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A COMPARATIVE ANALYSIS OF OUTSTANDING CLAIM RESERVES

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The key processes in the business of insurance companies which define the financial viability of their business activities, as the most important element, are the adequate amount of technical reserves. A qualitative assessment of the technical reserves level is the basic support to the management of the key business processes and proper strategic and financial decision-making in order to maximize the viability, profitability, competitiveness, and further development of the company. Based on the data on the operations of an insurance company, within a single line of insurance, different, in practice, most frequently used methods were applied in order to determine the deviation amplitude of the projected amounts from the actual claims. Another direction of research focuses on actuarial practice in non-life insurance companies operating in the territory of the Republic of Serbia. The comparative analysis of the obtained projection points to the fact that the chosen methods, commonly used in actuarial practice in the Republic of Serbia, should be monitored and reviewed. The results of the multidirectional research and detection of the existing problems provide a useful framework and a stimulating mechanism, as well as the guidelines to improve the operations and better positioning of insurance in the commercial and economic environment of the Republic of Serbia.

Keywords: technical reserves, outstanding claims reserves, chain indices, loss ratio

JEL Classification: G22

INTRODUCTION

The key processes in the business of insurance companies (IC) which define the financial viability of their business activities, as the most important element, are the adequate amount of technical reserves (TR). The TR level enables a critical insight into the numerous aspects of the insurers industry, which can be a useful indicator for a future business strategy. Through legal regulations and international accounting standards, supervisory authorities are focused on the TR level and their mobility in order to respond to the user's requests at any time.

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The importance of an adequate TR calculation in non-life insurance has resulted in numerous studies at the European Union level: H. Müller's Report (1997), G. Manghetti's Report (2000), the KPMG Report (2002), The Report of the Working Group on the Solvency of Non-Life Insurance Companies (European Commission, 2002), who found that the TR level is the main cause of the insolvency of non-life insurance companies, as long as there are many inconsistencies in their quantification. In addition, the existing standards do not provide a clear answer to numerous questions about the quality of the methods for assessing their quantity. "An example of a standard that leaves significant room for a wide range of accounting practices is the IFRS 4, which relates only to the general issues of the accounting treatment of insurance contracts, but does not provide solutions to all problems in this area" (Obradovic, 2014).

The issues of financial security have woven an intricate network of various mathematical, financial, statistical, even medical science contributions, including an extensive deployment of information technologies. The inherent uncertainty of the frequency, number, amount and time horizon of policyholders' claims is still the focus of many researchers. The bibliographies of numerous publications on the mentioned issues, both in the form of books, monographs and scientific papers, were compiled by K. D. Schmidt (2011).

There is a lack of research interests in non-life claim reserves in the domestic academic society. This fact has an impact on the research study published in this paper, which is defined as an analysis of the methodologies of outstanding claim reserves calculation, in the actuarial practice of non-life insurers of the Republic of Serbia (RS).

The primary goal of this paper is a comparative analysis of the results obtained by applying different methods for calculating the most reliable component of the TRs - i.e. reserves for claims incurred but not reported. As long as this technical reserves component is the most discouraged and in the focus of the research in the world actuarial authorities, the goal of the research is the possibility of applying their perceptions in the domestic, underdeveloped insurance market.

In accordance with the research purpose and goals, the general hypothesis:

H_0: The projections of the cumulative amounts of future monetary compensations should be inflationary adjusted, has been tested.

This general hypothesis has also induced an additional hypothesis:

H_1: The methodology required by the supervisory authorities should be reviewed through redesigning the current insurance legislation.

Two types of research had been requested for hypotheses testing. The general hypothesis directed one research direction, oriented towards a comparative analysis of the obtained results of the calculation of reserves for claims incurred but not reported, using the most commonly used methods in the world actuarial practice. Using the specific results of an insurance company's business, in a single line of business with a long development period (from 2006 to 2015), various methods were applied, as well as a comparative analysis of estimated claims with real claim payments in the next business year. The additional hypothesis directed the second research direction towards the methodologies used in domestic insurance companies. The questionnaire with 32 questions related to the methodologies used for calculating particular components of technical reserves was distributed in 2014 to non-life, as well as composite insurance companies operating in RS. Based on the responses received from 11 insurance companies, it was noted that the practice in claims reserves was conducted by the methodology required by the supervisor, with the lack of available staff and, hence, the necessary time for actuarial engagement on a similar research study.

Both research directions were monitored as a quantitative methodology, presented as a technical reserves calculation, as well as a qualitative methodology, through consulting relevant literature and by surveying domestic stakeholders.

This paper is structured into four thematic units. The first part is an introduction to the observed topic, which contains six subsections, with an overview of the most frequently used deterministic methods of claim projections, along with a review of the relevant scientific results. In the next section, such methods are applied to the paid claims of an insurance company in order to project future payments. In addition to the applied quantitative methodology, through 42 projections of both the dinar and the euro reserves for claims incurred but not reported, the qualitative research methodology was also interpreted and conducted through survey among actuaries in non-life insurance companies. In the concluding observations, the results of both directions of the survey were summarized, as a comparative analysis of the results of the projected claims and the responses in the distributed questionnaire. Identifying the key contributions and limitations of the presented research study, a set of scientific hypotheses have been specified, pointing to a future research direction.

DETERMINISTIC CLAIMS RESERVING METHODS

With a view to the potential significance of technical reserves and the impact of uncertainties on forecasts, various models have been developed, and these can be generally classified as deterministic and stochastic. Deterministic techniques provide the actuarial assessment of a potential cumulative value of the amounts of future claims paid based on the patterns in claims activities in the previous periods. However, the existing deterministic methods do not provide a concrete measure of the deviation of the obtained forecasting from possible realizations. Being aware of this shortcoming, actuaries apply different prediction models for obtaining multiple estimates of potential losses. However, no matter how wide is the range of these forecasts, questions referring to what amount may represent the optimal estimate or what is a reasonable estimate of dispersion remain open.

The determination of the optimal estimation of reserves is closely linked to absorbing the shortcomings of traditional deterministic techniques. As the Chain Ladder Method is generally the initial method in reserving, its stochastic modification has been investigated by many authors, including E. Kremer (1982), G. C. Taylor and F. R. Ashe (1983), K. D. Schmidt and A. Schnaus (1996), A. E. Renshaw and R. J. Verrall (1998), Th. Mack and G. Venter (2000), G. C. Taylor (2000), P. D. England and R. J. Verrall (2002). However, the sophistication of stochastic models requires a lot of time and other resources, so that, due to commercial imperative in terms of haste to obtain the desired forecasts as soon as possible, there is still room left for the application of stochastic models in the domain of academic research.

Deterministic methods assume that patterns in claims activities will continue to repeat in the future, which can be forecasted by observing and analyzing the past experiences in certain lines of activities. The most widely used format of displaying and analyzing data is a tabular form, where data can be systematized by: the number of claims incurred, the number of claims paid, the amount of reported claims or the amount of paid claims. Since the primary focus of an actuary, i.e. the person responsible for forecasting the amount of reserves, is on the potential payments that may occur in the next accounting period, it is recommended that a focus should be put on the analysis of the amounts of claims paid in the previous accounting periods, which may be annual, semi-annual or quarterly. Data in one table-type relate to the same year which the claim was incurred in, whereas the columns represent how many accounting periods have passed since the claim occurrence until the moment of the claim payment. Amounts in columns correspond to the same period of delay, whereas the sums paid in the same calendar year are represented along a diagonal line.

The random variable $X_{i,j}$ is the amount of the claims incurred in the year i and paid within $j - 1$ development years from the date on which the claim occurred. The table includes the values of the observable data, where $i + j \leq n + 1$, which is why this table is also called the run-off triangle. Actuarial studies related to the losses rating and reserving use run-off triangles with individual amounts of claims paid in a given observed period $X_{i,j}$ and the cumulative losses $S_{i,j}$ incurred in the year i and paid within $j-1$ development years from the date on which such damage occurred (Schmidt, 2006), i.e.:

$$S_{i,j} = \sum_{k=1}^{j} X_{i,k} \ , \quad i = 1,2,..,n, \ j = 1,2,\ldots,n\text{-}i\text{+}1 \qquad (1)$$

The traditional, deterministic methods of claim reserving can be grouped into two large families: the method of chain indices and the methods based on calculating loss ratios.

The Methodological Framework of Chain Indices Methodology

Generally, all forecasting models using the chain indices method are based on the following steps: determining the chain indices, selecting the average development factor and calculating the cumulative development factors, selecting the tail-factor and obtaining projections for the claims and reserves in the next accounting period (Faculty and Institute of Actuaries, 1997).

The basic idea behind the Chain Ladder Method is that there is regularity in claims loss settlement according to the periods of delaying the settlement of claims. Hereby, the amounts of claims paid in successive development periods are compared, i.e. a rise in the percentage of cumulative payments is observed. The quotient of two adjacent amounts in the accident year represents the chain index (age-to-age factor, development factor, link ratio) (Schmidt, 2006):

$$f_{i,j} = \frac{S_{i,j+1}}{S_{i,j}} \ , \text{ where } i\text{=}1,2,..,n, \text{ and } j\text{=}1,2,\ldots,n\text{-}i. \qquad (2)$$

Based on these assumptions, the amount of claims that may be reported is calculated by way of the expected value of conditional probabilities (Dahl, 2003):

$$E\left[S_{i,j+1} \middle| S_{i,1}, S_{i,2}, \ldots, S_{i,j}\right] = S_{i,j} \cdot r_j \qquad (3)$$

where r_j is the selected development factor (DF) among all of the obtained factors $f_{i,j}$ for the development period *j*. If both sides of the previous equation are divided by $S_{i,j}$, it follows that:

$$E\left[S_{i,j+1}/S_{i,j} \middle| S_{i,1}, S_{i,2}, \ldots, S_{i,j}\right] = r_j \,. \qquad (4)$$

As the amounts $S_{i,j}$ and $S_{k,l}$ are independent for $i \neq j$ and $j \neq l$, the development factor r_j does not depend on the accident year. Forecasting the amount of $S_{i,j}$ for $j \geq n\text{-}i\text{+}2$ is based on the following result, which is also mentioned by P. Dahl (2003):

Lemma 1: If $E[Z]$ is finite, then $E[Z] = E\big[E[Z|X]\big]$.

Starting from Assumption 3, by applying Lemma 1, we obtain:

$$E\left[S_{i,j+k} \middle| S_{i,1}, S_{i,2}, \ldots, S_{i,j}\right] = E\left[E\left[S_{i,j+k} \middle| S_{i,1}, S_{i,2}, \ldots, S_{i,j+k-1}\right] S_{i,1}, S_{i,2}, \ldots, S_{i,j}\right] =$$

$$= E\left[S_{i,j+k-1} \cdot r_{j+k-1} \middle| S_{i,1}, S_{i,2}, \ldots, S_{i,j}\right] = E\left[S_{i,j+k-1} \middle| S_{i,1}, S_{i,2}, \ldots, S_{i,j}\right] \cdot r_{j+k-1} =$$

$$= E\left[E\left[S_{i,j+k} \middle| S_{i,1}, S_{i,2}, \ldots, S_{i,j+k-2}\right] S_{i,1}, S_{i,2}, \ldots, S_{i,j}\right] \cdot r_{j+k-1} =$$

$$= E\left[S_{i,j+k-2} \cdot r_{j+k-2} \middle| S_{i,1}, S_{i,2}, \ldots, S_{i,j}\right] \cdot r_{j+k-1} = E\left[S_{i,j+k-2} \middle| S_{i,1}, S_{i,2}, \ldots, S_{i,j}\right] \cdot r_{j+k-1} \cdot r_{j+k-2} =$$

$$= S_{i,j} \cdot r_{j+1} \cdot r_{j+2} \cdot \ldots \cdot r_{j+k-1}$$

Therefore:

$$E\left[S_{i,j+k} \middle| S_{i,1}, S_{i,2}, \ldots, S_{i,j}\right]$$

$$= S_{i,j} \cdot r_{j+1} \cdot r_{j+2} \cdot \ldots \cdot r_{j+k-1} \qquad (5)$$

This result points to the procedure of obtaining all of the values of $S_{i,j}$ for each $j \in (n\text{-}i\text{+}2,\ldots,n)$.

The necessary reserves that the company determines are calculated as:

$$R_i = E\left[S_{i,n}\right] - S_{n-i+1} \quad , i\text{=}1,2,\ldots,n \qquad (6)$$

Formula (5) points to the fact that the choice of the average development factor r_j, for each development period, is very important for obtaining the desired forecast.

A run-off triangle is not complete until all the claims, at least in the oldest origin year, are paid; therefore, cost settlement for any particular year is unknown. In this respect, actuaries complete the chain indices derived from the available data in the run-off triangle, i.e. they use the remainder coefficient or the tail factor which predicts development beyond the last phase of the development for which a chain index can be calculated. Research related to determining the tail factor (TF) has resulted in numerous papers and methods; the Working Party of the American Association of Actuaries Casualty Actuarial Society - CAS (2013) presented their view in the paper "The Estimation of Loss Development Tail Factors: A Summary Report", CAS Tail Factor Working Party. The mentioned paper identifies a number of the methods grouped into 6 main classes: Bondy-Type Methods, Algebraic Methods, Benchmark-Based Methods, Curve-Fitting Methods, Methods Based on the Remaining Open Counts and Methods Based on the Peculiarities of the Remaining Open Claims.

The methods belonging to the group of Bondy-Type Methods are the most widely used in practice due to their simplicity; however, the resulting tail factor, obtained by their application, may be understated for "long-tail" lines. M. Bondy's Original Method (1960), justifies the use of the last link ratio as a predictor of future claims development (Boor, 2006), i.e. $f_{i,n+1} = f_{i,n}$. As the TF is determined for each origin year, the designation *i* can be omitted from the subscript, while each chain index is observed in the form $f_j = 1 + v(j)$, where $v(j)$ represents the development portion of the remainder coefficient. The numerous modifications of Bondy's original method have been developed. One of these assumes that the development portion of the chain index is reduced by 50%, i.e. $f_j + 1 = 1 + 0.5v(j)$, while alternative methods suggest that the development portion of the last index should be multiplied by two or squared, i.e. $f_{j+1} = 1 + 2v(j)$ or $f_{j+1} = 1 + v^2(j)$. Weller generalized the method in 1989 by using the average of the three most recent developments, whereas the Fully Generalized Bondy Method considers TF as: $f_n = (f_{n-1})^{B/B-1}$, where *B* stands for the Bondy exponent and the number ranges between 0 and 1 (CAS Tail Factor Working Party, 2013).

Algebraic methods focus on the relationships between the losses paid and incurred. Their main advantage is that they are based solely on information in the loss triangle. One of the most representative methods in this group is the Sherman-Boor Method or algorithm (Sherman & Diss, 2005; Boor, 2006), whose application has been becoming more and more popular in actuarial practice in recent years. A possible approach to estimating TF is the assumption of the existence of the geometric relationships between the chain indices, depending on the development period until the claim is paid. The most commonly used method is the method of determining the exponential rate of "decay", which uses chain indices $f(d_i)$ for calculating cumulative or incremental paid losses. Here, each chain index is treated as a function of the development portion, i.e. $f(d_i) = 1 + v(d_i)$, assuming that the development portion $v(d_i)$ "decays" at a constant rate *r*, i.e. $v(d_{i+1}) = v(d_i)r$ (Boor, 2006). The process consists of defining the exponential curve for development portions $v(d_i)$. The decay constant *r* can be estimated by using a linear trend in the values of the natural logarithm of development portions, and then the TF for the development age *d* can be estimated as:

$$T(d) = 1 + \upsilon(d) \cdot \sum_{m=1}^{\infty} r^m .$$

C. L. McClenahan (1975) initiated the technique of determining the theoretical curve, assuming that incremental paid losses "decay" at a constant monthly rate *p*, but after a few months *a*, in which there were no payments. Following the exponential trend of the development periods of the chain indices and the corresponding amounts in cash, their monthly rate of decay *r* is determined, based on which the TF is obtained by using the formula:

$$T = \{12 \times (1-p)\} / \{12 \times (1-p) - p^{m-a-10} \times (1-p^{12})]\}.$$

Skurnick simplified this method (Boor, 2006) by observing the annual rate of decay in incremental payments that is proportional to the most recent payment, while for each accident year, the appropriate rate of exponential decay and the corresponding TF are calculated as: $T = \dfrac{1-r}{1-r-r^y}$, where *y* marks the number of the development years which the TF will be applied to.

Determining the TF is still the focus of many researchers, because the value of TF significantly affects the projections of future payments to be made on claims in the following years. Due to appropriate assumptions, there is no single method that can produce accurate results; however, by testing the obtained results using different methods, one can obtain the most optimal coefficient of further developments in the payment of claims.

Chain Ladder Method (CLM)

The Chain Ladder Method is a representative method among that numerous projection methods that use chain indices. The CLM is most commonly used in actuarial practice, both by domestic and foreign ICs. P. D. England and R. J. Verrall (2002) note that the main objective of all deterministic methods is a comparative analysis of the results obtained by applying the CLM. However, J. N. Stanard (1985), P. Narayan and T. V. Warthen (1997), G. Barnett and B. Zehnwirht (2000) and G. C. Taylor (2000) focus their research on the key assumptions and examine the comparative adequacy of this method in terms of different lines of insurance.

The main characteristic of the CLM is the "original" weighting. Starting from the fact that every quotient in the column is weighted by the claim from which it originated, this method uses original weights, therefore the development factor is obtained as follows (Schmidt, 2006):

$$r_j = \frac{\sum_{i=1}^{n-j+1} S_{i,j}}{\sum_{i=1}^{n-j+1} S_{i,j-1}}, \; j=1,2,...,n\text{-}i \qquad (7)$$

The Methods Based on the Loss Ratio Calculations

The projections of payments to be made by an IC in future accounting periods are based on assumptions; therefore, each result obtained must be accepted with some caution. A lack of the methods based on TF is reflected in the most recent accident years because their development period to ultimate payments is very long. For this reason, the development factors derived from the past experience are relatively high and subject to numerous fluctuations, which are quite uncertain at the given moment. An alternative approach, which is relatively easy to use, is to calculate the loss ratio which indicates the share of the total claims paid (in %) in the premiums earned by the insurer. The essence of the adequate application of the concept of a loss ratio is that premiums should correspond to the risk exposure period. Therefore, if you use the run-off triangles that contain claims given by the accident years, then the amount of the final payments is to be compared with the premiums earned (Schmidt, 2008). In the case of presenting the data according to the years of the inception of the insurance coverage, the indicative measure is a written premium. The simplest approach is to, based on the previous loss rates and earned premiums, determine the aggregate monetary amount of future payments, which, when reduced by the amount of the payments made thus far, gives the amount of necessary reserves (Saluz, Gisler & Wüthrich, 2011). The application of this method is characterized by a greater stability of the results, especially for a small series or a new insurance line. The main shortcoming is that it relies too much on *a priori* information, simultaneously ignoring the payments that have already been realized.

The Average Cost per Claim Method

The Average Cost Per Claim Method assumes that the average amount of claims and their number for each development year are in a constant relation with the total number and amount of claims for the year observed. The application of this method is based on the use of the data concerning the number of the claims filed and the amount of claims incurred. This method can be applied both to paid and reported claims, where the number of such claims must correspond to the type of the amounts used. In addition, if the amounts of claims paid are used, they should be compared with the number of claims settled, whereas the number of reported claims should be compared to the amount of incurred claims. By dividing cumulative claim amounts by claim numbers, the amount of the average cost per reported claim is obtained. These costs are then projected to the finite amounts of individual costs in each development year by using the grossing-up factors. The same procedure is used to generate the final number of expected claims to be filed, which when applied as a multiplier to the expected average claim amount, gives the projection of the amount of the total liabilities of an IC. The necessary reserve is obtained by subtracting the obtained amount in respect of the amount of claims paid.

This projection can be very useful, because the analysis of the experience with respect to the amount and number of claims makes it possible to review the trends in the filing of damages and their liquidation, as well as the average amount of claims. The method itself can provide satisfactory answers, especially in the case of organizational or external fluctuations; it can also help in the detection of the adequacy of other actuarial projection techniques. It can be applied to the data aggregated by the year of origin, the accident, the respective year of inception or the calendar year. Although this method can be applied to all lines of insurance, it is most commonly used regarding the "long tail" lines.

The Bornhuetter-Ferguson (BF) Method

Bornhuetter-Ferguson's method combines the Average Cost Per Claim with the Chain Indices Method. The initial, realistic assumption is that the total loss for each year of operation can be divided into the respective past and future portions that are subjected to a separate analysis. The first part of the evaluation, which relates to the claim payments made, is known or adequately evaluated, taking into account the reserves for incurred but not reported claims. Uncertainties contained in future payments to be made will not be estimated by applying the same pattern of historical payment realizations; they will be estimated by using a more general estimator, based on the loss ratio for a given line of insurance. By summing up the two estimates, a more sensitive assessment of the possible final payments and therefore the necessary reserves is obtained.

If we analyze the amounts of cumulative payments, $S_{i,j}$, which are actually the variables that are independent of the year of origin *i*, the assumption of the BF method is that there are the parameters $\alpha_1, \alpha_2, .., \alpha_n$ and the rates $\beta_1, \beta_2, .., \beta_n$, where $\beta_n=1$ (because the development for the first year of origin is concluded), which are used for projecting the future and past portions of the aggregate payments, therefore (Mack, 2006), $\forall i : 1 \le i \le n, \quad \forall j : 1 \le j \le n-1$:

$$E[S_{i,1}] = \alpha_i \cdot \beta_1 \text{, and}$$

$$E[S_{i,j+k} | S_{i,1}, S_{i,2}, ..., S_{i,j}] = S_{i,j} + (\beta_{j+k} - \beta_j) \cdot \alpha_i \quad (8)$$

Since $S_{i,j}$ represent cumulative amounts, thus α_j is a cumulative TF. According to (8), it follows:

$$E[S_{i,j}] = \alpha_i \cdot \beta_j \quad \text{and} \quad E[S_{i,n}] = \alpha_i . \quad (9)$$

Starting from the relation $\forall i : 1 \le i \le n, \quad \forall j : 1 \le j \le n-i+1$, we obtain:

$$E[S_{i,n} | S_{i,1}, S_{i,2}, ..., S_{i,j}] = S_{i,j} + E[S_{i,n} - S_{i,n-i+1}],$$

this, according to the basic assumptions, implies the following:

$$\begin{aligned} &E[S_{i,n} | S_{i,1}, S_{i,2}, ..., S_{i,j}] = \\ &= S_{i,j} + (\beta_n - \beta_{n-i}) \cdot \alpha_i = \\ &= S_{i,j} + (1 - \beta_{n-i+1}) \cdot \alpha_i \end{aligned} \quad (10)$$

The BF projection is written as (Schmidt, 2008):

$$E[S_{i,n}] = S_{i,n-i+1} + (1 - \beta_{n-i+1}) \cdot \alpha_i \quad (11)$$

where β_{n-i+1} is an *a posteriori* estimation and α_i is an *a priori* estimation of ultimate losses.

As the CLM assumes that:

$$E\left[S_{i,n}\middle|S_{i,1},S_{i,2},...,S_{i,j}\right]=E\left[S_{i,j}\right]\cdot\prod_{k=j+1}^{n-1}r_k=E\left[S_{i,1}\right]\cdot\prod_{k=1}^{n-1}r_k,$$

We obtain: $E\left[S_{i,j}\right]=E\left[S_{i,n}\right]\cdot\prod_{k=0}^{n-1}r_k^{-1}$.

If this result is compared with (9), it is evident that:

$$\beta_j=\prod_{k=j+1}^{n-1}r_k^{-1} \tag{12}$$

Thus, (11) is now written as:

$$E\left[S_{i,n}\right]=S_{i,n-i+1}+\left(1-\frac{1}{\prod_{k=n-i+1}^{n-1}r_k}\right)\cdot\alpha_i \tag{13}$$

This relation points to a significant difference between the BF method and the CLM - the method of choosing estimators. For the CLM, we have (Schmidt, 2008):

$$E\left[S_{i,n}\right]=S_{n-i+1}\cdot\prod_{k=n-i+1}^{n-1}r_k=$$

$$=S_{n-i+1}+S_{n-i+1}\cdot\left(\prod_{k=n-i+1}^{n-1}r_k-1\right)=$$

$$=S_{n-i+1}+\frac{E\left[S_{i,n}\right]}{\prod_{k=n-i+1}^{n-1}r_k}\cdot\left(\prod_{k=n-i+1}^{n-1}r_k-1\right)$$

therefore:

$$E\left[S_{i,n}\right]=S_{n-i+1}+\left(1-\frac{1}{\prod_{k=n-i+1}^{n-1}r_k}\right)\cdot E\left[S_{i,n}\right] \tag{14}$$

The difference between (13) and (14) is only in the last member of the estimation: in the CLM, it is obtained from observable data, whereas the BF method allows α_i to be any estimator of the ultimate loss development. Therefore, the parameter α_i is an *a priori* exogenous factor, obtained by some other professional expertise. The application of the BF method is mainly based on the loss ratio, i.e. on the ratio of incurred claims to earned premiums as the α_i predictors of ultimate losses. Since the loss ratio indicates the historical experience of the IC activities regarding the share of claims (in %) in premiums, this product indicates the likely amount of the expected losses in the next business year. In terms of the CLM, the inverse product of the development factors indicates the percentage of the paid claims in the expected aggregate payment for a given development year, therefore $1-1/\prod_{k=n-i+1}^{n-1}r_k$ represents the amount (in %) of expected unpaid claims. If the projection of possible losses per development years is calculated using the ratio of claims to premiums, by multiplying this amount and the factor: $1-1/\prod_{k=n-i+1}^{n-1}r_k$, we obtain the amount of the necessary reserve (Schmidt, 2008).

In contrast to the method of the expected losses, where projection ignores the actual realization of payments, and the method of chain indices, where full credibility is given to paid claims, the BF method relies on data from the past, but not as the only benchmark for the evaluation of future payments. Concerning the development of losses, the credibility of projections is based on the claims development in most recent experience periods; therefore, the weighting factor of the initial realizations declines (Martínez-Miranda, Nielsen & Verrall, 2013). Incurred but not reported claims will be developed in the future based on the expected payments; incurred payments are not the predictors of a future development; therefore, payment fluctuations in the early stages do not impair the projection of the necessary reserves. This is actually the main argument for the implementation of the BF method for "long-tail" insurance lines, as well as in the case of other insurance lines characterized by significant fluctuations in the realization of incurred payments.

Stanard-Bühlmann Method

This method, also known as the Cape–Code (CC) Method, was independently developed by J. N. Stanard (1985) and H. Bühlmann (1983), as an improved variation of the BF method. The initial assumption concerning the division of ultimate claims to reported and incurred but not reported claims is retained, as well as the sensitivity of determining the loss ratio. In contrast to the BF method, where the loss ratio is estimated by the person liable for calculating reserves, the CC method determines the expected loss ratio based on the historical experience of the total amounts of reported claims. For each development year, the loss ratio is calculated based on the total reported claims and earned premiums, whereas the expected loss rate for the next development period represents the weighted average of all ratios obtained. Since the expected claims are based on the reported losses, a sufficient volume of data is required, which often limits the application of this method. "A lack of quality data is a critical factor, because with inadequate data no results will be produced, no matter how perfect the model may have been" (Kočović, Mitrašević, Kočović i Jovović, 2011, 2011).

The Methodology for Calculating Claim Reserves Prescribed by the National Bank of Serbia (NBS)

The Insurance Law of the Republic of Serbia, i.e. the Decision on the Detailed Criteria and the Manner of Calculating Claim Reserves, allows the application of actuarial methods for the calculation of incurred but not reported claim reserves; it also allows to calculate reserves based on the data on resolved and reserved incurred reported but not settled claims without the involvement of annuity claims. Also, the calculation should not include any costs associated with the settlement and payment of claims. According to this principle, the amount of reserves for incurred but not reported claims concerning the self-insured retention of the company for the particular insurance line represents the sum of settled and unsettled reported claims in retention within a certain insurance line, corrected by the coefficient for the calculation of claims incurred but not reported, i.e..

$$R_t^{IBNR} = a_t \cdot \left(S_t + R_t\right)$$

where S_t stands for the amount of settled (not including annuity) claims in retention in a particular insurance line, R_t is the amount outstanding (excluding annuities) incurred reported but unsettled claims in retention in the particular insurance line, a_t the coefficient for the calculation of incurred but not reported claims and R_t^{IBNR} resulting amount of incurred but not reported claims in the observed insurance line (Službeni glasnik RS, 2007).

The correction coefficient a_t is calculated on 31st December of the current year for those lines of insurance that have been conducting particular insurance activities for more than three years (or at least two years) and the same cannot be smaller than 0.1. It represents the arithmetic mean of the coefficients k_i calculated for the current and previous two insurance years. The coefficient k_i for each of the last three or two years is the quotient of: 1) the sum of the amounts of the claims settled during the year and the outstanding incurred reported claims on 31st December that have occurred in the previous period and are the first reported in the year for which this coefficient is determined and 2) the sum of the amounts of the claims settled during the year and the outstanding incurred reported claims on 31st December of the year for which this coefficient is determined. If insurance activities in a particular insurance line last for less than 2 years, the value of this coefficient is 0.1.

If the incurred claims reserve is calculated by applying some other method, its amount cannot be smaller than the amount obtained by using the above-described method; furthermore, the reserve calculated according to the method presented above must not be smaller than the reserve calculated at the end of the previous year.

METHODOLOGY AND RESEARCH RESULTS

Stanard & Poor's (S & P), one of America's leading financial services companies, calculates the level of TR by applying a comparative analysis of the results obtained by using the following three methodologies: the paid loss development method, the incurred loss development method, and the BF methods. According to their analysis, the triangulation techniques based on paid and incurred losses produce the most appropriate results when using the five-year weighted average of DF that best reflect the balance between stability and reliability in developing factors (Standard & Poor's Ratings Services, 2008).

The results of the research carried out by the global network of consulting and audit firms - KPMG at the EU level (2002) - show that a comparative analysis of the reserving results obtained by means of various actuarial methods is the generally accepted way to minimize the deviations of proposed projections from the actual realization of payments. In almost all European countries, the methods based on the run-off triangles proved to be the most effective and in terms of cumulative paid claims in the previous business years the CLM was the method most commonly used. Beside the mentioned method, one of the following methods is also simultaneously used: the Loss Ratio Method, the Average Cost per Claim Method or Bornhuetter-Ferguson's method. In Spain, it is even prescribed by the law that at least two methods must be used when determining reserves; furthermore, the selected methods must include data for at least five preceding years.

All of the mentioned studies have initiated research in the applied practices in non-life ICs operating in Serbia's economic environment. According to the results of the survey which was carried out on 11 non-life insurance companies (2 of which are in private and the remaining 9 in foreign ownership), the actuaries follow the Decision on the Detailed Criteria and the Manner of Calculating Claim Reserves (NBS) and the CLM when projecting the uncertain amounts of future claim reserves. Hence, the focus of this research is directed towards the application of various deterministic methods in order to determine whether their choice is the most appropriate or whether some other method provides better results closer to payment realizations in 2016.

In the line of business with a long development period, the claim payment data of an insurance company were used in this research. The projections of the potential amounts of future payments were done by using the triangulation methods applying the development triangles for paid and incurred losses in the period from 2006 to 2015 in order to make it possible to compare the results with the realizations of these amounts in 2016. Additionally, all the projections obtained by using the run-off triangles, the BF and the CC methods calculated amounts in dinars (RSD) and euros, respectively. Currency conversion was done at the official exchange rate applicable on 31st December.

Loss development triangles are formed based on the cumulative amount of payments as per accident year and payment delay periods of 12 to 120 months. For each development year, the chain indices were selected and obtained as follows: 1) conservative mean-value, i.e. the selection of the highest chain index value in the observed development period; 2) the arithmetic mean of all the chain indices as per columns for each year of claims development; 3) the arithmetic mean of the last three chain indices in each column; 4) the arithmetic mean of the last five chain indices in each column; 5) the median of the indices, i.e. the arithmetic mean of the indices that remains after eliminating the highest and the lowest index values in each column; 6) the geometric mean obtained by applying GEOMEAN, a function contained in the *Microsoft Office Excel 2007* software, i.e. as $\sqrt[n-1]{f_1 \cdot f_2 \cdot \ldots f_n}$, where $f_1, f_2, \ldots, f_n$ are chain indices, and 7) the weighting means obtained by using CL weights.

Among the many techniques used for determining the tail factors, the following methods were used: Bondy's method, which carries out the selection based on the last calculated chain index for the year that has the longest claims development period and the two more modifications of this method, where the development portion of the last chain index is squared or doubled, respectfully; Sherman-Boor's method; Method of Exponential Approximation; McClenahan's method and Scurnick's method.

The tail factors were determined for each of the seven mentioned ways of obtaining the development factor by using all the seven methods and the projection of future payments for incurred but not unreported claims was done for the development period from 2006 to 2015. So, 49 projections were obtained only for the chain-ladder based methods. The results of the projections were compared with the real payments in 2016, for all the claims that occurred from 2006 to 2015, but which had not been reported in that period. In the chain-ladder based methods, the amount the closest to the actual payments was the method where the development factors were obtained over a medial average, with the tail factor determined by using the Bondy method. In addition to the chain index methods, the amount of these potential payments by the expected cost method, the BF and the CC methods was obtained. The results of the projected incurred but not reported claims in the EUR currency are given in Table 1, while the same results in the RSD currency are accounted for in Table 2.

Table 1 The comparative analysis of the projection methods (in EUR)

Method	Projected amount of reserves for claims
Chain Index Method	12312428
Average Cost per Claim Method	13141133
CL Method with Bondy ROC	12356404
Bornhutter–Ferguson Method	12359573
CapeCod Method	12232147
Realization in 2016: 11728866	

Source: Authors

Table 2 The comparative analysis of the projection methods (in RSD)

Method	Projected amount of reserves for claims
Chain Index Method	1 578 908 008
Average Cost per Claim Method	1 527 416 691
CL Method with BondyROC	1 623 425 309
Bornhutter–Ferguson Method	1 659 685 804
Cape Cod Method	3 058 845 966
NBS Methodology	1 892 155 950
Realization in 2016: 1 344 383 096	

Source: Authors

The second direction of the research is focused on actuarial practice in the non-living ICs operating in the territory of the RS. The questionnaire containing 32 questions, focused on the calculation of the individual components of technical reserves, was distributed to the insurance companies only engaged in non-life insurance and composite insurance companies in order to detect divergence in the applied methodology.

The following questions were posed in the mentioned questionnaire: 1. Which line of non-business is presented in your insurance company's portfolio? 2. Are technical reserves calculated by a qualified actuary? 3. How many years of experience does the person responsible for technical reserves calculations have? 4. What percentage of the working hours during the year does this person spend on TR calculations? 5. Which types of TRs are calculated? 6. Unearned premium reserves are calculated by using: a) the pro-rata temporis method; b) the 1/24 method; c) the quarterly method; d) the same-rate method; 7. Please, explain how you use the method selected that was used in the previous question. 8. Which method is used for an RBNS estimation: a) the estimation of each separate claim; b) the average method; c) by using tables; c) the claim ratio method? 9. Please, explain how you use the method selected that was used in the previous question. 10. Which method is used for an IBNR estimation: a) the flat methods based on paid and RBNS claims; b) the claim ratio; c) the chain ladder; d) by using another method (specify which)? 11. Please, explain how you use the method selected that used in the previous question. 12. If you use the chain ladder method, then explain the methodology used for the calculation of development factors. 13. How many development years are presented in the claim triangles? 14. Do you calculate the tail factor and how? 15. Which data are presented in the claim triangles: a) paid claims; b) paid claims including costs; c) the sum of paid claims and RBNS? 16. Which data are presented in the claim triangles: a) the occurred claims; b) the reported claims; c) the paid claims? 17: Do you think that the expected inflation should be used in calculations? 18. Are the claims paid by the reinsurer included in the claim triangles? 19. How much is the average deviation of the projected reserves and the real paid claims? 20. Do you calculate the adequacy of the projected reserves? 21. How do you calculate adequacy? 22. Which method is used for claim costs reservation: a) the method of the claim costs ratio; b) by using another method? 23. Please, explain how you use the method selected that had been used in the previous question. 24. Do you use statistical methods for TR projections? 25. Specify which statistical methods you have used and how useful their application has proved to be? 26. Would you like to use statistical methods and how frequently? 27. Which method is used for premium rates calculations: a) the class method, b) the method of premium rate estimations, c) experientially, d) by using another method (specify which)? 28. Please, explain your using of the method selected that had been used in the previous question. 29. Are premium rates corrected, how often and in what manner? 30. Which percentage of technical premiums are variable costs? 31. Which percentage of gross premiums is a reinstatement? 32. Do you have any suggestion about the calculation of technical reserves?

The distributed questionnaire was completed by 11 ICs, of which the 2 domestic ones solely engaged in non-life insurance, and 9 foreign companies, of which the 7 companies only offer non-life insurance, whereas the 2 companies offer both non-life and life insurance.

In 81.82% of the surveyed ICs, the authorized actuaries are liable for calculating reserves; however, in 45.45% of these companies, the actuaries have less than 5 years of experience in the field of reserving. The actuaries employed in domestic ICs have over 6 years of work experience; yet about 10% of their working day is spent on calculating reserves, which is inadequate concerning the contribution that due to their experience and practice can be provided in terms of the development and amendments of the existing laws and regulations in this field. The situation in other ICs differs from one IC to another – their actuaries spend from 5% to as much as 50% of the working time on the calculation of reserves; the work experience of their actuaries varies from 3 to 6 years in terms of reserving tasks. The methodology applied by the employees regarding the valuation of certain components of the reserves is in line with the regulations prescribed by the National Bank of Serbia. Reserves for incurred but not reported claims until the end of the accounting period are determined by the actuaries in several ways: 88.89% of the actuaries follow the Decision of the NBS and its prescribed methodology, 33.33% apply the Expected Loss Method and 77.78% apply the Chain Ladder Method (CLM). The actuaries employed in domestic ICs apply the NBS methodology and the CLM when calculating reserves. They also apply different methods for the selection of the development factors: three actuaries use weighted averages, two use median values, whereas one actuary (employed in a domestic IC) uses both methods plus the arithmetic factors for the last three accident years.

The question: "Do you enter the liabilities borne by the reinsurer in the run-off triangles?" divided the insurers, both the foreign and the domestic ones; 5 actuaries do not register the amounts handled by reinsurers, whereas 4 insurance companies, quite unjustifiably, use these amounts when calculating the amounts of claims paid. The transfer of risks underwritten to a reinsurance company eases the insurers' liabilities in terms of future payments and their responsibilities concerning the payment of such claims. These different approaches concerning the data entered in the run-off triangles make a great difference in practice when quantifying the amounts of reserves. The use of reinsured amounts in the run-off triangles is by all means unjustifiable and should be restricted by law, since such practice is motivated by the wrongful obtaining of tax reliefs. Until the Solvency II Directive, which prohibits the use of these amounts in the projections of future cash flows, comes into force in Serbia, it is necessary that the NBS and its auditors and supervisors who monitor the activities of ICs should react and regulate these matters.

All the actuaries position the amounts in the run-off triangles according to the accident year and the development year; however 28.57% of the surveyed actuaries also enter the amounts payable by reinsurers. However, divergence is present in practice both with the foreign and the domestic insurers. When asked about the statistical methods they apply in terms of reserving, one actuary employed in a domestic IC answered that he applied the methods of correlation analysis, standard deviations and other methods, while the other actuaries do not apply statistical methods, but are willing to include statistical and stochastic projection methods. The encouraging fact is that the intellectual potentials of the hired actuaries strive towards the scientific soundness of the methods they use, which should be more than enough reason for competent internal and external bodies to mobilize their energy and efforts and provide continuous training opportunities in order to achieve the greater preparedness of our insurance market for harmonization with the complex new regulations implemented in the European Union.

Quantifying the costs of settling, reserving, estimating and liquidating claims in an unstable business environment faced with an increasing unfair competition in the race to win over new customers is not an easy task to do. An insight into the balance sheets and the income statements of the non-life insurance companies operating in the RS confirms the necessity to introduce more reliable methods and be more cautious when projecting the amounts of reserves. The reports on the audit of these companies, i.e. the auditor's opinion, also confirm our conclusion. At the end of 2013, while supervising the operation of the ICs and analyzing the individual items from their balance sheets, the auditors found that five insurers (AS Insurance, DDOR Novi Sad, Millennium Insurance, Sava Insurance and Triglav Insurance) had inadequate reserves. In the aforementioned ICs, the costs of insurance in the individual insurance lines significantly exceed the expense loading (the balance sheets, the income statements and the auditor's opinion are available on the website of the NBS for all the ICs operating in the territory of the RS). However, according to the information provided in the completed questionnaires, 10 actuaries calculate these costs according to the Decision on the Detailed Criteria and the Manner of Calculating Claim Reserves (NBS).

CONCLUSION

Inherent uncertainty with respect to both the occurrence and the amount of claims in non-life insurance reflects most on the projection of the amounts of technical reserves. Numerous scientific papers and studies are directed towards obtaining the best assessments of their amounts. However, there have almost been no empirical research studies regarding the topic in national academic/actuarial papers. This fact gives special relevance to this paper, which consists of the two directions of the empirical analysis.

- The results of the quantitative analysis, conducted in the previous section of the paper, imply the following conclusions:
- The calculations based on the loss triangles in the euro amounts indicate that in the methods based on the chain indices, the slightest deviation of the projection from the claims paid in 2016 is caused by implementing the development factors obtained via median value, with the remainder coefficient according to Bondy's method;
- The comparative analysis of the obtained projection of the euro amounts regarding the claims incurred but not reported indicates that

the most appropriate forecasting of payments in the following year is obtained by using the CC method, where the deviation from the actual realization is 4.29%, whereas the Average Cost per Claim Method provides the over-reserving of 12.04%. Bondy's method with its median value - as the best projection method concerning the triangulation methods - deviated about 5% from the actual realization of the incurred loss payments.

In the projections of the reserves conducted in the RSD amounts, the Cost per Claim Method produces the slightest deviation (+13.615%) from the incurred losses paid in 2016, whereas the projection performed by applying the Decision of the NBS has resulted in the over-reserving of 40.745% on the account of claims incurred but not reported.

In terms of non-life ICs, the realization of the loss payments is the highest in the first year of insurance coverage; in many other lines of insurance, insurance coverage is short-term. So far, these arguments have been sufficient for the regulators monitoring the activities of the ICs operating in the EU territory; therefore they do not insist on inflation-adjusted projections. The instability of market conditions, as well as a high inflation, present in the Republic of Serbia as well as in other developing countries, point to the need for the implementation of adjustments for inflation when projecting future payments to be made on claims. The projection of the amount of the technical reserves in the selected insurance company for one insurance line, as well as a comparative analysis of the obtained results, indicate that the application of the deflated data results in minor deviations between the expected and the realized payments. The best method of projecting amounts in RSD resulted in the over-reserving of 13%, whereas the projections in the euro amounts differ about 5% from such realizations, which confirms the basic hypothesis and points to the fact that inflation should not be neglected even in the short-term lines of insurance.

By analyzing the responses to the questions from the distributed survey, what was observed was an insufficient number of the actuaries hired to calculate the technical reserves amounts since their practical perception can be the best ground for the further monitoring of the given topic. The suggestions regarding the current situation and the directions of correcting the technical reserves calculation, accompanying the responses to the questions in the survey, indicate a detected lack of current regulations and a necessity for passing a detailed rulebook and the best possible model of calculating TRs, followed by mitigating the excessive rigidity of local regulations with respect to reserving incurred claims.

The comparative analysis of both directions of the research study has confirmed the additional hypothesis since the best methods detected in the quantitative research were not used in the actuaries' practice in the Republic of Serbia. The practitioners' perceptions and suggestions of the current situation and the directions concerning the correction of the calculation of technical reserves point to the insufficiency of the existing regulations and the necessity for establishing more detailed regulations and a better model for the calculation of TRs, including the mitigation of excessively rigid local regulations applicable to claim reserving.

An undeniable quality of the paper is reflected in the presentation of the numerous methods used to calculate reserves with respect to claims incurred but not reported, as well as the implementation of the various methods used for determining the remainder coefficient since the conducted research study has proved to have a significant effect on the amount of projected reserves.

Being aware of the fact that all the projections were made based only on a single line of business operation of an insurance company, the authors believe that the obtained results provide both the base and the incentive for similar empirical research studies. Simultaneously, this suggests the possible directions of further researching efforts. The intention to use the concrete, historical operating results to analyze the adequacy of the applied techniques in all non-life insurers could not have been realized due to the protection and confidentiality of their data.

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