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Calculation of The Chain Ladder and Bornhutter-Ferguson Methods in Calculating Claim Reserves for Insurance of Property Company in Sumatra

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Abstract: Property insurance provides financial protection against the risk of losses caused by damage or destruction of insured assets, such as infrastructure, vehicles, and equipment. To ensure they can fulfill future claim obligations, property insurance companies are mandated to maintain adequate reserves. Therefore, these companies need to accurately estimate claim reserves. This study aims to compare two widely recognized methods for estimating claim reserves: the Chain Ladder method and the Bornhuetter-Ferguson method. The analysis is based on secondary data sourced from property insurance operations in Sumatra, covering production and claim records from 2018 to 2023. The Chain Ladder method relies on historical claim delay patterns to forecast claims in the future, making it a relatively straightforward and data-driven approach. In contrast, the Bornhuetter-Ferguson method integrates historical claim data with prior assumptions about the loss ratio derived from earned premiums, offering a more blended perspective. To evaluate the accuracy of both methods, the Mean Absolute Percentage Error (MAPE) is used as a measure of performance. The findings reveal that the Bornhuetter-Ferguson method provides better estimates of claim reserves compared to the Chain Ladder method, underscoring its practical advantages for insurers in managing financial risk.

Keywords: Bornhuetter-Ferguson, Chain Ladder, Claim reserves, Property insurance

Introduction

Humans cannot avoid risks or unexpected events that can arise at any moment and endanger themselves. One such event is a natural disaster. Indonesia is located along the Pacific Ring of Fire, traversed by the Alpide belt, and crossed by the equator, making it susceptible to natural disasters including earthquakes, volcanic eruptions, floods, landslides, etc. Sumatra is one of the regions in Indonesia where active faults, volcanic paths (active tectonics), and subduction zones run throughout its territory. This results in a high risk of natural disasters in Sumatra, particularly in Aceh, Jambi, Bengkulu, Lampung, West Sumatra, and North Sumatra [1]. The natural disasters that occur have a significant impact on communities, causing severe damage to housing, property, physical, and finances.

The risks of natural disasters can be mitigated by seeking insurance institutions willing to take on those risks. Insurance represents a contractual agreement between two entities: the insurer, commonly known as the insurance provider or company, and the insured, also referred to as the policyholder. This arrangement

establishes a legal obligation whereby the insurer provides financial protection in the form of compensation for specified risks or losses, while the policyholder agrees to pay a premium in exchange for this coverage [2]. The insurance business consists of three forms: reinsurance, life insurance, and general insurance. One of the developed products of general insurance is property insurance. Property insurance protects assets such as infrastructures, furniture, machinery, and damage or loss due to fire, theft, and earthquakes [3].

Property insurance companies need to ensure sufficient funds are available to meet future claim obligations; this fund is known as the claims reserve. The claims reserve holds significant importance for insurance companies as it serves as a financial provision to settle claims that have been reported and meet the eligibility criteria for payment but are still undergoing the adjustment or settlement process. Settling claims in non-life insurance can often be difficult for companies to calculate. The claims settlement process sometimes takes a considerable amount of time due to the requirements



that must be met during the claim submission, as well as the need for investigations into the causes or extent of the losses incurred. If a company makes poor decisions in determining the claims reserve, it can lead to instability in the financial sector and even result in bankruptcy. Therefore, accurate calculation techniques are necessary to obtain an accurate claims reserve [4]. The claims reserves estimation plays a pivotal role for insurance companies, as it provides critical insights into their financial capacity to find future claim payment obligations. [5].

There are several methods that can be used to forecast the number of claims that will be submitted, include the Chain Ladder and Bornhuetter-Ferguson method. Chain Ladder is a simple approach that does not depend on a specific distribution. This method is designed to forecast future claims triangles by leveraging delay factors and the cumulative claims recorded along the primary diagonal of the run-off triangle [6]. Bornhuetter and Pearl Ferguson (1972) introduced the Bornhuetter-Ferguson method, which also does not rely on a specific distribution. This approach forecasts claims reserves by multiplying the ultimate claims that has been estimated by the percentage of claim growth in future years for occurrence year i , based on its delay pattern. The basic idea of this method is to incorporate information obtained from premium income into its calculations [7]. Research conducted by Raisha Amini et al. [8] compared the Chain Ladder and Bornhuetter-Ferguson methods in calculating claims reserves for indemnity insurance, using a limited data set covering only 2 years. This study will analyze claims reserve calculations using the Chain Ladder and the Bornhuetter-Ferguson methods for property insurance in Sumatra, utilizing data over 6 years to observe a more accurate long-term trend in predicting property insurance claims reserves in Sumatra.

Method

A. Research Data

In this research, the data used to calculate the estimation of claims reserves is secondary data obtained from property insurance in Sumatra, covering production and claims data from 2018 to 2023. The research uses Microsoft Excel in calculating the claim reserves prediction using the Chain Ladder and Bornhuetter-Ferguson methods also to analyse which method is provides a prediction value with the smallest

prediction error. Variables that used in this research are shown in Table 1.

Table 1. Description of Research Variable

No	Variable	Symbol	Description
1	Incremental claims data	$Y_{i,j}$	The claims amount that the insurance company is obligated to pay during the i -th and j -th development period
2	Cumulative claims data	$D_{i,j}$	Total claims to be paid by the insurance company during the i -th event period and j -th development period
3	Year of event	X_i	The period in which the claim is reported to the insurance company
4	Year of delay	X_j	The time range between claims reporting and claim payment by the insurance company

B. Research Methods

Run-Off Triangle

According to Mutaqin, et al stated that run-off triangle data is often used as a basis for estimating the proportion of losses for long-term business classes in general insurance companies [9]. The run-off triangle data provides a consolidated overview of total aggregate claims, along with a detailed summary of individual claim records within the dataset. Run-off triangle typically contains the amount or number of claims, presented either cumulatively or incrementally.

Table 2. Incremental Aggregate Run-Off Triangle

Event Period	Development Period						
	1	2	...	j	...	$n-1$	n
1	$Y_{1,1}$	$Y_{1,2}$	...	$Y_{1,j}$	...	$Y_{1,n-1}$	$Y_{1,n}$
2	$Y_{2,1}$	$Y_{2,2}$	...	$Y_{2,j}$	...	$Y_{2,n-1}$	$Y_{2,n}$
...	...	...	...	...	...	...	...
i	$Y_{i,1}$	$Y_{i,2}$	...	$Y_{i,j}$	...	$Y_{i,n-1}$	$Y_{i,n}$
...	...	...	...	...	...	...	...
$n-1$	$Y_{n-1,1}$	$Y_{n-1,2}$	...	$Y_{n-1,j}$	...	$Y_{n-1,n-1}$	$Y_{n-1,n}$
n	$Y_{n,1}$	$Y_{n,2}$	...	$Y_{n,j}$	...	$Y_{n,n-1}$	$Y_{n,n}$

Based on Table 2, the amount of the claim that happened in the i^{th} period and was paid in the j^{th} development period is represented by a random variable $Y_{i,j}$. That claim value is known if $i+j \leq n+1$ but not observed (unknown) if $i+j > n+1$. The cumulative run-off triangle is derived from incremental data by applying the following relationship [10].

$$D_{i,j} = \sum_{k=1}^j Y_{i,k}; \text{ for } 1 \leq i \leq n, 1 \leq j \leq n. \quad (1)$$

Where $D_{i,j}$ for the total amount (cumulative) of claims that happened in period i and were paid up to delay period j [11].

Chain Ladder Method

The Chain Ladder method is a widely used technique for estimating future claim reserves by analyzing data presented in the aggregate run-off triangle [6]. The initial stage in applying the Chain Ladder method involves constructing a run-off triangle using the equation

$$D_{i,j} = \sum_{i=1}^j Y_{i,j} \quad (2)$$

with $i \in \{1, 2, \dots, n\}$ and $j \in \{1, 2, \dots, n - i + 1\}$. The random variable $D_{i,j}$ represents the cumulative claims amount that happened in the i^{th} event period and were paid up to the j^{th} development period.

Table 3. Cumulative Aggregate Run-Off Triangle

Accident Period	Development Period					
	1	2	...	j	...	n
1	$D_{1,1}$	$D_{1,2}$	...	$D_{1,j}$	...	$D_{1,n}$
2	$D_{2,1}$	$D_{2,2}$	...	$D_{2,j}$	...	$D_{2,n}$
...	...	...	...	...	...	...
i	$D_{i,1}$	$D_{i,2}$	...	$D_{i,j}$	...	$D_{i,n}$
...	...	...	...	...	...	...
$n-1$	$D_{n-1,1}$	$D_{n-1,2}$	...	$D_{n-1,j}$	...	$D_{n-1,n}$
n	$D_{n,1}$	$D_{n,2}$	...	$D_{n,j}$	...	$D_{n,n}$

The total future claims are represented by the grey area at the bottom of the triangle (Table 3). To estimate these claims, loss development factors are determined. The loss development factor at the j^{th} period can be calculated using the equation

$$\hat{\lambda}_j = \frac{\sum_{i=1}^{n-j} D_{i,j+1}}{\sum_{i=1}^{n-j} D_{i,j}} \quad (3)$$

with $j \in \{1, 2, \dots, n-1\}$. Next, the development factor is utilized to project claims within the grey area of the cumulative run-off triangle, extending up to the j^{th} development period using the following equation

$$\hat{D}_{i,j} = D_{i,j-1} \hat{\lambda}_{i,j} \quad (4)$$

for $i \in \{2, 3, \dots, n\}$ and $j \in \{n-i+2, \dots, n\}$. Additionally, the total claims for the i^{th} event period, $i \in \{2, 3, \dots, n\}$, can be calculated using the following equation

$$\hat{R}_i = \hat{D}_{i,j} - \hat{D}_{i,j-1} \quad (5)$$

Hence, the total projected claims for the future obtained are

$$\hat{R} = \sum_{i=2}^n \hat{R}_i. \quad (6)$$

Bornhuetter-Ferguson Method

Chain Ladder method uses historical claims data from previous periods, while the Bornhuetter-Ferguson method uses the company's exposure to losses or claims. The Bornhuetter-Ferguson method utilizes earned premiums to determine the estimated claim reserves. Earned Premiums are the portion of premiums that the company has earned, while the portion of premiums that company has not yet earned is referred to Unearned Premium [12]. A distinguishing feature of the Bornhuetter-Ferguson method is its use of the ratio of loss as an extra variable in the estimation of claims reserve amount [13]. The loss ratio that occurred in the i^{th} period is calculated by dividing the total claims paid that occurred in the i^{th} period by the total premiums earned the total premiums earned during an i^{th} period (EP_i) such as

$$\delta_i = \frac{D_{i,n}}{EP_i}, \quad (7)$$

which $D_{i,n}$ is the cumulative amount of the claims that happened in the i^{th} period and were paid up to the n^{th} development period (actual claims paid at the i^{th} period). Then, calculate $\hat{\gamma}_i$ is cumulative development factors. $\hat{\gamma}_i$ describe the total incremental growth in claims between successive development periods, taking into account the accumulation of claims from the previous period.

$$\hat{\gamma}_i = \prod_{j=1}^{n-1} \hat{\lambda}_j \quad (8)$$

Thus, calculate $\hat{\beta}_i$ represents the delay pattern for the amount of claims reserve. The value of $\hat{\beta}_i$ is usually estimated considering the cumulative development factors at the i^{th} development period ($\hat{\gamma}_i$) that calculated as follow

$$\hat{\beta}_i = \frac{1}{\hat{\gamma}_i} = \frac{1}{\prod_{j=1}^{n-1} \hat{\lambda}_j} \quad (9)$$

with $\hat{\lambda}_j$ is the loss development factor at the j^{th} period. The value of $\hat{\beta}_i$ can be presented as a percentage, which can be interpreted as follows:

- The value approaching 100% indicates that the claim is nearing settlement.
- The value reaches 100% indicates that the claim has been fully settled.

In this method, the amount of claims reserve from the i^{th} event year at time i^{th} can be calculated using the following equation

$$\hat{R}_i = ACP + EP_i(\delta_i)(1 - \hat{\beta}_i) \quad (10)$$

The estimated total claims to be paid by the company in a given period using the Bornhuetter-Ferguson method are [8]

$$\hat{R} = \sum_{i=2}^n \hat{R}_i \quad (11)$$

Prediction Error

Prediction of error measures how accurate the predicted value made by some model. Mean Square Percentage Error (MAPE) is a metric that quantifies the accuracy of predictions and calculated by finding the average percentage deviation between the actual and predicted values [14]. Hence, the formula can be written into following equation

$$MAPE = \frac{1}{n} \sum_{t=1}^n \left| \frac{y_t - \hat{y}_t}{y_t} \right| \times 100\% \quad (8)$$

where y_t represents the actual value at time t , while $\hat{y}_t$ denotes the predicted value for that specific time period. The number of the data observations denotes by n . The criteria for the MAPE value are as follows [15].

Table 4. Cumulative Aggregate Run-Off Triangle

Value of MAPE	Criteria
$x < 10\%$	Forecasting ability is very good
$10\% \leq x < 20\%$	Forecasting ability is good
$20\% \leq x < 50\%$	Forecasting ability is quite good
$x > 50\%$	Forecasting ability is bad

A smaller value of MAPE indicates more accurate forecasts performance (Table 4).

C. Stages of Analysis

There are several steps that must be followed before obtaining the final estimated value of claim reserves.

1. First, calculate the incremental run-off triangle and cumulative run-off value
2. Estimate the development factor value of each delay period
3. In the Chain Ladder method, claim reserve estimates are directly calculated using the cumulative run-off triangle and development factors. In contrast, the Bornhuetter-Ferguson

method incorporates earned premium and loss ratio values as part of the calculation process.

4. The result of the claim reserve estimation is then used to calculate the prediction error (MAPE)
5. From the two methods, the value of estimated claim reserves can be compared, which can be selected as the results of estimating claim reserves based on the smallest MAPE value.

Flowchart from stages of analysis is bellow.

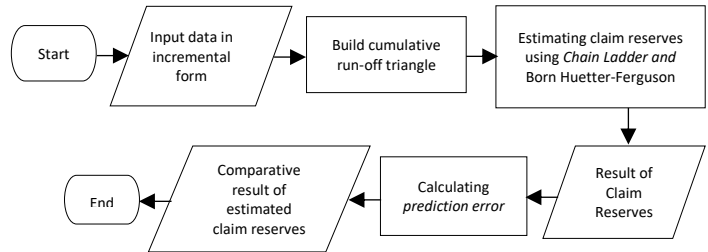


Figure 1. Flowchart

Results And Discussion

This study utilizes secondary data sourced from PT Asuransi Jasa Raharja Putera, located in Sumatra. The data consists of production and property claim data from 2018 to 2023. The production data includes 93,769 property insurance policies, which cover the policy ID and premiums recognized as revenue during the 2018-2023 period. The claim data includes 204 claim incidents, which cover the date of the incident, the reporting date, the payment date, and the amount of loss claimed.

Data Characteristics

Before determining the claim reserves value using the Chain Ladder and Bornhuetter-Ferguson methods, several steps must be completed, including creating an incremental and cumulative run-off triangle.

Table 5. Incremental Run-Off Triangle (IDR)

Loss Year	Development Year					
	1	2	3	4	5	6
2018 - S1	993,441,955	1,661,727,375	56,975,915	5,216,838	-	-
2018 - S2	333,035,962	307,551,900	-	-	1,515,725,813	-
2019 - S1	123,669,450	1,463,339,047	32,760,126	121,846,410	-	-
2019 - S2	1,025,094,228	693,674,080	1,368,852,989	680,371,501	-	-
2020 - S1	5,361,833,348	522,199,099	-	-	-	-
2020 - S2	164,219,095	165,474,876	16,447,533	-	-	-
2021 - S1	4,089,021,900	2,224,224,739	878,584,021	405,245,556	33,636,441	10,357,001
2021 - S2	155,200,380	20,312,148	1,822,500	-	-	-
2022 - S1	90,430,165	102,734,250	-	-	-	-
2022 - S2	39,306,256	-	598,129,928	-	-	-
2023 - S1	47,664,692	880,223,624	-	-	-	-
2023 - S2	341,631,470	-	-	-	-	-

Table 6. Continued Incremental Run-Off Triangle (IDR)

Loss Year	Development Year					
	7	8	9	10	11	12
2018 - S1	-	-	-	-	-	-
2018 - S2	-	-	-	-	-	-
2019 - S1	-	8,152,446	-	-	-	-
2019 - S2	-	-	2,546,811	-	-	-
2020 - S1	-	-	-	-	-	-
2020 - S2	-	-	-	-	-	-
2021 - S1	-	-	-	-	-	-
2021 - S2	-	-	-	-	-	-
2022 - S1	-	-	-	-	-	-
2022 - S2	-	-	-	-	-	-
2023 - S1	-	-	-	-	-	-
2023 - S2	-	-	-	-	-	-

Table 5 and Table 6 show that the year of delay is 6 years and is evaluated based on semester. This indicates that claims made in the 1st semester of 2018 were not resolved immediately. Instead, some of these claims were settled between the 2nd semester of 2018 and the 2nd semester of 2023 (over a six-year period), as detailed in Table 5 and Table 6. The claim amount of IDR 522,199,099 in the orange table can be interpreted as the total claims incurred in 1st semester of 2018 and settled in 2nd semester of 2018 or in other words, it took 1 semester to settle the claim. If we observe that the available information is limited to 2nd semester of 2023.

Furthermore, the claims information data in the incremental can be form into cumulative.

Table 7. Cumulative Run-Off Triangle (IDR)

Loss Year	Development Year					
	1	2	3	4	5	6
2018 - S1	993,441,955	2,655,169,330	2,712,140,083	2,717,362,083	2,717,362,083	2,717,362,083
2018 - S2	333,035,962	640,587,862	640,587,862	640,587,862	2,156,313,676	2,156,313,676
2019 - S1	123,669,450	1,587,008,497	1,619,768,623	1,741,615,033	1,741,615,033	1,741,615,033
2019 - S2	1,025,094,228	1,718,768,307	3,087,621,296	3,767,992,797	3,767,992,797	3,767,992,797
2020 - S1	5,361,833,348	5,884,032,447	5,884,032,447	5,884,032,447	5,884,032,447	5,884,032,447
2020 - S2	164,219,095	329,693,971	346,141,504	346,141,504	346,141,504	346,141,504
2021 - S1	4,089,021,900	6,313,246,900	7,191,830,660	7,597,076,216	7,630,712,657	7,641,069,658
2021 - S2	155,200,380	175,512,528	177,335,028	177,335,028	177,335,028	177,335,028
2022 - S1	90,430,165	193,164,415	193,164,415	193,164,415	193,164,415	193,164,415
2022 - S2	39,306,256	39,306,256	637,436,184	637,436,184	637,436,184	637,436,184
2023 - S1	47,664,692	927,888,316	927,888,316	927,888,316	927,888,316	927,888,316
2023 - S2	341,631,470	341,631,470	341,631,470	341,631,470	341,631,470	341,631,470

Table 8. Continued Cumulative Run-Off Triangle (IDR)

Loss Year	Development Year					
	7	8	9	10	11	12
2018 - S1	2,717,362,083	2,717,362,083	2,717,362,083	2,717,362,083	2,717,362,083	2,717,362,083
2018 - S2	2,156,313,676	2,156,313,676	2,156,313,676	2,156,313,676	2,156,313,676	2,156,313,676
2019 - S1	1,741,615,033	1,749,767,480	1,749,767,480	1,749,767,480	1,749,767,480	1,749,767,480
2019 - S2	3,767,992,797	3,767,992,797	3,770,539,608	3,770,539,608	3,770,539,608	3,770,539,608
2020 - S1	5,884,032,447	5,884,032,447	5,884,032,447	5,884,032,447	5,884,032,447	5,884,032,447
2020 - S2	346,141,504	346,141,504	346,141,504	346,141,504	346,141,504	346,141,504
2021 - S1	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658
2021 - S2	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658
2022 - S1	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658
2022 - S2	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658
2023 - S1	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658
2023 - S2	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658	7,641,069,658

Table 7 and Table 8 display the cumulative value for each delay period. As indicated earlier, the cumulative value for each delay period varies based on the number of claims reported during the corresponding event period. The longer the delay period, the smaller the claim amount from the event year will be, as part of the claim value has already been paid in previous delay periods. The green cells in the run-off triangle represent the cumulative value for each event period that still needs to be settled during the development period.

Estimation of Claim Reserves Using the Chain Ladder Method

The Chain Ladder method is a deterministic approach for claim reserves calculation, relying on the use of development factors, where the value is obtained using the calculation in equation (3). The following can be shown the development factor value of each claim based on the event period and delay period (Table 9 and Table 10).

Table 9. Development Factor Calculation Results

λ_1	λ_2	λ_3	λ_4	λ_5	λ_6
1.6473	1.1512	1.0555	1.0677	1.0004	1.0000

Table 10. Continued Development Factor Calculation Results

λ_7	λ_8	λ_9	λ_{10}	λ_{11}
1.0005	1.0002	1.0000	1.0000	1.0000

Once the development factor has been determined, the projected value for each claim amount can then be calculated based on the delay period. To estimate the projected value for each claim, multiply the cumulative value by the development factor.

Table 9. Result of Claims Reserve Estimation Using Chain Ladder Method

Loss Year	Development Year					
	1	2	3	4	5	6
2018 - S1	993,441,9	2,655,169	2,712,145	2,717,362	2,717,362	2,717,362,0
2018 - S2	333,035,9	640,587,8	640,587,8	640,587,8	2,156,313	2,156,313,6
2019 - S1	123,669,4	1,587,008	1,619,768	1,741,615	1,741,615	1,741,615,0
2019 - S2	1025,094	1,718,768	3,087,621	3,767,992	3,767,992	3,767,992,7
2020 - S1	5,361,833	5,884,032	5,884,032	5,884,032	5,884,032	5,884,032,4
2020 - S2	164,219,0	329,693,9	346,141,5	346,141,5	346,141,5	346,141,504
2021 - S1	4,089,021	6,313,246	7,191,830	7,597,076	7,630,712	7,641,069,6
2021 - S2	155,200,3	175,512,5	177,335,0	177,335,0	177,335,0	177,410,785
2022 - S1	90,430,16	193,164,4	193,164,4	193,164,4	206,249,4	206,337,509
2022 - S2	39,306,25	39,306,25	637,436,1	672,809,7	718,386,0	718,692,918
2023 - S1	47,664,69	927,888,3	1,068,168	1,127,445	1,203,818	1,204,332,7
2023 - S2	341,631,4	562,772,4	647,853,7	683,805,4	730,126,5	730,438,435

Table 10. Continued Result of Claims Reserve Estimation Using Chain Ladder Method

Loss Year	Development Year					
	7	8	9	10	11	12
2018 - S1	2,717,362	2,717,362	2,717,362	2,717,362	2,717,362	2,717,362,0
2018 - S2	2,156,313	2,156,313	2,156,313	2,156,313	2,156,313	2,156,313,6
2019 - S1	1,741,615	1,749,767	1,749,767	1,749,767	1,749,767	1,749,767,4
2019 - S2	3,767,992	3,767,992	3,770,539	3,770,539	3,770,539	3,770,539,6
2020 - S1	5,884,032	5,884,032	5,885,474	5,885,474	5,885,474	5,885,474,5
2020 - S2	346,141,5	346,314,9	346,399,8	346,399,8	346,399,8	346,399,85
2021 - S1	7,641,069	7,644,899	7,646,772	7,646,772	7,646,772	7,646,772,6
2021 - S2	177,410,7	177,499,6	177,543,1	177,543,1	177,543,1	177,543,19
2022 - S1	206,337,5	206,440,9	206,491,5	206,491,5	206,491,5	206,491,51
2022 - S2	718,692,9	719,053,0	719,229,3	719,229,3	719,229,3	719,229,32
2023 - S1	1,204,332	1,204,936	1,205,231	1,205,231	1,205,231	1,205,231,6
2023 - S2	730,438,4	730,804,4	730,983,6	730,983,6	730,983,6	730,983,60

The number of claims listed in Tables 11 and 12 can be used to determine the amount of claim reserves that the insurance company will need for each year that the event occurs. The blue table can be read as a reserve claim in the 12th development period that occurred in 2nd semester of 2018 was IDR 2,156,313,676.

Table 11. Claims Reserve Using Chain Ladder Method

Loss Year	Claims Reserves
2018 - S1	2,717,362,083
2018 - S2	2,156,313,676
2019 - S1	1,749,767,480
2019 - S2	3,770,539,608
2020 - S1	5,885,474,549
2020 - S2	346,399,852
2021 - S1	7,646,772,688
2021 - S2	177,543,198
2022 - S1	206,491,512
2022 - S2	719,229,325
2023 - S1	1,205,231,606
2023 - S2	730,983,609

The total claim reserve obtained is IDR 27,312,109,187 (Table 13). This indicates that, by applying the Chain Ladder method, the insurance company needs to allocate IDR 27,312,109,187 to cover anticipated claims for the 1st semester of 2024 is of IDR 27,312,109,187.

Estimation of Claim Reserves Using the Bornhuetter-Ferguson Method

First step from estimation of claim reserves using the Bornhuetter-Ferguson method is the calculation of loss ratio that occurred in the i^{th} period is calculated by dividing the total claims paid that occurred in the i^{th} period by the total premiums earned the total premiums earned during an i^{th} period (EP_i).

Table 12. Earned Premium Data

Loss Year	Earned Premium
2018 - S1	9,546,200,630
2018 - S2	11,459,180,161
2019 - S1	12,134,409,340
2019 - S2	11,755,523,508
2020 - S1	8,240,852,626
2020 - S2	8,838,822,357
2021 - S1	8,105,139,545
2021 - S2	9,650,921,886
2022 - S1	8,313,335,208
2022 - S2	10,964,655,617

Based on Table 14, earned premium data for the years 2018 to 2023 we can get loss ratio by equation (7).

Table 13. Loss Ratio Calculation Results

Loss Year	Loss Ratio
2018 - S1	28,47%
2018 - S2	18,82%
2019 - S1	14,42%
2019 - S2	32,07%
2020 - S1	71,40%
2020 - S2	3,92%
2021 - S1	94,27%
2021 - S2	1,84%
2022 - S1	2,32%
2022 - S2	5,81%
2023 - S1	10,73%

After obtaining the earned premium and loss ratio values (Table 15), we determine cumulative development factors ($\hat{\gamma}_i$) describe the total rise in claims accumulated between consecutive development periods, taking into account the accumulation of claims from the previous period. The table 16 presents the calculated cumulative development factors for each year of the i^{th} event.

Table 14. Calculation Results of Claim Value in the i^{th} Event Year

Loss Year	$\hat{\gamma}_i$
2018 - S1	2.1397
2018 - S2	1.2989
2019 - S1	1.1283
2019 - S2	1.0690
2020 - S1	1.0012
2020 - S2	1.0007
2021 - S1	1.0007
2021 - S2	1.0002
2022 - S1	1
2022 - S2	1
2023 - S1	1

The Bornhuetter-Ferguson technique of estimating claim reserves involves analyzing the cumulative claims' delay pattern (Table 17).

Table 15. Cumulative Claims Delay Pattern

$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	$\hat{\beta}_4$	$\hat{\beta}_5$	$\hat{\beta}_6$
100%	100%	100%	100%	99.98%	99.93%
$\hat{\beta}_7$	$\hat{\beta}_8$	$\hat{\beta}_9$	$\hat{\beta}_{10}$	$\hat{\beta}_{11}$	$\hat{\beta}_{12}$
99.93%	99.88%	93.55%	88.63%	76.99%	46.74%

Whereas in other years, the pattern of delays varies according to the earned premium value and loss ratio. The estimated total claims to be paid by the company in a given period using the Bornhuetter-Ferguson method are shown in Table 18.

Table 16. Claims Reserve Using Bornhuetter-Ferguson Method

Loss Year	Claim Reserves
2018 - S1	2,717,362,083
2018 - S2	2,156,313,676
2019 - S1	1,749,767,480
2019 - S2	3,770,539,608
2020 - S1	5,885,474,196
2020 - S2	346,399,660
2021 - S1	7,646,768,434
2021 - S2	177,542,954
2022 - S1	205,631,373
2022 - S2	709,927,538
2023 - S1	1,141,410,429
2023 - S2	523,598,538

The total claim reserves obtained is IDR 27,030,735,968. It can be concluded that by using the Bornhuetter-Ferguson method, the total of claims that must be prepared by the insurance company in in 1st semester of 2024 is IDR 27,030,735,968.

Prediction Error

The research utilizes Mean Absolute Percentage Error (MAPE) to measure prediction error. A lower MAPE value indicates a smaller error. In this study, the estimated claim reserves generated by the Chain Ladder and Bornhuetter-Ferguson methods will be compared. The method with the lowest error will be identified by comparing their respective MAPE values.

Table 17. MAPE Value

MAPE	
CL	BF
13.66%	7.87%

The MAPE values for the Chain Ladder and Bornhuetter-Ferguson methods are 13.36% and 7.87% (Table 19), respectively, indicating that the Bornhuetter-Ferguson method produces a smaller calculation error compared to the Chain Ladder method for property class loss insurance from 2018 to 2023 at property insurance in Sumatra. The exact amount of data produced is 26,542,681,870. In the meantime, IDR 27,312,109,187 and IDR 27,030,735,968 are the estimated values of claim reserves obtained using Chain Ladder and Bornhuetter-Ferguson approaches, respectively. Then, the projected value of each method is compared with the actual value to obtain the best method that can be used as the final result of claim reserves in the insurance loss. After the comparison, it was found that the estimated value of claim reserves using Bornhuetter-Ferguson method has the smallest prediction error value compared to Chain Ladder method, which is 7.87%. So, based on the results of the prediction error value, the method chosen in the estimation of loss insurance claim reserves for property business classes at PT Asuransi Jasa Raharja Putera in Sumatra is the Bornhuetter-Ferguson method.

Conclusions

Based on the analysis of the amount of claim reserves that have been obtained, it can be concluded that the results of the estimation of claim reserves using the Chain Ladder and Bornhuetter-Ferguson methods were IDR 27,312,109,187 and IDR 27,030,735,968. The prediction error results of the Chain Ladder and Bornhuetter-Ferguson methods are 13.66 % and 7.87 %. So, based on the prediction error value, the method chosen in the estimation of loss insurance claim reserves for property business classes at PT Asuransi Jasa Raharja Putera in Sumatra is the Bornhuetter-Ferguson

method with an estimated claim reserve value of IDR 27,030,735,968.

Conflicts of interest

This research and the writing of this journal are free from any conflicts of interest.

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