1,n}$
	⋮	⋮	⋮	⋮	⋰	
	i	$C_{i,1}$	…	$C_{i,j}$		
	⋮	⋮	⋰			
	n	$C_{n,1}$				

Table 1. is an illustration of incremental run-off triangle data, where $C_{i,j}$ represents the amount of incremental claims that occurred during event i and paid during development j. This data is utilized in the in the calculation of outstanding claim reserves, where cumulative data is formed based on incremental data. Suppose $D_{i,j}$ is a random variable that expresses the size of the claim in the cumulative run-off triangle data with an event period of $1 \le i \le n$, a development period of $1 \le j \le n$, and terms $i + j \le n + 1$. This random variable is determined using equation (Pertiwi et al., 2023;Pertiwi et al., 2023)

$$D_{i,j} = \sum_{k=1}^{j} C_{i,k}$$

Table 2. represents the run-off triangle data in cumulative form with $D_{i,j}$showing the amount of cumulative claims that occurred in the period of event i and paid in the period of development j.

Table 2. Run-off Triangle Data in the Form of Cumulative Data

Claim Data		**Development Year**				
		1	…	j	…	n
	1	$D_{1,1}$	…	$D_{1,j}$	…	$D_{1,n}$

Accident Year	⋮	⋮	⋮	⋮	⋰
	i	$D_{i,1}$	...	$D_{i,j}$	
	⋮	⋮	⋰		
	n	$D_{n,1}$			

Chain-Ladder method was first introduced in 1934 by Tarbell. This method outlines the methodology for calculating claims growth or the factor that correlates the amount of claim losses incurred from one period to the following one in a single claim dataset. The main assumption used in the Chain-Ladder methods is that there is a consistent time pattern of delaying the payment of insurance claims in claim reporting (Kasus et al., 2014; Liability, 2011). The Chain-Ladder method uses historical claims data and delays in reporting and paying claims to estimate claims that have occurred, but not yet reported (Adam, 2018).

The Chain-Ladder method uses development factors to predict future claims. The development factors f_j is defined by:

$$f_j = \frac{\sum_{i=1}^{n-j} D_{i,j+1}}{\sum_{i=1}^{n-j} D_{i,j}}$$

for j = 1, ..., n -1. So, if $D_{i,0}, D_{i,1}, \dots, D_{i,j-1}$ are given, then the estimator of cumulative claim is:

$$\hat{D}_{i,j} = f_{j-1} D_{i,j-1}$$

for j = 1, … , n-1 and $i + j \leq n$, the expectation of all outstanding claims for period i is

$$E[D_{i,n-1}] = \left(\prod_{j=n-i+1}^{n-1} f_j\right) D_{i,n-1}$$

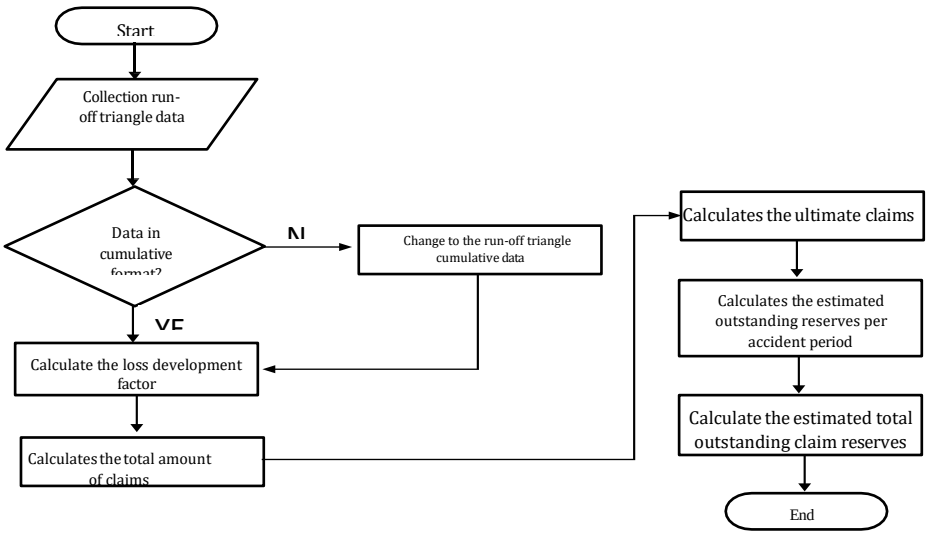
The estimator of outstanding reserves is given by

$$R_i = \hat{D}_{i,j} - \hat{D}_{i,j-i+1}$$

The amount of claim reserve estimation that must be provided by the insurance company until all claim settled R is the sum of incremental claim estimator on future triangles:

$$R = \sum_{i=1}^{j} R_i$$

3. METHODS



Flowchart 1. Flow to Estimate Claim Reserve

In this study, the data processing using Microsoft Excel as tool, which is used to estimate the reserve value of outstanding claims using the chain ladder method. The process involves several stages like flowchart (1) above to arrive at accurate estimations. The first step is to collect claim data in the form of a run-off triangle, the data must be in the form of cumulative data, otherwise in cumulative form a step is needed to convert incremental claim data into cumulative data. Then proceed to calculate the development factor to calculate the total amount of claim and ultimate claim. After that, the calculation of estimated outstanding reserves per accident period is carried out. Then the results are used in the estimated total outstanding claim reserves which will later be interpreted for the total outstanding claim reserves for the following year.

4. RESULTS AND DISCUSSIONS

4.1Data Sources and Types

The data used in this study is secondary data from general insurance companies in the United States published by the *National Association of Insurance Commissioners* under the title "*Statistical Compilation of Annual Statement Information for Property/Casualty Insurance Companies in 2019*". This data contains the insurance company's premium income and the amount of claims that have been paid by the insurance company to workers who suffered injuries while working from 2010 – 2019. The data is presented in the form of a cumulative *run-off triangle* like in table (Hossack et al., 1999).

Table 3. Run-off Triangle Data From NAIC

Accident Year / Development Year	1	2	3	4	5	6	7	8	9	10
2010	1,403,985	2,107,311	2,252,352	2,326,353	2,368,441	2,399,903	2,409,363	2,421,284	2,419,014	2,417,135
2011	1,393,890	2,113,683	2,248,179	2,315,961	2,363,074	2,375,924	2,399,974	2,399,040	2,403,160	
2012	1,362,446	2,030,513	2,178,354	2,252,792	2,277,317	2,307,305	2,311,058	2,322,938		
2013	1,289,406	1,970,723	2,134,680	2,185,579	2,227,043	2,243,118	2,264,174			
2014	1,302,962	2,007,732	2,126,344	2,199,255	2,226,150	2,265,202				
2015	1,277,070	1,961,439	2,110,195	2,163,083	2,220,720					
2016	1,248,865	1,936,379	2,065,761	2,148,338						
2017	1,254,215	1,915,067	2,075,565							
2018	1,267,784	1,969,560								
2019	1,277,846									

4.2 Claim Reserve Estimation

The data used for analysis is already in the form of a cumulative run-off triangle so that it goes directly to the next stage.

Calculating Development Factor

The first step is to calculate the development Factor by comparing the number of two years of development using the equation (Amini & Hikmah, 2022), so that nine development factors will be used in calculating the total amount of claims and the ultimate claims. The following are two an examples of development factor calculation:

$$f_1 = \frac{\sum_{i=1}^{9} D_{i,2}}{\sum_{i=1}^{9} D_{i,1}} = \frac{18{,}012{,}407}{11{,}800{,}623} = 1.52639$$

$$f_2 = \frac{\sum_{i=1}^{8} D_{i,3}}{\sum_{i=1}^{8} D_{i,2}} = \frac{17{,}191{,}430}{16{,}042{,}847} = 1.07159$$

The calculation is carried out until obtaining results f_9 using the same equation. The following is the result of the calculation of all vactor developmeny that can be seen in the table (Maher, 1992).

Table 4. Development Factor

Development Factor	$\hat{f}_1$	$\hat{f}_2$	$\hat{f}_3$	$\hat{f}_4$	$\hat{f}_5$	$\hat{f}_6$	$\hat{f}_7$	$\hat{f}_8$	$\hat{f}_9$
	1.52639	1.07159	1.03146	1.01783	1.01129	1.00625	1.00321	1.00038	0.99922

Calculates the total amount of claims

In calculating the total amount of claim using the equation (3) with accident period $1 \le i \le 10$ and development period $1 \le j \le 10$ with conditions $i + j > 10 + 1 = 11$. This calculation also uses the development vactor that has been obtained in the previous calculation seen in the table (4). The following are an examples calculation for the total amount of claims:

$$\hat{D}_{10,2} = f_1 \cdot D_{10,1} = (1.52639) \cdot (1,277,846) = 1,950,497$$

$$\hat{D}_{10,3} = f_2 \cdot D_{10,2} = (1.07159) \cdot (1,950,497) = 2,090,142$$

Ultimate claim is the result of calculations contained in the final column of the development period. To calculate the ultimate claim can be done by calculating the total amount of claim to the end or using the equation (4). An example of calculation using the equation (4) as follows:

$$\hat{D}_{3,10} = D_{3,8} \cdot \prod_{j=8}^{9} f_j = 2,270,552$$

The results of these calculations can be seen in the following table (5):

Table 5. Complete Result of Claim

Claim Data	Development Year									
Accident Year	1	2	3	4	5	6	7	8	9	10
2010	1,403,985	2,107,311	2,252,352	2,326,353	2,368,441	2,399,903	2,409,363	2,421,284	2,419,014	2,417,135
2011	1,393,890	2,113,683	2,248,179	2,315,961	2,363,074	2,375,924	2,399,974	2,399,040	2,403,160	2,401,293
2012	1,362,446	2,030,513	2,178,354	2,252,792	2,277,317	2,307,305	2,311,058	2,322,938	2,323,830	2,322,024
2013	1,289,406	1,970,723	2,134,680	2,185,579	2,227,043	2,243,118	2,264,174	2,271,445	2,272,317	2,270,552
2014	1,302,962	2,007,732	2,126,344	2,199,255	2,226,150	2,265,202	2,279,367	2,286,687	2,287,565	2,285,788
2015	1,277,070	1,961,439	2,110,195	2,163,083	2,220,720	2,245,796	2,259,839	2,267,097	2,267,967	2,266,205
2016	1,248,865	1,936,379	2,065,761	2,148,338	2,186,648	2,211,339	2,225,167	2,232,313	2,233,170	2,231,435
2017	1,254,215	1,915,067	2,075,565	2,140,856	2,179,032	2,203,637	2,217,417	2,224,538	2,225,392	2,223,664
2018	1,267,784	1,969,560	2,110,570	2,176,962	2,215,782	2,240,803	2,254,815	2,262,056	2,262,924	2,261,166
2019	1,277,846	1,950,497	2,090,142	2,155,892	2,194,336	2,219,114	2,232,991	2,240,162	2,241,022	2,239,281

Calculates the estimated outstanding reserves per accident period

The next step is to calculate the value of estimated outstanding reserves per accident using the equation (Marbun, 2016). The following are examples of calculating one of the outstanding reserves:

$$R_{10} = \hat{D}_{10,10} - \hat{D}_{10,1} = 961,435$$

$$R_{9} = \hat{D}_{9,10} - \hat{D}_{9,2} = 291,606$$

The results of the calculation can be seen in the following table (6):

Table 6. Outstanding Reserves per Accident Period

Accident Year	Outstanding Claim
2010	-
2011	(1,867)
2012	(914)
2013	6,378
2014	20,586
2015	45,485
2016	83,097
2017	148,099

2018	291,606
2019	961,435

Calculate the estimated total outstanding claim reserves

Based on table 6 calculation and using equation (6), the estimated total outstanding claim reserves of 2020 is USD 1,553,906. The amount of the estimate is obtained in the following way:

$$R = \sum_{i=1}^{10} R_i = 1{,}553{,}906$$

5. CONCLUSION

Based on calculations made to estimate general insurance claim reserves for the 2010-2019 period using the chain ladder method, it was found that the funds to be prepared by general insurance companies for 2020 amounted to USD 1,553,906. In addition, this calculation also serves as a benchmark in determining the amount of claim reserves in the general insurance financial statements for 2020. The chain ladder method is a method that still has the disadvantage of being less stable and the results are greatly influenced by the magnitude of claims in the previous period. Suggestions for future research to use comparison methods to get more accurate estimation results

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