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Research Article

MULTI-YEAR RESERVE AND PREMIUM RISK

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ABSTRACT. Claims development results are the changes in claims reserves and one of the major risk drivers in the profit and loss statement of a general insurance company. In this study, claims development result, future one year and multi-year reserve and premium risk computed with additive loss reserving model using data of an insurance company serving in the mandatory traffic insurance. The estimators of premiums were calculated by using linear, non-linear regression methods and Hachemeiter regression model. In conclusion, the reserve risk and premium risk are increased.

Keywords: *Claims development result, non-life insurance risk, regression, additive loss reserving model, premium estimation*

INTRODUCTION

The non-life insurance risk is essentially divided into two groups, the risk of reserve and the risk of premium [1]. The risk of reserve corresponds to loss payments that occurred during past accident years but have not been paid, while the risk of premiums corresponds to future accidents. Reserve risk is modeled by a traditional method in which uncertainty in future loss payments is determined by utilizing past experiences and consequential loss amounts are reserved. However, the report published by the European Commission under Solvency II, emphasized that all major loss and liability should be calculated, not only for the present time, but also 1 years later. With this development, the uncertainty in loss payments has started to be calculated based on loss payments over the 1-year period.

Unlike the traditional method in which calculations are made using past experiences, it is important to take the short term into account and make calculations in this way in terms of the following points [2]:

Whether insurance companies are able to meet their qualifications for the short term affects their long-term situation. Financial reports in insurance companies, insurance products activities such as pricing, Premium adjustments are made annually. Customers, investors, rating agencies and stock exchange market deals with the short-term performance of the company, the short-term position of the company is important for its financial strength and reputation in the insurance market.

Böhm and Glaab [3], Merz and Wüthrich [4] developed an analytical approach with the help of the chain ladder method in order to calculate the estimation of the uncertainty in the loss development results by considering the short term in their studies. Similarly, Mack [5], Merz and Wüthrich [6] obtained the same estimates using the additive method.

Along with ORSA (own risk and solvent assessment), which is recommended under Solvency II and is a part of the risk management system, it has been pointed out that companies take into account not only their current risks but also the risks they will face in the long term [2]. In addition, non-life insurance companies; A multi-year evaluation is required in order to make more accurate strategic decisions on issues such as how much of it can meet its obligations without the need for an additional resources or how much capital it needs to survive [7].

While making annual and multi-year evaluations, the changes that ocur with the updating of the loss reserves from year to year are used. These changes are called claims development results and are one of the main risk factors taken into account when examining the profit and loss status of the insurance company [6].

Claims development results; It was defined for the first time in Merz and Wüthrich [4] as the difference between two consecutive estimates of the final loss estimate. In the study, short-term and long-term comparisons were made in the calculation of loss reserves, and the importance of the short-term was emphasized. This study, in which observable claims development results for each accident year are obtained with the chain ladder method, is considered as the main source for the claims development results. In the study of Bühlmann, Felice, Gisler, Moriconi, Wüthrich [8], 1-year short-term claims development results were obtained using the Bayesian chain ladder method, and the mean square error of these results was calculated. In the study of Dahms, Merz, Wüthrich [9], the conditional mean squared error of the 1-year claims development result was calculated using the complementary loss ratio method (CLRM). Unlike the others, the analyzed data by dividing into two groups as incurred claims and paid claims.

In non-life insurance types, there are many methods by which unpaid loss estimates are determined using past experience. Among these methods, the Chain Ladder Method is the most widely used because it is independent of distribution and simple to application. However, the Chain Ladder method; There are some deficiencies that may cause deviations that may occur in the estimation, such as the necessity of homogeneity of the data, the inadequacy of the development factor to give the correct estimation value, and the fact that the first observations in the accident years do not represent the claims development values properly [10].

In addition, different methods have been started to be used, based on the idea that more accurate results will be obtained for making estimations by considering other variables as well as loss development triangle data. One of these methods is the additive loss reserve method. The additive loss reserve method is a method that uses both the loss development triangle data and a priori information such as the number of policies for accident years or the premium obtained [11, 12]. In this study, the additive loss reserve method is used.

In this study, the calculations of the claims development results are made by using the loss development triangle and premium data for the quarter periods between 2007 and 2013 of an insurance company serving in the compulsory traffic insurance branch in Turkey. The company's quarterly premium estimates for the next 3 years, parameter estimates of the cumulative loss reserve method and the required premium amount totals are obtained.

CLAIMS DEVELOPMENT RESULT

Claims Development Result (CDR) Definition

The claims development result is the change in claims reserves over time and is one of the main risk factors in an insurance company's profit and loss statement [13]. The importance of the claims development results in the income-expense table is explained with the help of Table 1.

Table 1. *Income-Expense Table*

	Estimated values on January 1 for year I	Observed values on December 31 for year I
Earned premiums	4 000 000	4 020 000
Losses at accident year I	-3 200 000	- 3 240 000
Loss experience for previous accident years	0	-40 000
Expenses	-1 000 000	-990 000
Investment income	600 000	610 000
Income before taxes are paid	**400 000**	**360 000**

In Table 1; For the year I, the values on 1 January are the estimated values for the next calendar year (I,I+1], and the values on 31 December are the actual values for the same year [4].

In this table, earned premiums represent premium income, expenses are commissions paid, investment income is financial returns from assets. Although all these concepts and the situations the involve are easier to understand, the concept of "loss experience for previous accident years" is less understandable than the others. This concept expresses the difference between the claims reserve in the I calendar year and the claims reserve in the I+1 calendar year for the claims in the calendar years before the I calendar year.

Claims reserve for calendar year I+1 is an adjusted loss reserve obtained by taking into account the claims payments incurred during the calendar year (I,I+1), profit and loss status for previous years, development of claims for payments in previous years are used, but a specific term is not widely used.With the study of Merz, Wüthrich and Lysenko [12], this difference started to be expressed as "claims development result".

As these results are included in the balance sheet of the insurance company and directly affect the financial strength of the company, it is one of the leading areas of interest for evaluations under Solvency [9].

One Year CDR

Taking the short-term into account when calculating the loss reserves-making calculations for the 1-year period-is a perspective that has been encouraged by Solvency II and has started to take place in the literature recently. The following definition has been made regarding the Solvency Capital Requirement: "The Solvency Capital Requirement corresponds to the capital an insurance or reinsurance agreement must have for the probability of bankruptcy to be fixed at 0.5% (bankruptcy occurs once every 200 years). This amount of capital is calculated taking into account all possible losses over the next 12 months. Solvency Capital Requirement; It reflects the impact of risk mitigation techniques as well as the actual risk profile of the insurance or reinsurance agreement and that all measurable risks have been taken into account."

"Solvency Capital Requirement; It should be determined by taking into account the situation in which all the risks to which an insurance or reinsurance agreement is exposed are taken into account in the calculations made. As a result of this situation unexpected loss should also be considered. This capital requirement corresponds to the value-at-risk of an insurance or reinsurance company's own capital at a confidence level of 99.5% over a 1-year period [14]."

With these definitions and explanations, the time period is taken as 1 year and the loss reserve is re-estimated at the end of the year using the loss information observed during the year [15]. In this way, possible changes in the loss reserve estimates of companies aredetermined. In the studies carried out with a 1-year time interval to determine these changes, 1-year claims development results are taken into account while examining theprofit-loss status of the company.

One-year claims development result for a specific beginning year is calculated as follows:

R_0 : Initial estimate of reserve amount
R_1 :Reserve estimate for a year from now
C_1 :Loss payments to be made within one year
CDR_1 :Claims development result
U_0 :Initial estimate of ultimate loss
U_0 :Ultimate loss estimate for a year from now

$CDR_1=R_0-C_1-R_1=U_0-U_1$ equality refers to one year claims development result.

As can be seen from the equation, the claims development result is the difference between two consecutive estimates of the ultimate loss amount [16]. It is seen how sufficient the reserves are until the end of this period, taking into account the 1-year claim development result and the claims payments to be made within the 1-year period.

The traditional method, which is frequently used in the literature and is one of the main loss reserve methods, deals with the estimation of the volatility in claims payments. The short-term perspective, which takes into account the 1-year period, deals with the estimation of the volatility in reserves [17].

CDR Calculation with Chain Ladder Method

The chain ladder method is the most widely used method for calculating loss reserves. The main reason for this is that the method is simple, independent from distribution and can be used almost without any assumptions [18].

Several different forms of loss data can be used when constructing loss reserve models that are used to estimate the total amount of ultimate loss. These are cumulative loss data, paid or incurred loss data, loss number data, etc. Chain ladder method is applicable to cumulative payments and incurred claims data. It is a highly preferred method in practice, as reliable loss reserves can be obtained when appropriate estimates of chain ladder factors are used. The shortcomings of the model are as follows [10]:

- Data must be homogeneous. Development factors should not contain any volatility.
- For the last accident years, the development factor may be insufficient to give the correct estimation value. For example, let the number of accident years be until 2011 and the number of development years be as large as 20. In this case, estimating the development value 19-20 years later for the last accident years, the development factor may be insufficient.
- The first observations in the accident years may sometimes not represent the claims development values well, which can cause problems for the last accident years.

In this study, $i \in \{0,\ldots,I\}$ shows accident years and $j \in \{0,\ldots,J\}$ shows development years.

$C_{i,j} = \sum_{i=1}^{j} X_{i,j}$ in this equation, $C_{i,j}$ is cumulative loss amount for accident year, $C_{i,J}$ is nihai loss amount, $f_o, f_1, \ldots, f_{j-1}$ shows development factors for chain ladder method. The estimation for $C_{i,j}$ random variable is given in equality; $E\left[C_{i,j} \middle| C_{i,j-1}\right] = f_{j-1} C_{i,j-1}$.

For convenience, we assume I=J for loss data. For accident year $i \in \{0,\ldots,I\}$; unpaid loss amount at time t=I and unpaid loss amount at time t=I+1 is calculated respectively with following equations:

$$R_i^I = C_{i,J} - C_{i,I-i} \qquad \text{(t=I)}$$

$$R_i^{I+1} = C_{i,J} - C_{i,I-i+1} \qquad \text{(t=I+1)}$$

At t=I observation values: $D_I = \left\{ C_{i,j}; i + j \le I, i \le I \right\}$. One year later, at t=I+1 observation values: $D_{I+1} = \left\{ C_{i,j}; i + j \le I+1, i \le I \right\} = D_I \cup \left\{ C_{i,I-i+1}, i \le I \right\}$.

For accident year i $\in\{0,\dots,I\}$ and calendar year (I, I+1] observable claims development result is calculated as:

$\hat{CDR}_i(I+1) = \hat{R}_i^{D_I} - \left(X_{i,I-i+1} + \hat{R}_i^{D_{I+1}} \right) = \hat{C}_{i,J}^{I} - \hat{C}_{i,J}^{I+1}$

Total observable claims development result is calculated with equation: $\sum_{i=1}^{I} CDR_i(I+1)$

Table 2. *Claims development result for accident years*

i				$CDR_i(I+1)$
0	0	0	0	0
1	4.378	4.313	0	65
2	9.348	3.305	4.344	1.698
3	28.392	16.048	7.997	4.347
4	51.444	38.972	27.552	-15.050
5	111.811	38.873	54.577	18.360
6	187.084	83.525	106.326	-2.767
7	411.864	217.794	183.340	10.731
8	1.433.505	1.073.458	417.540	-57.458
	2.237.826	1.476.288	801.646	-40.074

The resulting value of -40,075 units is the total claims development result for all accident years. As a result of the claims development found, when viewed from the time t = I = 1, it shows that the reserves are not sufficient for all accident years at time t = I and there is a shortage of 40.075 units.

CDR Calculation with Additive Loss Reserving Method

In the additive loss reserve method, incremental payments for each development year and the loss payments for the next years are estimated with the help of the development factors found by using the volume measurement parameter for that period. These development factors are called incremental loss ratio.

The method has two parameters (m_j and s_j^2) that provide $E\left[X_{i,j}\right] = v_i m_j$ and $V\left[X_{i,j}\right] = v_i s_k^2$ equations for each j development year.

For T=n, unbiased estimators of method's parameters are given in following equations [6]:

$$^{(n)}\hat{m}_j := \frac{\sum_{i=1}^{n+1-j} X_{i,j}}{\sum_{i=1}^{n+1-j} v_i} \quad , \ j \in \{1,\ldots,n\}.$$

$$\hat{s}_j^2 := \frac{1}{n-j} \sum_{i=1}^{n+1-j} v_i \left(\frac{X_{i,j}}{v_i} - {}^{(n)}\hat{m}_j \right)^2 \quad , \ j \in \{1,\ldots,n\text{-}1\}.$$

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Non-Life Insurance Risk

The estimation of the variance of the m year observable claims development result is as follows where m is the number of future calendar years [3]:

$$\hat{V}\left[C\hat{D}R_i^{(n \to n+m)} \right] = \sum_{j=1}^{n} \frac{^{(n+m)}v_{\le j}^2}{^{(n+m)}v_{\le j} \, {}^{(n)}v_{\le j}} \left(\sum_{t=1}^{m} v_{n+1+t-j} \right) \hat{s}_j^2$$

Multi-Year Reserve Risk

Multi-year reserve risk is the multi-year non-life insurance risk obtained for previous years. In other words, the multi-year reserve risk is equal to the estimated variance of m-year observable claims development results [3].

$$\hat{V}\left[C\hat{D}R_{PY}^{(n \to n+m)} \right] = \sum_{j=2}^{n} \frac{^{(n)}v_+^2}{\min\left({}^{(n+m)}v_{\le j}, {}^{(n)}v_{\le j} \right) {}^{(n)}v_{\le j}} \left(\sum_{t=1}^{\min(j-1,m)} v_{n+1+t-j} \right) \hat{s}_j^2$$

Multi-Year Premium Risk

Multi-year premium risk is the non-life insurance risk for future years. In other words, the multi-year premium risk is equal to the estimated variance of m-year observable claims development results [3].

$$\hat{V}\left[C\hat{D}R_{NY}^{(n\to n+m)}\right]=\sum_{j=1}^{m}\left[\left(\sum_{t=1}^{m-j+1}v_{n+t}\right)\frac{{}^{(n+m)}v_{+}^{2}}{{}^{(n+m)}v_{\le j}^{2}}+{}^{(n)}v_{>j}\frac{{}^{(n+m)}v_{>j}^{2}}{{}^{(n+m)}v_{\le j}^{2}}\right]\hat{s}_j^2+\sum_{j=1}^{m}\frac{1}{{}^{(n)}v_{\le j}}$$

$$x\left[\left(\sum_{t=1}^{m-j+1}v_{n+t}\right)\frac{{}^{(n+m)}v_{+}}{{}^{(n+m)}v_{\le j}}+{}^{(n)}v_{>j}\frac{{}^{(n+m)}v_{>j}}{{}^{(n+m)}v_{\le j}}\right]^2\hat{s}_j^2+\sum_{j=m+1}^{n}\frac{\left(\sum_{t=1}^{m}v_{n+t}\right)^2}{{}^{(n+m)}v_{\le j}\;{}^{(n)}v_{\le j}}\left(\sum_{t=1}^{m}v_{n+1+t-j}\right)\hat{s}_j^2$$

APPLICATION

For the application part, T.C. The Undersecretariat of Treasury of the Prime Minister, The General Directorate of Insurance received development triangles and premium quantities from 25 companies serving in the field of compulsory traffic insurance, including data on the amount of loss paid for in the quarter period of 2007-2013. The premium amounts from 2007-2013 to each the graphs of the premium amounts for 23 companies, which have been fully awarded for the quarter period, have been reviewed over time based on the increase in the premium. A company whose premium amount in the past years has increased linearly has been analyzed in two ways as linear and non-linear, based on the assumption that the premium amounts will increase in the future.

Application Results Regarding the Assumption of a Linear Increase in Premiums for Future Years

The premiums of a company selected among 23 companies, which currently sells compulsory traffic insurance policies in Turkey and whose premiums for the past years have increased in accordance with a regular pattern, have been analyzed assuming that the premiums for the coming years increase linearly.

The projections of the premium for the next 3 years are included in Table 3, assuming the amount of loss for this company is a linear increase in premium quantities during known periods and bonus amounts for future years.

***Table 3**. Premium amounts and premium estimates for future years*

Ay i		Premium	Ay i		Premium
1	2007Q1	30.542.768,5	21	2012Q1	82.517.599
2	2007Q2	27.444.071,2	22	2012Q2	89.576.027
3	2007Q3	30.042.957,4	23	2012Q3	96.316.269
4	2007Q4	33.116.540,3	24	2012Q4	103.891.234
5	2008Q1	35.016.535,6	25	2013Q1	105.057.550
6	2008Q2	36.975.229,4	26	2013Q2	112.589.844
7	2008Q3	36.994.258,0	27	2013Q3	120.316.078
8	2008Q4	38.330.344,6	28	2013Q4	142.612.597
9	2009Q1	39.216.905,0	29	2014Q1	146.206.761
10	2009Q2	41.174.327,8	30	2014Q2	149.800.924
11	2009Q3	44.294.204,5	31	2014Q3	153.395.088
12	2009Q4	47.590.908,5	32	2014Q4	156.989.252
13	2010Q1	49.938.910,9	33	2015Q1	160.583.415
14	2010Q2	51.174.033,6	34	2015Q2	1.641.77.579
15	2010Q3	55.163.653,7	35	2015Q3	167.771.743
16	2010Q4	57.732.277,8	36	2015Q4	171.365.906
17	2011Q1	54.952.975,6	37	2016Q1	174.960.070
18	2011Q2	56.428.189,6	38	2016Q2	178.554.234
19	2011Q3	63.688.729,4	39	2016Q3	182.148.397
20	2011Q4	70.464.495,2	40	2016Q4	185.742.561

The regression model obtained in order to calculate the premium estimates for the next 3 years is given in Equation (1):

$$\hat{y}_i = 41976014,76 + 3594163,651\hat{x}_i \qquad 1$$

In this equation, x_i shows accident year and y_i shows premium estimation for accident year.

Table 4. *Under the assumption that premiums increase linearly, reserve and premium risk for the long term*

m	Reserve risk	Premium risk
1	10.142.107,4	5.349.865,9
2	11.173.312,5	12.659.707
3	11.260.977,2	18.508.724
4	11.303.321,5	23.568.074
5	11.337.932,6	28.278.033
6	11.366.402,8	32.817.198
7	11.389.061	37.273.359
8	11.407.472,1	41.695.527
9	11.422.040,7	46.114.546
10	11.433.505,5	50.550.435
11	11.442.770,6	55.016.925
12	11.450.670,7	59.524.055

If we look at the one-year forward period for the 4th quarter of 2013, which corresponds to the value of n = 28; it is seen that the reserve risk is 11.303.321.5 and the premium risk is 23.568.074. From these results, it is seen that the incurred loss amount before the 4th quarter of 2014 and expected to be paid within this period is 11.303.321,5 TL more than the estimated. It is seen that the premium risk for the same period is 23.568.074. This amount is reserve amount for the loss that will occur after the 4th quarter of 2014.

Table 5. *Under the assumption that premiums increase linearly, reserve and premium risk for the short term*

t	Reserve risk	Premium risk
0	10.142.107,44	5.349.865,89
1	4.688.344,05	9.078.568,99
2	1.402.388,50	4.496.449,61
3	977.482,09	938.545,18
4	885.233,59	262.857,55

5	803.987,78	245.007,61
6	718.051,99	266.747,90
7	647.849,22	229.625,59
8	576.708,63	235.820,39
9	511.893,52	208.075,15
10	460.382,22	161.291,31
11	425.276,88	122.545,39
12	394.181,53	120.245,99

The value of 885.233.59, which corresponds to the value of t = 4, is the claims development result obtained from the last quarter of 2014 to the next quarter. The premium risk for the same period is equal to 262.857.55. This amount is the reserve amount that should be allocated for the claims that will occur after the first quarter of 2015.

The standard error of the estimation of the reserve amount for the years before the last quarter of 2013 is 11.485.531, the standard error of the estimation of the reserve amount for the years after the last quarter of 2013 is 60.898.197, and the standard error of the estimation of the total reserve amount is 64.344.699. The standard errors of the reserve estimate for the years before and after the last accident year are divided by the reserve estimates, and 29 coefficients of variation are calculated. These coefficients are found as 7.52% for the previous years, 4.04% for the following years and 3.88% for the total reserve estimation.

Application Results Regarding the Assumption of a Non-Linear Increase in Premiums for Future Years

In this section, the analysis is made by assuming that the premiums of the next years increase non-linear.

Table 6. *Premium amounts and premium estimates for future years*

Ay i		Premium	Ay i		Premium
1	2007Q1	30.542.768,5	21	2012Q1	82.517.599
2	2007Q2	27.444.071,2	22	2012Q2	89.576.027
3	2007Q3	30.042.957,4	23	2012Q3	96.316.269
4	2007Q4	33.116.540,3	24	2012Q4	103.891.234

5	2008Q1	35.016.535,6	25	2013Q1	105.057.550
6	2008Q2	36.975.229,4	26	2013Q2	112.589.844
7	2008Q3	36.994.258,0	27	2013Q3	120.316.078
8	2008Q4	38.330.344,6	28	2013Q4	142.612.597
9	2009Q1	39.216.905,0	29	2014Q1	149.259.348
10	2009Q2	41.174.327,8	30	2014Q2	161.897.086
11	2009Q3	44.294.204,5	31	2014Q3	175.721.570
12	2009Q4	47.590.908,5	32	2014Q4	190.505.578
13	2010Q1	49.938.910,9	33	2015Q1	206.381.889
14	2010Q2	51.174.033,6	34	2015Q2	223.393.281
15	2010Q3	55.163.653,7	35	2015Q3	241.582.533
16	2010Q4	57.732.277,8	36	2015Q4	260.992.423
17	2011Q1	54.952.975,6	37	2016Q1	281.665.730
18	2011Q2	56.428.189,6	38	2016Q2	303.645.233
19	2011Q3	63.688.729,4	39	2016Q3	326.973.709
20	2011Q4	70.464.495,2	40	2016Q4	351.693.938

The regression model obtained in order to calculate the premium estimates for the next 3 years is given in Equation (2):

$$\hat{y}_i = 25799630,34 + 2271966,34\hat{x}_i - 138305,616\hat{x}_i^2 + 7129,76\hat{x}_i^3 \qquad 2$$

In this equation, x_i shows accident year and y_i shows premium estimation for accident year.

Table 7. *Under the assumption that premiums increase non-linearly, reserve and premium risk for the long term*

m	Reserve risk	Premium risk
1	10.142.107,4	5.411.068,8
2	11.173.312,5	12.944.418,6
3	11.260.977,2	19.292.032,6
4	11.303.321,5	25.125.413,9
5	11.337.932,6	30.894.599,8

6	11.366.402,8	36.798.680,9
7	11.389.061	42.950.204,1
8	11.407.472,1	49.245.212,8
9	11.422.040,7	56.283.095,6
10	11.433.505,5	63.573.649,9
11	11.442.770,6	71.341.457,3
12	11.450.670,7	79.628.440,3

The results are compared with the results in Table 7; it is seen that the reserve risk is the same and the premium risk changes. As the number of future periods increases, the premium risk is higher than the first assumption. The reason for this is that it is calculated with the assumption that the premiums for the next years increase non-linearly.

Table 8. *Under the assumption that premiums increase non-linearly, reserve and premium risk for the short term*

t	Reserve risk	Premium risk
0	10.142.107,44	5.411.068,79
1	4.688.344,05	9.180.385,12
2	1.402.388,50	4.546.825,74
3	977.482,09	949.122,90
4	885.233,59	266.002,38
5	803.987,78	247.929,39
6	718.051,99	269.865,41
7	647.849,22	232.320,34
8	576.708,63	238.556,27
9	511.893,52	210.490,14
10	460.382,22	163.186,17
11	425.276,88	122.545,39
12	394.181,53	121.679,80

The results are compared with the results in Table 8, it is seen that the reserve risk is the same. For t = 4, the premium risk is equal to 266,002.38 for the last quarter of 2014. This amount is the reserve amount that should be allocated for the claims that will occur after the first quarter of 2015. The estimation of premiums using the non-linear regression method increased the premium risk.

The standard error of the estimation of the reserve amount for the years before the last quarter of 2013 is 11.485.531, the standard error of the estimation of the reserve amount for the years after the last quarter of 2013 is 81.624.080, and the standard error of the estimation of the total reserve amount to is 85.011.114. The coefficient of variation is calculated by dividing the standard errors of the reserve estimates for the years before and after the last accident year by the reserve estimates. These coefficients are found as 7.52% for the previous years, 3.75% for the following years and 3.65% for the total reserve estimation.

Application Results for Hachemeister Regression Method

In this section, premiums calculation made with Hachemeister regression method [19].

Table 9. *Premium amounts and premium estimates for future years*

Ay i		Premium	Ay i		Premium
1	2007Q1	30.542.768,5	21	2012Q1	82.517.599
2	2007Q2	27.444.071,2	22	2012Q2	89.576.027
3	2007Q3	30.042.957,4	23	2012Q3	96.316.269
4	2007Q4	33.116.540,3	24	2012Q4	103.891.234
5	2008Q1	35.016.535,6	25	2013Q1	105.057.550
6	2008Q2	36.975.229,4	26	2013Q2	112.589.844
7	2008Q3	36.994.258,0	27	2013Q3	120.316.078
8	2008Q4	38.330.344,6	28	2013Q4	142.612.597
9	2009Q1	39.216.905,0	29	2014Q1	147.492.522
10	2009Q2	41.174.327,8	30	2014Q2	152.958.313
11	2009Q3	44.294.204,5	31	2014Q3	163.958.253
12	2009Q4	47.590.908,5	32	2014Q4	175.925.134
13	2010Q1	49.938.910,9	33	2015Q1	182.572.501
14	2010Q2	51.174.033,6	34	2015Q2	192.482.544
15	2010Q3	55.163.653,7	35	2015Q3	221.858.333

16	2010Q4	57.732.277,8	36	2015Q4	239.572.456
17	2011Q1	54.952.975,6	37	2016Q1	254.765.881
18	2011Q2	56.428.189,6	38	2016Q2	274.661.903
19	2011Q3	63.688.729,4	39	2016Q3	310.747.224
20	2011Q4	70.464.495,2	40	2016Q4	325.992.183

The regression model obtained in order to calculate the premium estimates for the next 3 years is given in Equation (3):

$$\hat{y}_i = 32548255,28 + 5086129\hat{x}_i \qquad 3$$

In this equation, x's represent accident year and y's represent premium estimation for accident year.

Table 10. *Reserve and premium risk for the long term*

m	Reserve risk	Premium risk
1	12.394.385	8.472.592
2	13.017.438	15.395.252
3	13.104.722	22.859.376
4	13.285.924	27.592.672
5	13.395.724	33.860.263
6	13.495.672	39.638.918
7	13.553.824	45.839.592
8	13.649.245	49.245.213
9	13.668.439	60.372.962
10	13.702.851	66.349.286
11	13.739.424	73.017.515
12	13.957.328	82.461.273

The results are compared with the results in Table 10; it is seen that the reserve risk and the premium risk changes. As the number of future periods increases, the premium risk is higher than the first two assumptions. In the calculations made with the last assumption, the premium risk increased more than the reserve risk.

Table 11. *Reserve and premium risk for the short term*

t	Reserve risk	Premium risk
0	11.573.204	7.149.554
1	5.122.852	11.893.373
2	1.683.148	6.018.415
3	1.127.525	1.724.626
4	990.467	547.214
5	923.145	491.472
6	834.674	508.142
7	778.251	470.174
8	619.414	488.261
9	553.865	466.289
10	502.186	211.485
11	490.571	221.573
12	449.621	218.372

The results are compared with the results in Table 11, it is seen that the reserve risk and premium risk is increased. For t = 4, the premium risk is equal to 547.214 for the last quarter of 2014. In the calculations made with the last assumption, the premium risk increased more than the reserve risk.

The standard error of the estimation of the reserve amount for the years before the last quarter of 2013 is 20.112.764, the standard error of the estimation of the reserve amount for the years after the last quarter of 2013 is 99.124.062, and the standard error of the estimation of the total reserve amount is 100.352.621. The coefficients of variation are calculated by dividing the standard errors of the reserve estimates for the years before and after the last accident year by the reserve estimates. These coefficients are found to be 9.02% for the previous years, 4.14% for the following years and 3.97% for the total reserve estimation.

DISCUSSION

In this study, reserve risk and premium risk has been obtained. Thus, uncertainties in the estimation of the multi-year claims development result have been revealed. In addition, the correlation values between these two risks calculated. The estimators of premiums are calculated by using linear, non-linear regression methods and Hachemeiter regression model. In conclusion, the reserve risk and premium risk are increased. In order to predict the reserve risk and premium risk, the additive loss reserve method has been used.

In recent years, especially with Solvency II, there has also been an interest in estimating potential losses due to differences in reserve estimates with actual values. The reserve risk in Solvency II means that the reserves are insufficient as a result of companies making wrong estimations while determining their technical provisions. In addition, obtaining claims development results within the scope of Solvency II has an important place in the balance sheet of companies. In this case, loss reserve calculations, determination of reserve and premium risk, and uncertainty in the claims development results have become a priority problem for insurance companies. In this study, the uncertainties in claims development results are examined and the volatility of the company's reserve amounts is obtained.

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