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ADVANTAGES AND DISADVANTAGES OF LOSS RESERVING METHODS IN NON-LIFE INSURANCE

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Abstract: We analyse characteristics of the three most commonly used methods for estimating loss reserves in non life insurance: the chain ladder method, the loss ratio method, and the Bornhuetter-Ferguson method. Our aim is to give a comparative analysis of the results obtained from applying these methods to a practical case, and to put emphasis on their advantages and disadvantages.

Keywords: Loss Reserves, Chain Ladder Method, Loss Ratio Method, Bornhuetter-Ferguson Method.

MSC: 62P05.

1. INTRODUCTION

Loss reserving is one of the main tasks of actuaries in non-life insurance. The actual amount of insurer's liabilities for losses incurred is unknown until all claims are finally settled . Therefore, it is necessary to estimate their values. The required loss reserves are exposed to significant variability due to many risks that include imprecise estimates, changes in law or accidental variations. In addition, the use of inappropriate actuarial methods and assumptions can lead to inadequacy of estimated liabilities and non-objective disclosure of insurance company results. Such variability can have a significant impact on the solvency of the insurer. If the actual claims are higher than expected, the estimated reserves will not be adequate for their coverage. Different reserving methods give different estimates of the required reserves. Thus, the amount of loss reserves amount, which is shown in insurer's balance sheet, represents only one from a range of possible values, chosen by the actuarial judgement. Therefore, it is of key importance to identify advantages and disadvantages of the used reserving methods. We present three methods for estimating loss reserves: the chain ladder method, the loss ratio method, and the Bornhuetter-Ferguson method.

2. LOSS RESERVES

Loss reserves represent the estimated value of liabilities for unpaid claims at the date of settlement. The reason for the loss reserves assessment and formation is the time mismatch between the moments of the loss occurrence, the moment when loss is reported to insurer and the moment when the ultimate amount of compensation for claims that were not paid is determined. The total loss reserves include two categories: reserves for reported but not settled losses, and reserves for incurred but not reported losses. Reserves for reported but not settled losses (case reserves) represent the estimated amount required for future payment of claims, that will be reported to insurer, as well as for covering reactive claims. Reserves for incurred but not reported losses (IBNR) are the estimated amount of provisions for incurred losses, that have not yet been reported, and in addition, these reserves also include future changes in the estimated amounts of known claims and reserves for reported but unsettled losses [3].

The loss reserving process can be adequately applied only to grouped data. In order to obtain a valid conclusion for the future development of losses, data groups should be homogeneous. The data must be grouped in such a way as to allow a comprehensive overview of the evolution of losses. One of the common ways of organizing data is a triangle of loss development, representing the number or the amount of paid or total reported losses. In the sixth section of the paper, an example of a triangle of incremental paid losses is given. The estimated values of

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successive groups of claims in a given development period are presented in the columns of the triangle, while the diagonal elements represent the development of losses during the same calendar period [2].

The starting point for the assessment of incurred but not reported losses (IBNR) is to study the dynamics of changes of the incurred losses. Determination of reserves for incurred but unreported losses is based on data about losses and assessment of the loss development factor for different time intervals. In order to facilitate the assessment, it is necessary that all the data about losses and allocated costs for the settlement of losses are classified according t to the date of occurrence of the harmful event and the date of its report [9]. Particularly important information for the determination of IBNR reservations is the amount of losses that had occurred before the accounting period and reported and settled during the accounting period. In the literature, numerous actuarial methods for assessment of reserves are recommended, but we will explain the underlying assumptions of the chain ladder method, the expected loss ratio method, and the Bornhuetter-Ferguson method. Due to the fact that special attention in actuarial science is dedicated to these methods that are most often used in practice, it was a challenging task for the authors to determine their advantages and disadvantages, which are manifested in practice.

3. THE CHAIN LADDER METHOD

One of the oldest methods for estimating reserves for incurred but not reported losses, which is still commonly used, is the chain ladder method. The first step in applying this method is the assessment of the loss development factor, which is determined on the basis of cumulative settled (reported) claims in the following manner:

$$\hat{f}_j = \frac{\sum_{i=1}^{n-j} C_{i,j+1}}{\sum_{i=1}^{n-j} C_{i,j}} \tag{1}$$

where:

$\hat{f}_j$ - estimate of the loss development factor

$C_{i,j}$ - cumulative losses that have occurred in $i-$th period, and that are settled (reported) until the end of j-th period

$$C_{i,j} = \sum_{h=1}^{j} D_{i,h} \tag{2}$$

$D_{i,h}$ - losses occurred in i-th year settled (reported) in $h-$th year.

After the determination of the loss development factor for all development years, the amount of ultimate claims for the i-th period of loss occurrence is

estimated:

$$\hat{C}_{i,n} = C_{i,j} \cdot \hat{f}_j \cdots \hat{f}_{n-1} \tag{3}$$

where:

$\hat{C}_{i,n}$ - estimate of the final cumulative amount of losses in the last ($n-$th) development period. On the basis of estimated ultimate claims estimated reserves for losses for $i-$th year of loss occurrence ($i = 1, ..., n$; $j = n - i + 1$) are:

$$\hat{R}_i = \hat{C}_{i,n} - C_{i,j} \tag{4}$$

where: $\hat{R}_i$ - estimate of total reserves for losses occurred in $i-$th year if the estimate is based on the triangle of settled claims, or reserves for incurred unreported losses, if the estimate is based on the triangle of reported losses.

In its simplest form, the chain ladder method aims to obtain a forecast only for final losses, that is, the losses in the last observed year, and does not include the assessment of possible further loss development (tail factor). For the assessment of final value of losses, the factor of possible further loss development (tail factor) is often used $\hat{f}_{ult} > 1$. By applying this factor, the final value of losses occurred in $i-$th year - $\hat{C}_{i,ult}$ is:

$$\hat{C}_{i,ult} = \hat{C}_{i,n} \cdot \hat{f}_{ult} \tag{5}$$

where $\hat{f}_{ult} = \prod_{j=n}^{\infty} \hat{f}_j$ [7].

The final tail factor is a result of individual assessment of actuaries about the future value of claims.

4. THE EXPECTED LOSS RATIO METHOD

The main assumption of the expected loss ratio method is that certain types of insurance always exhibit a predictable loss ratio. This ratio is multiplied by the earned annual premium to determine the estimated incurred losses in the year of insurance or multiplied by the earned premium in the calendar year in order to determine the estimated losses incurred in the year of the occurrence of the harmful event [4]. The ultimate cumulative losses for $i-$th year of occurrence according to the expected loss ratio method are estimated as follows [6]:

$$\hat{C}^{LR}_{i,n} = E(s) \cdot \tilde{P}_i \tag{6}$$

where:

$\tilde{P}_i$ - earned premium in $i-$th period

$E(s)$ - predefined loss ratio.

The key question for this method is how to choose the appropriate ratios for the given types or subtypes of insurance. There are many sources that can be used

to predict the loss ratio:
a) data on previous results for the given type of insurance;
b) the assumptions used in the tariff determination process;
c) experience of underwriters and employees in the sector of claims settlement.
d) market statistics for similar types of insurance, if available.

The use of an external initial assessment of final claims has the objective of stabilizing the results. However, it should be emphasized that regardless of the source, even for types of insurance that have a stable loss ratios in previous years, it may happen that the loss ratio deviates considerably from the previous experience due to the presence of cycles in the insurance market and other economic impacts. This method is suitable for use in cases where we do not have data on the development of losses, when data are insufficient or unreliable. The best examples are new types of insurance and types of insurance with a very long pattern of settling claims [5]. The main critique of the method is that the assessment of total loss depends only on the premium and the loss ratio for a particular type of insurance, and completely ignores the development pattern of losses for the observed year of the loss occurrence.

5. THE BORNHUETTER-FERGUSON (BF) METHOD

For the incurred unreported losses, Bornhuetter and Ferguson recommend a method that combines the expected loss ratio method and the method of development of paid/reported losses by the years of occurrence of the harmful event [5]. The final cumulative losses for the i-th year of occurrence according to the Bornhuetter-Ferguson's method are estimated as follows:

$$\hat{C}_{i,n}^{BF} = C_{i,j} + \hat{C}_{i,n} \cdot \left(1 - \frac{1}{F_j}\right) \tag{7}$$

where:

$C_{i,j}$ – paid (reported) losses until the date of assessment

F_j- cumulative factor of development of losses for $i-$th year of occurrence, from $j-$th development period until final period ($F_j = \hat{f}_j \cdots \hat{f}_{n-1} = \prod_{j=n-i+1}^{n-1} \hat{f}_j$).

$\hat{C}_{i,n}$ - estimate of final cumulative amount of losses from $i-$th period of occurrence.

The estimate of the ultimate cumulative amount of losses starting from the $i-$th period of occurrence is determined by the expected loss ratio method by multiplying the earned premium for that year with the expected ratio of losses. In practice, an alternative way of determining and selecting the development pattern developed by Mack [8] is used. The Bornhuetter-Ferguson method for the projection of expected losses based on the data about reported claims relies on the assumption that the remaining unreported losses are in relation with the total expected losses, not in relation with the reported claims. The expected losses used in this analysis are largely based on the previous years' ratio of losses and

Table 1: Input variables

Year of acc. of a loss	Development period of incremental losses						Earned prem. $\tilde{P}_i$	Res. for incurr. rep. losses
	0	1	2	3	4	5		
2011	37.733,64	99.737,68	5.502,65	1.124,90	616,27	2.380,00	413.585,77	
2012	195.427,70	133.538,58	9.617,62	2.388,05	540,00		603.111,21	111
2013	232.390,26	158.795,95	10.712,01	1.323,85			746.310,98	222
2014	265.525,99	95.808,79	12.403,05				767.148,36	1.548
2015	179.618,60	129.875,03					773.350,47	8.279
2016	258.252,47						838.828,18	17.617

Table 2: Results of the estimation of loss reserves according to the chain ladder method

Year of acc. of a loss	Cumulative settled losses $C_{i,j}$	Selected cumulative factor of loss development $\prod_{j=n-i+1}^{n-1} \hat{f}_j$	Estimate of final amount of claims $\tilde{C}_{i,n}$	Estimate of final ratio of losses $\tilde{C}_{i,n}/\tilde{P}_i$	Estimated total reserves for losses $\tilde{R}_i$	Reserves for incurred reported losses	Reserves for incurred unreported losses
2011	147.095,14	1,00000	147.095,14	35,57%	0	0	0
2012	341.511,95	1,01645	347.128,49	57,56%	5.616,54	111,00	5.505,54
2013	403.222,07	1,01887	410.830,47	55,05%	7.608,40	222,00	7.386,40
2014	373.737,83	1,02445	382.874,67	49,91%	9.136,84	1.548,00	7.588,84
2015	309.493,63	1,05658	327.005,16	42,28%	17.511,53	8.279,24	9.232,29
2016	258.252,47	1,77330	457.958,08	54,59%	199.705,61	17.617,35	182.088,26
$\sum$	1.833.313,09		2.072.892,01	50,04%	239.578,92	27.777,59	211.801,33

the business plan of a company [1]. This technique proved to be appropriate for types of insurance with a significant deviation in the proportion of claims for reported losses in earlier development years, causing that the chain ladder method leads to unsatisfactory results. This category includes cases where losses are reported over a long period of time (10 years or more) and the proportion of reported claims in the first two to three years is small.

6. COMPARISON OF THE RESULTS

In this part of the paper, a comparison of the results obtained by applying the chain ladder method, the expected loss ratio method, and the Bornhuetter-Ferguson method is presented using the data on paid losses, earned premium, and the reserves for incurred reported losses classified according to the year of occurrence.

Results of the application of the methods are presented in Tables 2, 3, and 4.

According to the chain ladder method, the estimated total loss reserves (excluding the costs related to claims settlement) amount to 239,578.92 currency units. In the following discussion, we estimate total loss reserves according to the Bornhuetter-Ferguson method, and the method of the expected loss ratio, where the ultimate loss ratio calculated on the basis of the chain ladder method is used as a preliminary estimate of the loss ratio and corrected, if necessary, on the basis of personal actuarial assessment, based on the past experience. In both methods, in contrast to the chain ladder method, the loss ratio in 2016 is corrected based on the previous five-year experience.

According to the expected loss ratio method, the estimated total loss reservations (excluding the costs related to the claims settlement) after the correction of

Table 3: Estimated reserves based on the expected loss ratio method

Year of acc. of a loss	Estimate of final ratio of losses according to chain lader $\tilde{C}_{i,n}/\tilde{P}_i$	Selected ratio of losses $E(s)$	Estimate of final amount of claims $\tilde{C}_{i,n}^{LR}$	Estimated total reserves for losses $\tilde{R}_i^{LR}$	Reserves for incurred reported losses	Reserves for incurred unreported losses
2011	35,57%	35,57%	147.095,14			
2012	57,56%	57,56%	347.128,49	5.616,54	111,00	5.505,54
2013	55,05%	55,05%	410.830,47	7.608,40	222,00	7.386,40
2014	49,91%	49,91%	382.874,67	9.136,84	1.548,00	7.588,84
2015	42,28%	42,28%	327.005,16	17.511,53	8.279,24	9.232,29
2016	54,59%	48,89%	410.064,87	151.812,40	17.617,35	134.195,05
	50,04%		2.024.998,81	191.685,72	27.777,59	163.908,13

Table 4: Estimated reserves for losses according to Bornhuetter-Ferguson's method

Year of acc. of a loss	Estimate of final ratio of losses according to chain lader $\tilde{C}_{i,n}/\tilde{P}_i$	Selected ratio of losses $E(s)$	$1/\prod_{j=n-i+1}^{n-1} \hat{f}_j$	Estimate of final amount of claims $\tilde{C}_{i,n}^{BF}$	Estimated total reserves for losses $\tilde{R}_i$	Reserves for incurred reported losses	Reserves for incurred unreported losses
2011	35,57%	35,57%	100,0%	147.095,14	0	0	0
2012	57,56%	57,56%	98,4%	347.128,49	5.616,54	111,00	5.505,54
2013	55,05%	55,05%	98,1%	410.830,47	7.608,40	222,00	7.386,40
2014	49,91%	49,91%	97,6%	382.874,67	9.136,84	1.548,00	7.588,84
2015	42,28%	42,28%	94,6%	327.005,16	17.511,53	8.279,24	9.232,29
2016	54,59%	**48,89%**	56,4%	437.072,89	178.820,42	17.617,35	161.203,07
	50,04%			2.052.006,82	218.693,73	27.777,59	190.916,14

the estimated ultimate loss ratio in 2016 amounts to 191,685.72 currency units.

According to the Bornhuetter-Fergusons method, the estimated total reserves for losses (excluding the costs related to the claims settlement) after the correction of the estimated ultimate loss ratio in 2016 amounts to 218,693.73 currency units. Since each applied method results in a different amount of ultimate losses, actuaries must decide which method provides the best estimate. An attempt to reconcile more different estimated values is extremely difficult. It is important to evaluate the results of each reservation method in order to determine the reasons for different values. As it was previously mentioned, the expected loss ratio method is the most appropriate for use in cases where we do not have development data, when the data are insufficient or unreliable. The chain ladder method is appropriate when there is a relatively stable pattern of loss development and a relatively large number of reported claims. Since this is not the case with our example where we have an uneven pattern of reported claims, Bornhuetter-Ferguson's method is more appropriate. In the process of selection of development factors, actuaries should be able to assess the trend in the development pattern of losses. Seeking explanations for unusual, historical trends in the development of losses is critical for the estimation of reserves as actuaries have to assess whether events that cause a different, unusual development of losses can affect future patterns. If an irregularity is detected in the pattern for one particular year, activities of insurance company need to be further analyzed in order to discover reasons that could cause this anomaly. Since the size of the loss depends on the risk of the business mix, an actuary who estimates the reserves should be related to employees in the department responsible for risk assessment and decisions on risk portfolio

of the insurance company. The mentioned department must receive feedback of the results from an actuary who assesses the reserves in order to properly correct its activities. If the actual loss statistics related to the paid claims, reserves for reported but not settled losses, reserves for incurred unreported losses and the number and amount of paid claims, do not coincide with the forecasted amounts, an additional analysis is needed. A retrospective reserve adequacy test (RUN-OFF analysis) can provide valuable information regarding the suitability of different methods in examining the adequacy of loss reserves.

7. CONCLUSION

In this paper, three methods for estimating loss reserves are presented and analyzed: the chain ladder method, the expected loss ratio method, and the Bornhuetter-Ferguson method, which under certain assumptions can provide an adequate assessment of loss reserves. These three deterministic methods are based on the assumption that the pattern of losses in the past will continue in the future. In order to ensure the adequacy of loss reserves, the above methods should be applied cautiously, respecting their advantages and disadvantages and combining them with subjective assessments of actuaries, based on their expertise and experience. In the process of estimating loss reserves, actuary should provide an adjustment of the reserving methodology to the characteristics of the insurers business and external changes, which have a decisive influence on the size and frequency of claims, in order to be able to identify the most appropriate method. The contribution of the paper is to show that the estimate of the claim reserves can not be easily established, and application of these methods contains elements of unreliability. A possible stream of future research is to focus on the application of stochastic models for estimating claim reserves that eliminate certain shortcomings of these classical methods.

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