Analysis of Premium Reserve Using Zillmer Method and Canadian Method for Endowment Joint Life Insurance

Yuhza Al Ghifari[1*], Fauziah Nur Fahirah Sudding[2]

[1,2] *Study Program of Actuarial Science, School of Business, President University, Cikarang, 17550, Indonesia*

[*]*Corresponding author: yuhza.alghifari@gmail.com*

Abstract— Several life insurance companies are unable to compensate policyholder prompting financial losses, the situation can be foreseen if the insurance company has a properly established and calculated reserve value. Endowment life insurance is one types of life insurance. Life insurance provides protection for one person (single life) or two or more people (multiple life). According to the insured death status, there are two terminologies used in multiple life insurance: joint life and last survivor. The Zillmer Method and Canadian Method used in this study for 3 age cases for a couple of husband and wife whereas a husband is older than wife, a husband has the same age as wife, and a husband is younger than wife to determine the amount of reserves adjusted for endowment joint life insurance. Researchers first determine the benefits, then calculate the annuity, and finally calculate the annual premium in order to compute reserves. The Zillmer Method premium reserve value is minus in the beginning year to cover cost for the company, meanwhile Canadian Method is not. According to the result of this study, the case that the age of wife is same as the husband have lesser reserve than any cases which represent this is beneficial for the company to cover several costs for the policy in the beginning of period. Based on data analysis, the period of the insurance contract and the age of the insured define the reserve value. The older the insurance participant, the lesser the value of reserve.

Keywords— *Canadian Method; Zillmer Method; Endowment Life Insurance; Joint Life Insurance; Life Insurance*

I. INTRODUCTION

Life Insurance is an insurance service that is used as a form of protection provided by the insurer against risks to the life of the insured party arising from an unpredictable event such as death, accident, or loss of ability to earn income [1]. To anticipate the possibility of financial losses that may arise due to unexpected events in the future, a person usually joins an insurance program, so that the loss suffered by that person is reduced with a guarantee from the insurance company. Insurance companies are one solution that help the community in dealing with risks that occur in the future.

Life insurance is divided into five types, namely Term Life Insurance, Whole Life Insurance, Unit Link Insurance, Pure Endowment Life Insurance, and Endowment Life Insurance. Based on the number of lives covered, life insurance is divided into two types, namely single life insurance and multiple life insurance. The distinction between the two types of insurance lies in the number of lives covered, single life insurance provides protection to only one person and multiple life insurance provides coverage to more than one person. Multiple life insurance is divided into two types, the first is joint life insurance which provide benefits to the insured if one of the insured dies, while in last survivor life insurance, the insurer provide benefits to the insured when all the insured dies [1].

The insurance company has an important role in calculate the premium reserve which is company obligations to prepare funds to meet payments insurance customer benefits. Premium reserve is very important for insurance companies because premium reserve is used to pay the compensation to be returned to the insured or also used if claims occur [2]. Premium reserve calculation is divided into two, namely retrospective and prospective. Retrospective method is the calculation of premium reserve value using the total amount of income in the past. Prospective method is the calculation of premium reserves using the present worth of all potential future revenue [1].

Several studies have been carried out to determine the premium reserve. The value of Zillmer reserves is affected by the interest rate and mortality table used. The amount of reserve value prospectively until the *n*-th payment period be the same amount of compensation used [3]. The premium reserve calculation using the Canadian method on endowment joint life insurance is more effective than using the Commissioners method, because less reserves are produced, which increases company benefits. [4]. The Zillmer method effectives to all types of insurance and Canadian method effectives only to endowment insurance, because the reserves produced is lesser and make the company benefit higher [5]. The premium reserve value of the Full Preliminary Term

method is cheaper than the premium reserve value of the Premium Sufficiency method [6]. The monthly premium cost higher than annually premium [7]. The Canadian method is very useful in creating table joint life insurance reserves, because calculation of reserve value using Canadian method is good in covering underpaid in the first years [8].

Based on the mentioned methods, this study compares premium reserves using the Zillmer method and the Canadian method on endowment joint life insurance.

II. METHOD

This research is a theoretical research by analyzing relevant theories to the problems discussed based on literature review. The steps taken in this study are as follows:
1. Forming a joint life proablitiy of two insured.
2. Establish a joint life annuity formula.
3. Calculate the actual present value of endowment joint life insurance.
4. Forming a combined annual net premium formula of joint life insurance.
5. Establish a premium resrve formula for endowment joint life insurance using the Canadian method and Zillmer method.

III. RESULT AND DISCUSSION

A. Joint Life Insurance

Joint life insurance is insurance who bears two lives or more where compensation paid if one of the insured dies [9]. Calculation of life annuities and life insurance together analogous to the single life condition. If there are two people who participate in joint life insurance who x years old and y years old assuming both live for k years are independent. Cash value of an early life term joint life annuity for a person aged x year and y year formulated as follows:

$$\ddot{a}_{xy:\overline{n|}} = \sum_{k=0}^{n-1} v^k \, {}_kp_{xy} = \frac{N_{xy}-N_{x+n,y+n}}{D_{xy}} \tag{1}$$

The actuarial present value of the benefit is one unit on endowment insurance with payable if the two insurance participant is still alive until the insurance contract expires formulated as follows:

$$A_{xy:\overline{n|}} = \sum_{0}^{n-1} v^{k+1} \cdot {}_kp_{xy} \cdot q_{x+k,y+k} + v^n \cdot {}_np_{xy}$$
$$A_{xy:\overline{n|}} = \frac{M_{xy}-M_{x+n,y+n}+D_{x+n,y+n}}{D_{xy}} \tag{2}$$

Premium annual endowment insurance for x and y year-old policyholders who paid at the beginning of the year notated with and formulated as (Bowers):

$$P_{xy:\overline{n|}} = \frac{A_{xy:\overline{n|}}}{\ddot{a}_{xy:\overline{n|}}} = \frac{M_{xy}-M_{x+n,y+n}+D_{x+n,y+n}}{N_{xy}-N_{x+n,y+n}} \tag{3}$$

B. Zillmer Method

This method was discovered by Dr. August Zillmer (1831-1893) and generally used in Europe is also followed in Indonesia. This is because, in addition to historical factors, insurance companies in Indonesia are generally still weak because businesses are still young and growing. The Zillmer method involves gross premiums, net premiums and various costs.

The flat net premium is expressed by P and the gross premium is expressed by P''. There are many $j\%$ of the gross premium so that the relationship is: $P'' = P+jP'', j$ in %. So that:

$$P'' = \frac{1}{1-j}.P. \tag{4}$$

and f represent the difference between the initial cost and the follow-up cost including the cost of compensation with the value:

$$f = (P'' - jP'' - b)a_x - Pa_x \tag{5}$$

The formula of Zillmer method for joint life as follows:

$$_kV^z{}_{xy:\overline{n|}} = A_{xy+k:\overline{n-k|}} - P_{xy:\overline{n|}}. \; \ddot{a}_{xy+k:\overline{n-k|}} - f\frac{\ddot{a}_{xy+k:\overline{n-k|}}}{\ddot{a}_{xy:\overline{n|}}} \tag{6}$$

C. Canadian Method

Canadian method is a method that uses the net premium as the basis for calculating reserves by equilibrating the net premium and the initial modified premium of the Canadian method with the difference between a life insurance policy net premium and the pure premium. $P_{x:\overline{n|}}$ declares n-term insurance with the same amount of compensation then this method determines that:

$$P_{x:\overline{n|}} - \alpha^C = P_x - \frac{C_x}{D_x} \tag{7}$$

Canadian reserves are the same as flat net premium reserves. Therefore written:

$$\alpha^C + \beta^C . a_{x:\overline{n-1|}} = P . a_{x:\overline{n|}}$$

or

$$\beta^C = \frac{P.a_{x:\overline{n|}} - \alpha^C}{a_{x:\overline{n-1|}}} \tag{8}$$

The formula of Canadian method for two people insured be:

$$_kV^C = A_{\overline{x+n,y+n|}} - \beta^C . \ddot{a}_{\overline{x+n,y+n|}} \tag{9}$$

D. Case Illustration

This research determine premium reserves on joint life endowment insurance with Zillmer method and Canadian method. The case are made into 3 cases, a husband and wife are a man aged 30 years with a woman 25 years old, a husband aged 30 years with a wife 30 years old, and a husband aged 25 years with a wife 30 years old decided to sign up for insurance along with a coverage period of 25 years. Premium paid at the beginning of the year as long as the insured is still life and the amount of compensation that received by the heirs when the husband or wife dies is Rp.500,000,000 (Based on Allianz PASTI Brochure). The insurance company calculate the amount of reserves joint insurance premium followed by a husband and wife using the Zillmer and Canadian method. Table mortality used in the calculation is Indonesian Mortality Table 2019 with interest based on BI-Rate on October 2022 that is $i = 4.75\%$.

The calculation of premium reserves for policyholders aged 30 with 25 years, 30 years with 30 years, and 25 years with 30 years in year 0 with a term of 25 years using the Prospective, Zillmer, and Canadian method, is Rp. 0, Rp. -7,078,568.47, and Rp. 9,540,130.38 for age 30 with 25 years, Rp. 0, Rp. -7,050,039.7, and Rp. 9,393,611.91 for age 30 with 30 years, Rp. 0, Rp. -7,118,736.59, and Rp. 9,612,953.86 for age 25 with 30 years. Zillmer method has minus amount on the year 0 to cover company costs in the beginning year. Zillmer method has lesser amount than Canadian method because Zillmer method consider the cost for the company. In spite of both method have a big gap amount of reserve in the beginning year, in the following years the amount of reserve improve and would indeed have the same amount as benefit in the end of period. Shown in Figure. 1, 2, and 3 that is the value of premium reserve for 3 cases below:
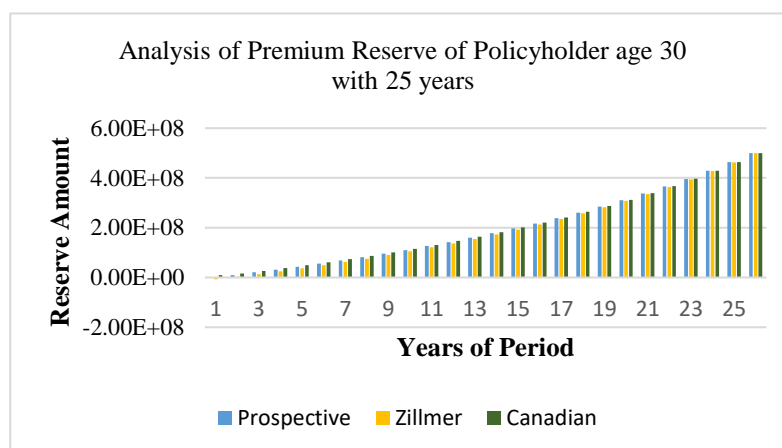

Figure. 1 Analysis of Premium Reserve Policyholders age 30 with 25 years old
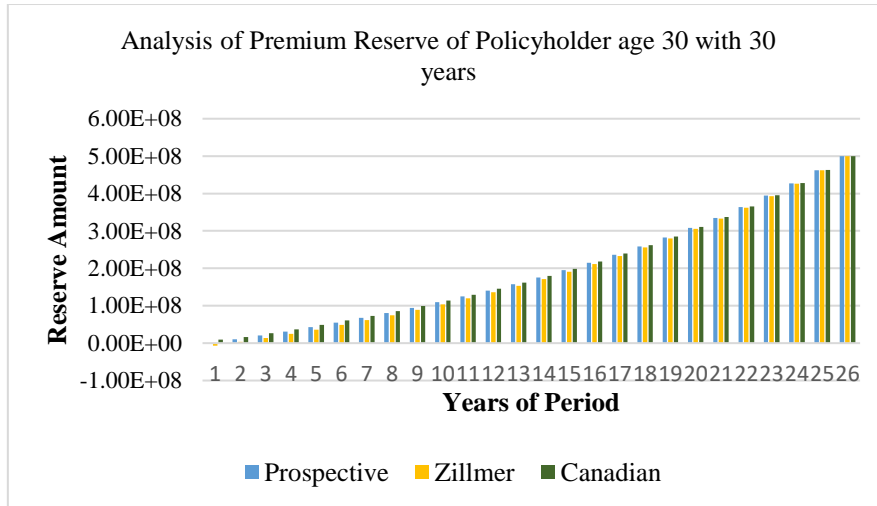
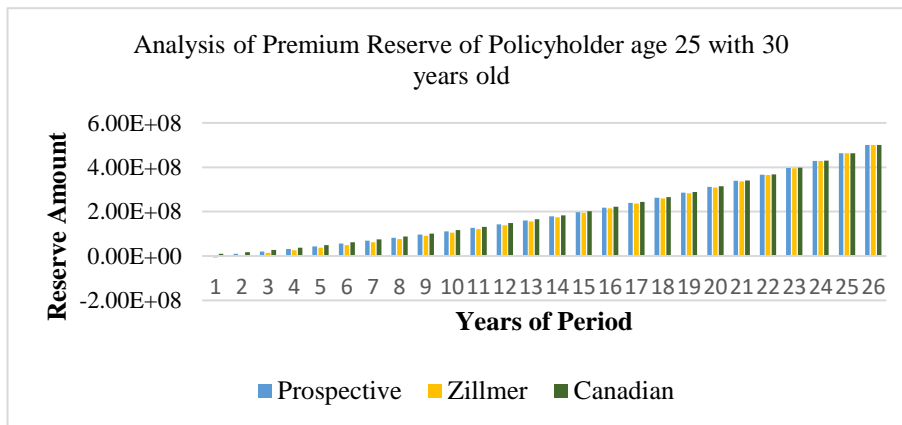Figure. 2 Analysis of Premium Reserve Policyholders age 30 with 30 years old

Figure. 3 Analysis of Premium Reserve Policyholders age 25 with 30 years old

IV. CONCLUSION

Based on the problem statement of this study, concluded that the results of the calculation of premium reserves using the Zillmer method show that in the year 0, the value of endowment joint life of husband (30) with wife (25), husband (30) with wife (30), and husband (25) with wife (30) is lesser than the actual premium. Meanwhile in the year 25 the premium reserve with Zillmer has the same amount with the actual premium reserve.

The results of the calculation of premium reserves using the Canadian method show that in the year 0, the value of endowment joint life of husband (30) with wife (25),   husband (30) with wife (30), and husband (25) with wife (30) is bigger than the actual premium. Meanwhile in the year 25 the premium reserve with Canadian has the same amount with the actual premium reserve.

The results of premium reserves using Zillmer method and Canadian method have the same amount in the year 25. The premium reserve of husband (25) with wife (30) has the highest reserve amount than the other, followed by the premium reserve of husband (30) with wife (25) and husband (30) with wife (30). Overall, the amount of premium reserves using Canadian method is the one that close to the actual premium reserve in positive amount which used Prospective method.

This study results helps the insurance company to consider used the method that have more reserve to the company related to their policyholder age case that appear in the future.

REFERENCES

[1]   T. Futami, "Matematika Asuransi Jiwa Bagian I," in *Incorporated Foundation Oriental Life Insurance Cultural Development Center*. Tokyo, Japan, 1993.

[2]   R. Safitri, "Perhitungan Nilai Cadangan Asuransi Jiwa Seumur Hidup dengan Metode Zillmer danFackler," Universitas Lampung, 2017, Accessed July 4, 2022, http://digilib.unila.ac.id/id/eprint/28622.

[3]   L. Dewi, N. Satyahadewi, and E. Sulistianingsih, "Penentuan Cadangan Premi Pada Asuransi Jiwa Dwiguna dengan Metode Zillmer," Buletin Ilmiah Mat. Stat. dan Terapannya (Bimaster), vol.2, no.3, pp.155-162, 2013.

[4]   Y.S. Fitriyani, N. Satyahadewi, and H. Perdana, "Perbandingan Cadangan Premi Pada Asuransi Jiwa Dwiguna Menggunakan Metode Commissioners and Canadian," in Buletin Ilmiah Mat. Stat. dan Terapannya (Bimaster), vol.10, no.1, pp.195-202, 2021.

[5]   R. Zelvia, "Kajian Cadangan Asuransi Dengan Metode Zillmer dan Kanada," Repository UNILA, vol.1, no.1, pp.14-15, 2012.

[6]   L.A. Tarigas, N. Satyahadewi, and H. Perdana, "Penentuan Cadangan Premi Pada Asuransi Jiwa Dwiguna Menggunakan Metode Full Preliminary Term and Premium Sufficiency," Buletin Ilmiah Mat. Stat. dan Terapannya (Bimaster), vol.8, no.3, pp.379-386, 2019.

[7]   N. Amalia, "Perhitungan Cadangan Manfaat Asuransi Jiwa Endowment Semikontinu Menggunakan Metode Full Preliminary Term," Repository UIN Syarif Hidayatullah, vol.1, no.1, pp.52, 2020, Accessed 15 October, 2022, https://repository.uinjkt.ac.id/dspace/handle/123456789/52928.

[8]   D. Ekawati, and Fardinah, "Penentuan Cadangan Premi Asuransi Jiwa Bersama Dwiguna dengan Metode Canadian," *Journal of Mathematics: Theory and Applications*, vol.2, no.1, 2019.

[9]   N.L. Bowers, H.U. Gerber, J.C. Hickman, D.A. Jones, and C. J. Nesbitt, "Actuarial Mathematics," Schaumburg: The Society of Actuaries, 1997.