



# Comparison of the Zillmer Method with the Adjusted Ohio Method in Calculation of Premium Reserve Value in Dwi-Purpose Life Insurance

Aldino Reisananda<sup>1\*</sup>, Betty Subartini<sup>2</sup>, Riaman<sup>3</sup>

<sup>1,2,3</sup>*Faculty of Mathematics and Natural Science, Jatinangor, Indonesia*

*\*Corresponding author email: aldino19001@mail.unpad.ac.id*

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## Abstract

Life insurance is one of protections in society by providing economic protection for insurance users who experience an adverse event. The insured who is an insurance user has an obligation to pay the premium at the time that is determined by the insurance company and the policyholder. Insurance companies need funds to fulfill claims from policyholders, so premiums that have been paid are stored in the form of premium reserves. Premium reserves need to be managed by the company properly so that the company does not experience losses. The purpose of this research is to provide information to determine the appropriate value of premium reserves in dual-life insurance. In this study, the calculation of premium reserves is done using the Zillmer Method and the adjusted Ohio Method, with the Prospective Method as the basis for the calculation. Based on the research results of premium reserve calculations in this study, both the Zillmer method and the Ohio method show premium reserve values that are directly proportional to the policyholder's age. The premium reserve calculations also indicate that the Zillmer method and the Ohio method yield the same results when the insurance coverage period ends. However, there is a significant difference in the premium reserve calculations at the beginning of the insurance coverage period.

*Keywords:* Premium reserve, Endowment Life Insurance, Zillmer Method, Ohio Method

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## 1. Introduction

With the rapid developments of time, humans have increasingly complex needs. One of them is in life, well-being is the dream of all humans. Most well-being assurances can be obtained by insuring oneself. Life insurance is one type of insurance needed by the community and is a fairly developed insurance in Indonesia. Life insurance is a form of financial protection that provides a benefit payment to the beneficiaries or designated beneficiaries if the insured person passes away. Life insurance has three products offered to customers, namely, whole life insurance, term life insurance, and endowment life insurance. The insured is a living person who receives life insurance protection. If the insured person passes away during the coverage period, the life insurance benefit will be paid to the designated beneficiaries or recipients. Premiums have a basis used in their calculation, where premium reserves can be in the form of net premiums and gross premiums. The calculation of premium reserves in life insurance can be done through several methods, such as the methods used in this research, namely the Zillmer Method and Ohio Method.

## 2. Literature Review

This section describes previous research literature on the Zillmer Method. The selected literatures deal with the Zillmer Method study compared to Premium Sufficiency Method on Dwi-Life insurance, Oktavian et al. (2014) analyzed the method in the calculation of the premium reserve which the Zillmer reserve method uses a measure, namely the Zillmer rate where the Zillmer rate is the basic benchmark for this method in measuring the loading costs of a company. This method is worth using if the insurance company has measured the size of the loading and determined the Zillmer rate right.

Ibrahim et al. (2022) also carried out the Zillmer method which having the result of the difference between the Zillmer method and premium sufficiency that the result of Zillmer method caused by the difference of the fees which focused on the agent commissions only and the Zillmer method is more suitable for insurance companies that are more concerned about capital adequacy because a surplus strain condition in companies that are not appropriately capitalized will cause the surplus to fall past the minimum limit and lead to insolvency.

### 3. Materials and Methods

#### 3.1. Materials

This research was conducted using assumption data within 8 people in the range of 25-60 years old. With the term of payment of 20 years and within 10 years of payment period. The assumption of range of age between 25-60 years old based of the average of people who can make premium payment from the age of 20 until 60 years old and above. By the materials that are provided going to be used for the calculation on the premium reserve using the Zillmer and Ohio method in Dwi-Life insurance.

#### 3.2. Methods

Methods include: the stages and formulas that are used in data analysis, arranged sequentially step by step. The methods before the premium reserve calculation we need find the Initial Term Annuity based on the mortality table which is follows:

$$\ddot{a}_{x:\overline{n}|} = \frac{N_x - N_{x+n}}{D_x} \quad (1)$$

Next, after we got the result of the Initial Term Annuity, we need to find the Single Net Premium which the calculation based on the mortality table as follows:

$$A_{x:\overline{n}|} = \frac{M_x - M_{x+n} + D_{x+n}}{D_x} \quad (2)$$

Furthermore, we need to find the Net Premium for the Annual term which the calculation also based on the mortality table as follows:

$${}_mP_{x:\overline{n}|} = \frac{A_{x:\overline{n}|}}{\ddot{a}_{x:\overline{n}|}} \quad (3)$$

After we got our result for the Initial Term Annuity, Single Net Premium, and Annual Net Premium the calculation for the premium reserve starting from the Prospective Method of Premium Reserve.

##### 3.2.1. Prospective Method Premium Reserve

The calculation of prospective premium reserves is defined as the difference between the future benefit value and the future cash premium value. If  $x$  is the age of a policyholder,  $n$  is the insurance payment period, premium payment occurs annually, and  $t$  is the prospective reserve year, then the prospective premium reserve is symbolized by  ${}_tV$ . The general formula for prospective reserves is:

$${}_tV_{x:\overline{n}|} = A_{x+t:\overline{n-t}|} - {}_mP_{x:\overline{n}|} \cdot \ddot{a}_{x+t:\overline{m-t}|} \quad (4)$$

##### 3.2.2. Zillmer Method Premium Reserve

The Zillmer method was discovered by Dr. August Zillmer (1831-1893). The Zillmer method is a reserve calculation involving gross premiums and net premiums, the gross premium itself contains several costs used by insurance companies. This method uses prospective premium reserves as the basis for its calculation. Premium reserves in the Zillmer method involve gross premiums where the amount of compensation is reduced by the cash value of future gross premiums plus the cash value of future expenses so that for endowment life insurance for  $n$  years and the insured is aged  $x$ , with annual premiums for  $m$  years paid at the beginning, the Zillmer reserve formula is obtained with the equation as follows:

$${}_tV_{x:\overline{n}|}^{(Z)} = A_{x+t:\overline{n-t}|} - \left( {}_mP_{x:\overline{n}|} + \frac{f}{\ddot{a}_{x:\overline{n}|}} \right) \cdot \ddot{a}_{x+t:\overline{m-t}|}; m < n. \quad (5)$$

##### 3.2.3. Ohio Method Premium Reserve

Ohio method premiums for the first year are expressed by  $\alpha_o$  and for subsequent years are expressed by  $\beta_o$ . In determining reserves adjusted to the Ohio method, there are requirements that must be met, namely a limited payment life or an endowment policy that provides a premium payment period of less than 20 years. So, reserves adjusted

using the Ohio method for contracts at age  $x$ , coverage period and premium payment period are the same, namely  $n$  years, sum insured 1, paid at the beginning of the policy year, can also be formulated in the equation as follows:

$${}_tV_{x:\overline{n}|}^{(0)} = A_{x+t:\overline{n-t}|} - \beta_0 \cdot \ddot{\alpha}_{x+t:\overline{m-t}|} \tag{6}$$

#### 4. Results and Discussion

The reserve calculation is carried out using the material for each policy from the policy age, coverage period  $n$ , premium payment period  $m$  and compensation money. The reserve calculation uses equation (4) for the Prospective method reserve, equation (5) for the adjusted reserve calculation using the Zillmer method, and equation (6) for the adjusted reserve calculation using the Ohio method and the size of the premium reserve for eight policy holders which has been calculated using Microsoft Excel can be seen in Table 1 to Table 8

**Table 1.** 1st to 10th Year Premium Reserves for AR policy holders using the Prospective method, Zillmer, Ohio

Name	Age	$t$	Prospective Reserve	Zillmer Reserve	Ohio Reserve
AN	25	1	IDR6,952,453.16	IDR6,938,367.02	IDR3,470,420.93
		2	IDR14,086,439.31	IDR14,073,763.07	IDR10,952,926.97
		3	IDR21,407,974.95	IDR21,396,745.50	IDR18,632,102.22
		4	IDR28,921,311.05	IDR28,911,566.11	IDR26,512,404.12
		5	IDR36,628,838.20	IDR36,620,616.11	IDR34,596,371.46
		6	IDR44,533,705.07	IDR44,527,044.90	IDR42,887,339.04
		7	IDR52,640,362.44	IDR52,635,304.24	IDR51,389,997.40
		8	IDR60,955,098.91	IDR60,951,683.94	IDR60,110,932.66
		9	IDR69,484,446.09	IDR69,482,716.81	IDR69,056,974.62
		10	IDR78,233,919.40	IDR78,233,919.40	IDR78,233,919.40

**Table 2.** 1st to 10th Year Premium Reserves for BI policy holders using the Prospective method, Zillmer, Ohio

Name	Age	$t$	Prospective Reserve	Zillmer Reserve	Ohio Reserve
BI	30	1	IDR6,974,003.86	IDR6,921,527.48	IDR3,470,461.66
		2	IDR14,124,204.07	IDR14,076,983.71	IDR10,971,575.85
		3	IDR21,456,548.91	IDR21,414,718.95	IDR18,663,807.20
		4	IDR28,977,665.08	IDR28,941,364.49	IDR26,554,086.81
		5	IDR36,691,949.71	IDR36,661,320.84	IDR34,647,038.85
		6	IDR44,603,023.79	IDR44,578,212.15	IDR42,946,495.45
		7	IDR52,715,847.49	IDR52,697,002.60	IDR51,457,683.72
		8	IDR61,035,654.00	IDR61,022,929.73	IDR60,186,128.87
		9	IDR69,569,277.91	IDR69,562,833.40	IDR69,139,015.33
		10	IDR78,323,630.54	IDR78,323,630.54	IDR78,323,630.54

**Table 3.** 1st to 10th Year Premium Reserves for CR policy holders using the Prospective method, Zillmer, Ohio

Name	Age	$t$	Prospective Reserve	Zillmer Reserve	Ohio Reserve
CR	35	1	IDR7,001,260.65	IDR6,883,550.73	IDR3,461,660.58
		2	IDR14,177,865.24	IDR14,071,949.18	IDR10,992,912.88
		3	IDR21,532,992.93	IDR21,439,167.77	IDR18,711,620.19
		4	IDR29,072,100.45	IDR28,990,672.65	IDR26,623,523.03
		5	IDR36,799,781.92	IDR36,731,066.71	IDR34,733,479.05
		6	IDR44,721,552.02	IDR44,665,874.97	IDR43,047,313.24
		7	IDR52,843,426.83	IDR52,801,125.03	IDR51,571,389.13
		8	IDR61,174,745.97	IDR61,146,171.79	IDR60,315,505.15
		9	IDR69,724,056.96	IDR69,709,577.83	IDR69,288,661.71
		10	IDR78,500,627.77	IDR78,500,627.77	IDR78,500,627.77

**Table 4.** 1st to 10th Year Premium Reserves for DP policy holders using the Prospective method, Zillmer, Ohio

Name	Age	$t$	Prospective Reserve	Zillmer Reserve	Ohio Reserve
DP	40	1	IDR7,035,843.41	IDR6,824,455.44	IDR3,438,538.69
		2	IDR14,239,766.96	IDR14,049,521.87	IDR11,002,262.17
		3	IDR21,620,208.11	IDR21,451,636.91	IDR18,751,539.74
		4	IDR29,183,525.52	IDR29,037,179.59	IDR26,693,076.73
		5	IDR36,936,201.47	IDR36,812,653.65	IDR34,833,720.56
		6	IDR44,883,479.46	IDR44,783,323.10	IDR43,179,063.80
		7	IDR53,034,169.54	IDR52,958,027.27	IDR51,738,414.90
		8	IDR61,397,815.20	IDR61,346,342.61	IDR60,521,877.88
		9	IDR69,986,477.39	IDR69,960,370.02	IDR69,542,193.88
		10	IDR78,814,372.75	IDR78,814,372.75	IDR78,814,372.75

**Table 5.** 1st to 10th Year Premium Reserves for EG policy holders using the Prospective method, Zillmer, Ohio

Name	Age	$t$	Prospective Reserve	Zillmer Reserve	Ohio Reserve
EG	45	1	IDR7,078,872.10	IDR6,749,980.34	IDR3,398,982.19
		2	IDR14,322,033.16	IDR14,025,946.30	IDR11,009,189.26
		3	IDR21,734,560.13	IDR21,472,086.84	IDR18,797,810.28
		4	IDR29,324,039.36	IDR29,096,029.22	IDR26,772,889.36
		5	IDR37,099,767.91	IDR36,907,119.60	IDR34,944,272.80
		6	IDR45,070,576.16	IDR44,914,239.78	IDR43,321,366.46
		7	IDR53,248,300.51	IDR53,129,292.07	IDR51,916,744.09
		8	IDR61,650,197.06	IDR61,569,619.04	IDR60,748,629.12
		9	IDR70,297,294.90	IDR70,256,350.07	IDR69,839,173.20
		10	IDR79,212,125.10	IDR79,212,125.10	IDR79,212,125.10

**Table 6.** 1st to 10th Year Premium Reserves for FB policy holders using the Prospective method, Zillmer, Ohio

Name	Age	$t$	Prospective Reserve	Zillmer Reserve	Ohio Reserve
FB	50	1	IDR7,094,785.80	IDR6,632,998.11	IDR3,330,652.06
		2	IDR14,339,353.27	IDR13,923,218.89	IDR10,947,349.74
		3	IDR21,745,385.99	IDR21,376,026.21	IDR18,734,652.58
		4	IDR29,329,478.72	IDR29,008,125.09	IDR26,710,054.10
		5	IDR37,108,785.48	IDR36,836,785.51	IDR34,891,653.42
		6	IDR45,103,341.63	IDR44,882,175.12	IDR43,300,564.45
		7	IDR53,334,634.57	IDR53,165,923.70	IDR51,959,434.86
		8	IDR61,826,262.52	IDR61,711,784.60	IDR60,893,127.66
		9	IDR70,603,828.20	IDR70,545,527.82	IDR70,128,608.84
		10	IDR79,694,556.36	IDR79,694,556.36	IDR79,694,556.36

**Table 7.** 1st to 10th Year Premium Reserves for GR policy holders using the Prospective method, Zillmer, Ohio

Name	Age	$t$	Prospective Reserve	Zillmer Reserve	Ohio Reserve
GR	55	1	IDR7,037,463.03	IDR6,410,973.23	IDR3,204,061.70
		2	IDR14,242,532.41	IDR13,676,912.22	IDR10,781,583.51
		3	IDR21,634,194.79	IDR21,131,166.63	IDR18,556,237.54
		4	IDR29,233,434.54	IDR28,794,903.15	IDR26,550,123.81
		5	IDR37,062,411.27	IDR36,690,474.52	IDR34,786,583.57
		6	IDR45,142,043.23	IDR44,838,990.10	IDR43,287,704.54
		7	IDR53,493,504.05	IDR53,261,826.41	IDR52,075,901.76
		8	IDR62,140,963.29	IDR61,983,388.30	IDR61,176,784.50
		9	IDR71,112,700.11	IDR71,032,235.37	IDR70,620,347.89
		10	IDR80,444,366.73	IDR80,444,366.73	IDR80,444,366.73

**Table 8.** 1st to 10th Year Premium Reserves for HK policy holders using the Prospective method, Zillmer, Ohio

Name	Age	t	Prospective Reserve	Zillmer Reserve	Ohio Reserve
HK	60	1	IDR7,061,941.06	IDR6,064,927.57	IDR3,046,288.72
		2	IDR14,313,825.31	IDR13,412,350.32	IDR10,682,971.59
		3	IDR21,768,790.49	IDR20,965,800.21	IDR18,534,601.76
		4	IDR29,440,802.05	IDR28,739,479.83	IDR26,616,099.83
		5	IDR37,349,289.44	IDR36,753,132.45	IDR34,948,159.25
		6	IDR45,517,646.56	IDR45,030,533.14	IDR43,555,709.08
		7	IDR53,981,747.57	IDR53,608,086.40	IDR52,476,759.55
		8	IDR62,785,195.26	IDR62,530,028.39	IDR61,757,464.50
		9	IDR71,976,424.32	IDR71,845,518.87	IDR71,449,178.90
		10	IDR81,617,753.21	IDR81,617,753.21	IDR81,617,753.21

In Table 1 to Table 8 it can be seen that the number of reserves adjusted using the Prospective method ( ${}^m_tV_{x:\overline{n}|}$ ) produces a value that is greater than the Zillmer method ( ${}^m_tV_{x:\overline{n}|}^{(Z)}$ ) and the Ohio method ( ${}^m_tV_{x:\overline{n}|}^{(O)}$ ). However, the longer the payment period, the smaller the resulting difference will be and at the end of the payment period, namely the 10th year, the resulting difference will be zero so the reserves will have the same value. The calculation results adapted to the Zillmer method have a greater premium reserve value compared to the Ohio method, so it can be seen that:

- In the Prospective reserve method, the reserve value obtained is greater than the Zillmer method and the Ohio method because the Prospective reserve only uses net premiums without taking into account any costs or loading costs.
- In the Zillmer method reserves, the premium reserve value in the first year is greater than the Ohio method because the Zillmer method uses a measure, namely the Zillmer rate or Zillmer level where the Zillmer level is the basic benchmark for this method in measuring a company's loading costs.
- The reserve value using the Prospective method, Zillmer method and Ohio method varies each year but the value is directly proportional to the age of the policy holder and also at the end of the insurance period, the three methods produce the same reserve value.
- As the age of the policy increases, the number of premium reserves that need to be paid will be greater because as the age of the policy increases, the risk of death also increases.

From these results, it can be concluded that the premium reserve value of the Zillmer method produces a greater reserve value from the beginning of the payment period compared to the Ohio method which has a smaller reserve value in the first year because the Ohio method tends to recognize acquisition costs more evenly during the policy period so that This method approach focuses on managing acquisition costs during the contract period. Referring to the Indonesian Mortality Table, where a person will have an increasing chance of dying as they get older. The reserves required for a claim will also be greater. Reserve calculations must also pay attention to costs because the company will experience losses if the results of the reserve calculation do not match the company's costs. The Zillmer method shows suitable results when compared with the reserve value results of the Ohio method.

## 5. Conclusion

The resulting reserve calculation shows that the Zillmer method has a larger initial reserve size compared to the Ohio method and the reserve calculation must pay attention to costs or loading because the company will experience losses if the reserve results do not match the company's costs. The Zillmer method shows suitable results when compared with the Ohio method, because in calculating reserves the Ohio method produces smaller reserves from the beginning of the payment period.

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