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Comparison of chain-ladder, Bornhuetter-Ferguson, and Benktander-Hovinen methods for individual claims reserving

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Abstract. The estimation of claims reserve is one of the important problems in general insurance companies because the companies are always required to be able to provide sufficient reserves to finalize payment of claims in the future. This paper provides a solution for estimating claims reserved in the case of individual data of liability insurance claims. We have compared the implementation of reserving methods, including chain-ladder, Bornhuetter-Ferguson, and Benktander-Hovinen methods. Overall, the Benktander-Hovinen method is the best method in the case study in comparison with others.

1. Introduction

General insurance companies must have enough funds to make a payment of claims that are not finalized at the moment evaluation. The funds are furthermore called as claims reserve. Estimation of claims reserve has become the central of attention in general insurance companies. It is because if the claims reserve estimation is bad, then the insurance company can go bankrupt.

There are many different statistical methods that are available for estimating claims reserve. In general, there are two different approaches to estimate claims reserve, deterministic and stochastic methods. The deterministic methods consist of chain-ladder (CL) method [1] and Bornhuetter-Ferguson (BF) method [2]. These methods are widely applied in practice because they are simple and give accurate results [3]. The stochastic methods are divided into two parts, frequentist and Bayesian. A Benktander-Hovinen (BH) method [4,5] is a method that leads us toward Bayesian considerations [3]. This method is essentially combination of CL method and BF method.

The main focus in this study is not only on estimating the claims reserve using CL method, BF method, and BH method, but also determining the best method. The choice of the best method is done by bootstrapping individual claim histories (BICH) method [6]. The bootstrap method BICH is a method that can rank reserving methods by their mean square error of predictions (MSEP). The best method is a method that can give the smallest MSEP.

2. Claims reserving problem

We denote $X_{i,j}$ as incremental data representing claims number or claims amount. The index $i \in \{1,2,\cdots,I\}$ denotes the occurrence period of claims and the index $j \in \{1,2,\cdots J\}$ denotes the development period. The observation data up to time I are denoted by $\mathcal{D}_I = \{X_{i,j}; i + j \le I, j \le J\}$. The cumulative data for $X_{i,j}$ are denoted by

$$C_{i,j} = \sum_{k=1}^{j} X_{i,k}. \tag{1}$$

3. Claims reserving method

Following [7], we explain the theories of CL, BF, and BH methods in below.

3.1. CL method

The CL method is a method based on the assumption that there exists development factors $f_1, f_2, \cdots, f_J$ so that for all $i \in \{1,2,\cdots,I\}$ and $j \in \{1,2,\cdots J\}$

$$E\left[C_{i,j} | C_{i,1}, C_{i,2}, \cdots, C_{i,j-1}\right] = f_{j-1} C_{i,j-1}. \tag{2}$$

The CL estimator of the ultimate claim $C_{i,J}$, given the observations $C_{i,1}, C_{i,2}, \cdots, C_{i,j}$, is then given by

$$\widehat{C_{i,J}}^{CL} = \hat{E}\left[C_{i,j} | C_{i,1}, C_{i,2}, \cdots, C_{i,j-1}\right] = C_{i,j} f_j \cdots f_{J-1}. \tag{3}$$

Suppose $\beta_{j=\prod_{k=j}^{J} f_k^{-1}}$, then (3) can be written as

$$\widehat{C_{i,J}}^{CL} = C_{i,j} + (1 - \beta_j) C_{i,j} \tag{4}$$

3.2. BF method

The BF method estimates the ultimate claim by

$$\widehat{C_{i,J}}^{BF} = C_{i,j} + (1 - \beta_j)\mu_0^{(i)}, \tag{5}$$

where $\mu_0^{(i)}$ is a priori estimate ignoring the data $\mathcal{D}_I$.

3.3. BH method

The BH estimator is given by

$$\widehat{C_{i,J}}^{BH} = C_{i,j} + (1 - \beta_j)\left[\beta_j \widehat{C_{i,J}}^{CL} + (1 - \beta_j)\mu_0^{(i)}\right], \tag{6}$$

for $i \in \{1,2,\cdots,I\}$.

4. Case Study

4.1. Data

The data used in this study are individual data of liability insurance claims obtained from a certain general insurance company in Indonesia. The data consist 270 claims from January 2014 until December 2014. The descriptive statistics of the data are displayed in Table 1.

Table 1. Descriptive statistics.

Description	Payments (IDR)
Minimum	150,000
25% Quantile	1,231,875
Median	2,548,925
Mean	5,495,427
Standard Deviation	9,040,095

75% Quantile	5,925,084
Maximum	87,877,500

4.2. Result

Data are analysed using Rapp (a free actuarial program for general insurance). Table 2 shows the total reserve estimation of liability insurance claims for occurrence claims period $i \in \{1,2,\cdots,12\}$ in Indonesian Rupiahs (IDR).

Table 2. Total reserve estimation of liability insurance claims.

Occurrence Claims Period	Method		
	CL	BF	BH
1	0	0	0
2	0	0	0
3	3,446,043	3,522,086	3,447,621
4	18,034,686	9,964,976	17,560,871
5	16,871,471	15,758,641	16,796,009
6	11,449,863	13,877,766	11,626,568
7	16,135,661	24,645,096	17,774,565
8	24,811,760	35,940,769	27,894,970
9	54,523,198	50,158,191	53,015,770
10	169,107,294	100,701,784	129,351,177
11	62,129,097	56,285,932	57,875,717
12	16,119,680	138,536,862	133,616,756
Total	392,628,754	449,392,103	468,960,025

Table 2 shows the results of the claims reserve estimation using the CL, BF, and BH methods. The claims reserve on each occurrence claims periods correspond to the claims that are not finalized in the periods. If the number of claims that are not finalized are many, then the claims reserve that are estimated are many. Based on Table [2], the total reserve estimation of liability insurance claims from BF method and BH method give larger results than the CL method. To determine the best of the three methods, we use BICH bootstrap by estimating MSEP. Table 3 shows that the BH method has the smallest MSEP and is followed by the BF and CL methods. In line with [6], the BH method is the best method for this case study.

Table 3. MSEP of each Method.

Method	MSEP
CL	441,458,297
BF	346,104,336
BH	325,916,021

5. Conclusion

We have compared the result of claims reserve estimation from Indonesian liability insurance claims using CL method, BF method, and BH method. Based on the result, BH method has the smallest MSEP. Overall we decide the BH method is the best for the case study.

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