ATLANTIS PRESS
Advances in Economics, Business and Management Research, volume 72
12th International Conference on Business and Management Research (ICBMR 2018)

Implementation of a Quantile Regression Model for the Loss Reserve of Vehicle Insurance Company XYZ

Ariandy Dena Putra
Universitas Indonesia
Jakarta, Indonesia
ariandydp@gmail.com

Bona C. Siahaan
Universitas Indonesia
Jakarta, Indonesia

***Abstract*—The issue of claim reserves on insurance companies is one that insurance businesses need to cope with. The availability of such reserves within a company is fundamental for them to maintain their business activities. They are also required in precise calculations regarding the allocation of funds owned by the company based on the sale of products issued, in order to generate profits. Based on the limitations of the traditional models, this paper intends to introduce an alternative model for estimating claim reserves, called the quantile regression model. According to Chan (2015), the quantile regression model is considered to have the ability to calculate claim reserves against data with heterogeneous variance and with no clear distribution, which is mostly insurance data known for. The main purpose of the research is to attempt to calculate an estimation for claim reserves by adopting the quantile regression model, and to observe whether the model can be applied to the context of the XYZ insurance company in Indonesia. The data used in the research are the claims data of XYZ company for motor vehicle insurance products from 2013 to 2015.**

***Index Terms*—Claim reserve; Vehicle insurance; Quantile regression; Claim model**

I. Introduction

Indonesia has one of the largest market shares in Southeast Asia in the automotive industry. The nature of the Indonesian territory and the inadequate availability of public transportation means that the need for private vehicles is very high. Based on bps.go.id statistical data for 2011 - 2015, the number of passenger vehicles increased by 41.17% from 2011 to 2015 and motorcycle vehicles by 43.64% in the same period. This means that the increase in the number of vehicles in this five year period was almost 50%. From these statistical data. it can be concluded that the needs and purchasing power of Indonesian people for motorized vehicles between 2011 and 2015 were very high.

The growth of motorized vehicles can be viewed from two sides, the positive and negative. The positive side of this situation is that an increasing number of motorized vehicles can be seen as an increase in the purchasing power of Indonesian people for consumption goods and their living needs. However, the negative side is that the increase has not been offset by the construction of facilities and infrastructure related to motorized vehicle transportation, especially in the context of cars and motorbikes. These unbalanced conditions have had an impact on society, one of which is accidents, in this case accidents related to motorized vehicles, not other accidents such as workplace accidents or construction accidents.

With regard to motor vehicle accidents, of course they entail a new risk to life in Indonesia. The emergence of this new risk can also be seen from positive and negative sides. The negative side is that it is very clear that Indonesian people need it prepare themselves, both financially and mentally, to address this new risk. However, the positive side of the emergence of this new risk is that it has a positive impact on the insurance industry in Indonesia.

Insurance is one of the available options for minimizing risk that people have. According to Zweifel and Eisen [1], insurance is sometimes referred to as ”business uncertainty”. The insurance business can only prosper when its risks and uncertainty of profit are reduced by providing products and services which can bear the risk of such uncertainty. In the Indonesian context, according to Law No. 2 [2] concerning insurance business, the definition of insurance is an agreement between two or more parties, whereby the insurer binds itself to the insured, by receiving an insurance premium, and provides compensation to the insured in the case of loss, damage or loss of expected profit, or third party legal liability of the insured, arising from an uncertain event, or by making a payment based on the death or life of an insured person.

The increasing number of claims is certainly an important issue to be considered by insurance companies. Zweifel and Eisen [1] explain that in the context of actuarial management, the need to take into account the risks of an insurance company with regard to the products issued with the assumption of a claim on the product by the insurance policy holder. The issue of insurance claims is clearly related to the context of reserve funds to pay for the claims submitted. Wirawan [3] explains that the problem regarding claim provision faced by insurance companies is one of the issues that must be tackled by them. The availability of claim reserves within companies is fundamental for them to be able to maintain the continuity of their business. This claim backup also requires detailed calculations regarding the allocation of funds owned by the

company based on product sales receipts issued, in order for them to make a profit.

The calculation of claim estimates is generally still used in traditional models, including the Linear Regression Model (LRM) and Generalized Linear Model (GLM). LRM is defined by Neter [4] as an analysis tool that can be used when the linear relationship between the response variable and the explanatory variables. GLM is defined by Jong and Heller [8] as an advanced concept of LRM, which describes the relationship between nonlinear variables. This is because in general insurance data there is often a non-linear relationship between variables. According to Chan [5], the traditional LRM and GLM models only focus on the average distribution of losses in estimations, so the calculation is considered less accurate if there are types of data that have inhomogeneous variance or extreme values.

Based on the limitations of previous models, this paper introduces another calculation model, namely the quantile regression model. This model is considered to have several advantages over the traditional ones in estimating claim backup. According to Chan [5], the quantile regression model has the ability to calculate claim reserves against data that have homogeneous variance and do not have a clear distribution. An example of homogeneous variance is the value of extreme claims, especially extreme values in the context of insurance business problems. This extreme claim value phenomenon creates heterogeneous variance in the data, caused by different risk factors in the claim problem. These diverse risk factors are the cause of the emergence of extreme claim values and also create heterogeneous variance in the data. So, when used with XYZ motor vehicle insurance claim data, which have a high level of heterogeneity in their variance, the model is very supportive and able to provide a more precise estimation calculation.

Researchers have attempted to apply the quantile regression model to the context of insurance in Indonesia in order to observe whether it can be used . The variables used in this study are ones related to motor insurance claims, namely the period of occurrence, the development period, and the value of claim payments. The run-off triangle-based method is used to estimate the reserve claim of motor vehicle insurance company XYZ by applying the quantile regression calculation model.

II. Literature Review

The definition of insurance according to Law of the Republic of Indonesia number 2 [2] concerning insurance is an agreement between two or more parties, whereby the insurer binds itself to the insured, by accepting insurance premiums, and provides compensation to the insured in the case of loss, damage or loss of expected profit, or legal liability to third parties that may suffer loss or injury by the insured, arising from an uncertain event, or making a payment based on the death or life of an insured person. General insurance business according to the same law is a risk coverage service business that provides reimbursement to the insured or policyholder in the case of loss, damage, costs incurred, loss of profits, or legal liability to third parties, which may be experienced by the insured or policyholder because of an uncertain event. The definition of motor vehicle insurance given by the Insurance Information Institute [6] is an act of protection against financial losses from accidents. It is a contract between the policyholder and the insurance company in which the policyholder agrees to pay a premium and the insurance company reimburses any loss as agreed in the insurance contract.

Claim backup is necessary for insurance companies to be able to run their insurance business properly and correctly. Insurance companies require a claim to be made in order to be able to make payments when the claim is filed by the insured or the policyholder. Claims have a big influence on the health condition of insurance companies. The accuracy of the insurance company in calculating claim reserve estimates can provide positive value to their business, including determination of the appropriate premium product number. On the other hand, errors in determining the estimated claim reserves can cause losses for companies, regulators and investors. Such losses can take the form of ones in the company's financial statements, or its inability to pay claims to the insured, which will form a bad image in the community of the company. The Financial Services Authority [7] explains that the financial health of insurance and reinsurance companies is determined by several factors, one of which is technical reserves. Technical reserves are calculated as company liabilities and consist of several components, one of which is claim reserves. To calculate the amount of claim reserves that are prepared, the minimum is calculated equivalent to the sum of the estimated value of the claims that are in the process of completion (RBNS / Reported But Not Settled) and the estimated value of claims that have been made but have yet to be reported (IBNR / Incurred But Not Reported)

Analysis of claim reserves can be made by various statistical analysis methods. This paper only discusses two methods, namely general methods and alternative methods in analyzing claims. The general method used in analyzing claim reserves consists of several major methods, such as the GLM (Generalized Linear Model) popularized by Jong and Heller [8], and the Chain-ladder of England and Verrall [9].

III. Research Methodology

The data used in the study are motor vehicle insurance claims for PT relating to the XYZ general insurance period of 2013 - 2015. The data refers to the overall data of claims recorded by XYZ insurance companies and are aggregated, nor are they separated between two-wheeled vehicles or those with four wheels or more. Determination of the data sample is made by the sampling method with the following criteria: (1) the research data used are XYZ company motor vehicle insurance claim data, and (2) the data are motor vehicle insurance claim data for the period 2013 to 2015.

The data were then grouped into a monthly period form. This is done because in the context of the motor vehicle insurance business line is a business line with a short time

TABLE I
ESTIMATES OF THE 2013 RUN-OFF TRIANGLE FOR THE QUADRATIC AND CUBIC MODELS (τ = .75)

Periode	1	2	3	4	5	6	7	8	9	10	11	12
1	10806000	29062000	42016500	32582530	38647518	6201875	34960000	4978000	6215300	2765000	1794300	3285000
2	3886250	59754017	60275200	19128000	12562500	14800000	3865000	4265700	2974000	2344600	1328900	**848552**
3	13982000	82075600	38123000	11098100	1587500	2734000	5820300	7543000	2645300	1910000	**1472293**	**884422**
4	13204000	66790500	67433915	20580000	24286400	1639000	6742000	2932100	3960000	**2607135**	**1600061**	**961174**
5	2729400	87374400	85786850	12802200	8975400	38416900	2100000	3375850	**4082928**	**2560074**	**1571179**	**943824**
6	16519150	78917790	17672850	28691145	13790000	31010301	1960000	**5990080**	**3837261**	**2406036**	**1476642**	**887035**
7	37581500	58635000	30370950	57167850	6021000	19175000	**11873659**	**7771074**	**4978170**	**3121409**	**1915683**	**1150771**
8	1601000	65804300	32927975	23887000	9929997	**16472595**	**11014539**	**7208797**	**4617974**	**2895559**	**1777074**	**1067507**
9	10382000	98757500	35981200	76247000	**30429214**	**20787527**	**13899754**	**9097113**	**5827634**	**3654039**	**2242571**	**1347136**
10	5025000	46004700	24013500	**38212160**	**26669906**	**18219379**	**12182540**	**7973231**	**5107672**	**3202609**	**1965518**	**1180707**
11	7953950	97083100	**62851887**	**44817333**	**31279939**	**21368694**	**14288356**	**9351446**	**5990560**	**3756197**	**2305268**	**1384799**
12	25127600	**73941179**	**53866884**	**38410463**	**26808310**	**18313929**	**12245762**	**8014608**	**5134179**	**3219229**	**1975718**	**1186835**

Note: data is in quadratic model.

Periode	1	2	3	4	5	6	7	8	9	10	11	12
1	10806000	29062000	42016500	32582530	38647518	6201875	34960000	4978000	6215300	2765000	1794300	3285000
2	3886250	59754017	60275200	19128000	12562500	14800000	3865000	4265700	2974000	2344600	1328900	**3205926**
3	13982000	82075600	38123000	11098100	1587500	2734000	5820300	7543000	2645300	1910000	**2347261**	**3305499**
4	13204000	66790500	67433915	20580000	24286400	1639000	6742000	2932100	3960000	**2414211**	**2344053**	**3300981**
5	2729400	87374400	85786850	12802200	8975400	38416900	2100000	3375850	**3185157**	**2324982**	**2257417**	**3178977**
6	16519150	78917790	17672850	28691145	13790000	31010301	1960000	**5557065**	**3325144**	**2427164**	**2356630**	**3318692**
7	37581500	58635000	30370950	57167850	6021000	19175000	**10596257**	**5667267**	**3391085**	**2475298**	**2403365**	**3384506**
8	1601000	65804300	32927975	23887000	9929997	**18851795**	**9826751**	**5255707**	**3144823**	**2295540**	**2228831**	**3138721**
9	10382000	98757500	35981200	76247000	**35585679**	**19712802**	**10275562**	**5495748**	**3288454**	**2400383**	**2330627**	**3282074**
10	5025000	46004700	24013500	**54485102**	**34974104**	**19374018**	**10098967**	**5401298**	**3231939**	**2359130**	**2290573**	**3225668**
11	7953950	97083100	**67920058**	**55086154**	**35359920**	**19587743**	**10210373**	**5460882**	**3267592**	**2385155**	**2315841**	**3261252**
12	25127600	**62478796**	**69812386**	**56620915**	**36345087**	**20133479**	**10494846**	**5613029**	**3358631**	**2451608**	**2380363**	**3352114**

Note: data is in quadratic model.

period, with the waiting time between the occurrence of claims and their settlement being short, generally less than one year [10], [11].

The steps taken in the research were arranged in five stages. The first stage was to collect the relevant data needed for the research. These required data were PT. XYZ insurance company data, which consisted of the reported claim event variable, the claim settlement period variable after being reported, the claim frequency variable, and the variable amount of payment from the claim that was reported. After obtaining the data needed, the next step was to compile them into a run-off triangle. To estimate claims and losses for claims in the future requires data in the form of such a triangle. In this case, the form of the run-off triangle matrix of the data used is in the row part of the data, which gives the month of the accident (the month of occurrence), while the column part of the data states the month that the claim was made/reported (reporting month).

The following step was to estimate the claim reserves by using the quantile regression model, based on the previously processed run-off triangle data. After estimating the claim reserves, the estimated allowance for losses was calculated based on the estimated claims obtained. Therefore, in the final stage of the study, a comparison between the estimation of the loss reserve and the company's original data can be made to establish the accuracy of the quantile regression model.

IV. RESULT

This section gives the results of the run-off triangle estimation for 2013 using the quantile parameters that were determined for both the quadratic and cubic models, namely τ = .75. The estimation results for the run-off triangle for 2013 are shown in Table 1.

The results in Table 1 were obtained based on calculations with the loss function used for 2013. For example, in the quadratic table values $y_{12,2}$, namely claims for the December 2013 period, but only reported in January 2014 (with waiting time j=2), were obtained by the following equation:

$$\begin{aligned} Q_{75}(lny_{ij}|z_{ij}) =& 16.74319 + (-0.263174 * 2) + \\ & (-0.010716 * 2^2) + (0.1141351 * \\ & 25,127,600) \end{aligned} \tag{1}$$

The result of the calculation is the value that is used as a filler in the December period (row 12), with the waiting time j=2 (column 2), with a value of IDR 73,941,179. Next, examples in the cubic table for values $y_{12,2}$, namely claims for the December 2013 period but only reported in January 2014

TABLE II
ESTIMATED VALUE OF 2013 RESERVES AND TOTAL ACTUAL CLAIM VALUE FOR 2014

Model Kuadratik		Model Kubik		Klaim Aktual	
Periode	Nilai Klaim	Periode	Nilai Klaim	Periode	Nilai Klaim
2	848,552.44	2	3,205,925.95	2	-
3	2,356,715.63	3	5,652,759.52	3	675,000.00
4	5,168,369.77	4	8,059,244.26	4	1,812,500.00
5	9,158,004.59	5	10,946,531.43	5	-
6	14,597,053.22	6	16,984,696.14	6	54,799,833.00
7	30,810,766.23	7	27,917,777.49	7	4,773,000.00
8	45,054,045.23	8	44,742,168.28	8	758,600,000.00
9	87,284,989.59	9	82,371,328.33	9	16,601,000.00
10	114,713,722.45	10	135,440,798.14	10	60,471,050.00
11	197,394,478.02	11	204,854,969.98	11	180,832,085.00
12	243,117,095.33	12	273,041,252.45	12	205,787,625.00
Total	750,503,792.51	Total	813,217,451.97	Total	1,284,352,093.00

(with waiting time $j = 2$), were obtained by the following equation:

$$Q_{75}(lny_{ij}|z_{ij}) = 16.01393 + (1.286994 * 2) + (-0.2900048 * 2^2) + (0.0144218 * 2^3) + (0.0238895 * 25,127,600) \quad (2)$$

The result of the calculation is the value that is used as a filler in the December period (row 12) with the waiting time $j = 2$ (column 2), with a value of IDR 64,478,796.

Furthermore, from the results of the calculation of the lower run-off triangle estimation, the total estimate of motor vehicle insurance claim provision relating to claims in 2013 but only reported and paid in 2014 can be calculated. The results of the calculation of total claim reserves for 2013 and the total actual claim value in 2014 are shown in Table 2.

It can be seen that the total estimate of motor vehicle insurance fund reserves required to pay claims from 2013 but only reported in 2014, using estimates τ=.75 for both models, is IDR 750,503,792 for the quadratic models and IDR 813,217,451 for cubic models. The total value was obtained based on the sum of the values in each reserve period, starting from period 2 to period 12, namely February to December.

Furthermore, these results illustrate the values of actual claims that occurred in each time period in 2014, and for each 2013 claim that was recently issued and paid. This result also gives the total value of the accumulation of new claims reported in 2013 and paid in 2014. In the actual data table for 2014, for period 2 (February) and period 5 (May) no claims were paid. It can be seen that in 2014 total claims that were made amounted to IDR 1,284,352,093.

Based on the MAPE calculation from the actual data and estimated data from 2013, for the quadratic model the value is 41.57%, and for the cubic model it is 37%.

V. DISCUSSION

The results of the calculation of the estimated motor vehicle insurance claims for XYZ insurance company in 2014, 2015, and 2016 can be analyzed managerially in relation to actions taken when using the estimation model of quantile regression. If XYZ wants to make a claim using this quantile regression model, it is necessary to pay attention to the value of the losses that can be experienced due to an error value in the calculation of the claim reserve estimate. Possible losses experienced by the company can weaken its financial performance if they occur in accordance with the estimates obtained. However, to minimize possible losses faced by using the quantile regression model, several steps can be taken.

With regard to the first action, for the estimated value of claims obtained by the model, it is recommended that they be allocated to types of investment options that have short-term liquidity without large returns, such as deposits or money market mutual fund units. This is done to avoid if the need for claim payments comes, the insurer can withdraw the investment funds and transfer them to the required claim payment fund. However, if there is no need to pay claims, then the company will still obtain returns on their investment in the claim reserve. This minimizes company losses by continuing to invest in reserve claim funds for the types of investments that have short-term liquidity without high returns.

The second step that can be taken by the insurance company is to make adjustments to the estimated value of the claim reserves obtained from the quantile regression model, with historical data of the company's claims. This is useful for making adjustments to the feasibility of claim recovery obtained from estimates from the model. If adjustments have been made, they are expected to minimize the value of losses faced by the insurance company from the provision of claims made.

VI. CONCLUSION

The quantile regression model in the study is quite appropriate for use as an estimate of claim reserves for XYZ insurance companies, with a quadratic model for 2014, and cubic models for 2013 and 2015, based on the estimation results and the actual value of the reserve being fairly close. So that the calculation of estimations using the quantile regression model

can be used as an alternative model for claims by insurance companies, especially XYZ for 2013, 2014 and 2015 data.

The quantile regression model has the ability to estimate sufficiently good claims with the MAPE for 2013, 2014, and 2015, respectively at 37%, 28.53%, and 36.74%. The MAPE obtained for 2013 and 2015 is the result of the calculation with the cubic model, while for 2014 it is the result of calculations with the quadratic model. This illustrates that the estimated percentage error in claim value from the actual value of the company's claims is as much as the MAPE obtained.

REFERENCES

[1] P. Zweifel and R. Eisen, *Insurance Economics*. New York: Springer Science+Business Media, 2012.
[2] Otoritas Jasa Keuangan, *Peraturan Otoritas Jasa Keuangan No.2*. Jakarta: Otoritas Jasa Keuangan, 2014.
[3] W. Wirawan, Implementasi Metode Generalized Estimating Equations Dalam Mengestimasi Cadangan Klaim Pada Asuransi Kendaraan Bermotor di Indonesia (Studi Kasus: PT XYZ), Jakarta, 2017.
[4] J. Neter, *Applied Linear Regression*, 3rd ed. Chicago: Irwin McGraw Hill, 1996.
[5] J. S. Chan, "Predicting loss reserves using quantile regression Running title: Quantile regression loss reserve models," Journal of Data Science, vol. 13, pp. 127–156.
[6] Insurance Information Institute, *Insurance Handbook: A guide to insurance: what it does and how it works*. New York: Insurance Information Institute, 2010.
[7] Otoritas Jasa Keuangan, *Peraturan Otoritas Jasa Keuangan Tentang Kesehatan Keuangan Perusahaan Asuransi dan Perusahaan Reasuransi*. Jakarta: Otoritas Jasa Keuangan, 2016.
[8] P. Jong and G. Heller, *Generalized Linear Models for Insurance Data*. New York: Cambridge University Press, 2008.
[9] P. D. England and R. J. Verrall, *Stochastic Claims Reserving in General Insurance*, Institute of Actuaries, 2002.
[10] M. Olofsson, Stochastic loss reserving testing the new guidelines from the Australian Prudential Regulation Authority (APRA) on Swedish portfolio data using a bootstrap simulation and the distribution-free method by Thomas Mack, 2006.
[11] J. Friedland, *Estimating Unpaid Claims Using Basic Techniques*, Casualty Actuarial Society, 2010.
[12] Badan Pengawas Pasar Modal dan Lembaga Keuangan, *Pedoman Pembentukan Cadangan Teknis Bagi Perusahaan Asuransi dan Perusahaan Reasuransi*. Jakarta: Badan Pengawas Pasar Modal, 2012.
[13] D. C. Dickson, M. R. Hardy, and H. R. Waters, *Actuarial Mathematics for Life Contingent Risks*, 2nd ed. New York: Cambridge University Press, 2014.
[14] H. U. Gerber, *Life Insurance Mathematics*, 3rd ed, Swiss Association of Actuaries Zurich, 1997.
[15] A. Himawan, Bisnis Keuangan: Hingga September, Ada 145 Perusahaan Asuransi di Indonesia, 2016. Retrieved from Suara.com: http://www.suara.com/bisnis/2016/12/08/062530/hingga-september-ada-145-perusahaan-asuransi-di-indonesia.
[16] Investopedia, n.d. Retrieved date needed here from http://www.investopedia.com/terms/a/actuary.asp.
[17] Y. W. Jati, Bisnis & Financial, 2016. Retrieved from Bisnis Indonesia: http://finansial.bisnis.com/read/20161010/215/591162/kuartal-ii2016-industri-asuransi-jiwa-raup-pertumbuhan-428.
[18] S. Kim and H. Kim, "A New Metric od Absolute Percentage Error for Intermittent Demand Forecast," International Journal of Forecasting, 2016.
[19] R. Koenker, *Quantile Regression*. New York: Cambridge University Press, 2005.
[20] R. Koenker and G. Bassett, "Goodness of Fit and Related Inference Processes for Quantile Regression," Journal of the American Statistical Association, vol. XCIV, pp. 1296–1310, 1999.
[21] E. Lehmann and G. Casella, *Theory of Point Estimation*, 2nd ed. New York: Springer-Verlag New York, 1998.
[22] H. Madsen and P. Thyregod, Introduction to General and Generalized Linear Models, Taylor & Francis Group, LLC, 2010.
[23] R. Norberg, "A Contribution to Modelling of IBNR Claims", Scand, Actuarial Journal, pp. 155–203, 1986.
[24] R. M. O'Brien, *Age-Period-Cohort Models: Approaches and Analyses with Aggregate Data*, Boca Raton: CRC Press, 2015.
[25] Otoritas Jasa Keuangan, *Surat Edaran Otoritas Jasa Keuangan Nomor 21/SEOJK.05/2015 tentang Penetapan Tarif Premi atau Kontribusi pada Lini Usaha Asuransi Harta Benda dan Asuransi Kendaraan Bermotor*. Jakarta: Otoritas Jasa Keuangan, 2015.
[26] Otoritas Jasa Keuangan, *Statistik Perasuransian*. Jakarta: Otoritas Jasa Keuangan, 2015.
[27] Otoritas Jasa Keuangan, Publikasi: Daftar Perusahaan Asuransi Umum, Jiwa, Reasuransi, Asuransi Wajib dan Asuransi Sosial, 2016. Retrieved from http://www.ojk.go.id/id/kanal/iknb/berita-dan-kegiatan/publikasi/Pages/Daftar-Perusahaan-Asuransi-Umum,-Jiwa,-Reasuransi,-Asuransi-Wajib-Dan-Asuransi-Sosial.aspx.
[28] Persatuan Aktuaris Indonesia, *Petunjuk Teknis 2: Penetapan Tarif (Pricing) Produk Asuransi Jiwa dan Pendokumentasiannya*. Jakarta: Komisi Standar Praktek - PAI, 2010.
[29] M. Rouaud, Probability, Statistics and Estimation, Creative Commons Attribution 2.5, 2017.
[30] G. Seber and C. Wild, *Nonlinear Regression*. New Jersey: John Wiley & Sons, 2003.
[31] G. Taylor and G. McGuire, Loss Reserving: Past, Present and Future, Casualty Actuarial Society, 2003.
[32] D. N. Trisnawati, I. N. Widana, and K. Jayanegara, "Analisis komponen biaya asuransi jiwa dwiguna (endowment)," Jurnal Matematika, vol. 4, pp. 12–21, 2014.
[33] Undang Undang Republik Indonesia Nomor 28, Pajak Daerah Dan Retribusi Daerah, 2009.
[34] Undang-Undang Republik Indonesia, Undang-Undang Republik Indonesia Nomor 40, 2014.
[35] M. V. W'uthrich and M. Merz, *Stochastic Claims Reserving Methods in Insurance*. Chichester: John Wiley & Sons Ltd, 2008.