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Estimation of Prospective Benefit Reserve Based on Gross Premium Valuation Method using Indonesian Mortality Table IV and De-Moivre Assumptions

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ABSTRACT

According to regulations, life insurance companies must meet several requirements related to the company's financial health, one of which is a technical reserve. Technical or premium reserves are funds that the insurance companies must prepare. These funds will cover financial losses experienced by someone who applies for the claim. Thus, the author will use the Gross Premium Valuation (GPV) method in this research. Premium reserves can be determined using two approaches: retrospective and prospective reserves. In this research, the author will determine the prospective reserves with GPV for single decrement insurance and single life n-year continuous term life. The distribution of deaths used in determining the probability of death is the Indonesian life table IV and the de-Moivre assumption *with parameter* $(\omega=111)$. Different assumptions for the death probability distribution will result in different premium reserve values, so we can see a difference in premium reserves resulting from the two death probability distributions. This research uses data from male policyholders aged 40 years who followed continuous term life insurance for 20 years. Benefits will be paid right at the time of death, with a discrete method of premium payments made at the beginning of each year for 10 years.

1. Introduction

Humankind will not know what will happen in the future, so life in this world will be full of uncertainty. In living a life, there will be a lot of unexpected events, both desired and unwanted. The various possibilities of these events certainly have risks. These risks can include death, illness, fire, and others. Many people start to protect themselves to avoid all the risks. The protection can be like physical protection or financial protection. Financial protection aims to protect individuals with financial compensation for property, health, or life. One of the implementations to minimize financial risk is insurance.

Insurance is a form of agreement between the insured (policyholder) and the insurer (insurance company) where the insurance company agrees to bear the risks that will occur to the insured in the future. Meanwhile, according to the Financial Services Authority, insurance is an agreement between an insurance company and a policyholder within a certain period. The policyholder will pay a premium to the insurance company to get benefits from possible risk losses that will occur. There are many type of insurance: life and nonlife insurance. For example, life insurance as health insurance and nonlife like an education, accident, and so on. Life insurance is a type of insurance whose purpose is to protect policyholders when there is a risk caused by living too long or dying too soon. In life insurance, the company covers the form of sum assured, premium bonuses, and others.

In life insurance, the amount of benefit to be provided by the insurance company to the insured depends on the premium paid. Whether a single payment or payments are made periodically according to the type of insurance, this payment will stop when the policyholder dies or the insurance contract has expired. The premiums received by this insurance company will be collected in a relatively long time, so the funds collected are immense. When a policyholder who experiences financial risk submits a claim during the coverage period, this becomes a loss for the insurance company. In this case, the insurance company pays several individuals with a sufficient premium to cover the risk of loss that the policyholder will experience to handle the risk that occurs to the policyholder.

Funds to pay when a policyholder dies are funds taken from premium reserves. Government Regulation of the Republic of Indonesia number 73 of 1992, regarding the Implementation of General Insurance Business Article 14 Paragraph (1), states that technical reserves or premium reserves are an obligation for every insurance and reinsurance company. Therefore, the Financial Services Authority makes regulations that life insurance companies must meet several requirements related to the company's financial health, one of which is technical reserves. Technical or premium reserves are several funds the insurance company must prepare because these funds will be used to cover financial losses experienced by someone who follows insurance. Several methods can be used to calculate premium reserve funds: the New Jersey method, Full Preliminary Term, Zillmer, and Gross Premium Valuation (GPV). With the GPV method, the costs that must be borne by the policyholder have entered into the calculation so that the results given will be more in line with real conditions. Because in life insurance products, there are often other costs that are charged to the insured so that the resulting premium is no longer a net premium. Therefore, we used the GPV method for this study. Basically, calculating reserves can use prospective and retrospective approaches. The retrospective approach is the calculation of premium reserves based on the total amount of income in the past so that it can provide faster results for reserves each year sequentially, but it so complicated. Meanwhile, the calculation of prospective is a calculation of benefit reserves based on the present value of all future income. Theoretically, calculations using both retrospective and prospective will result in the same reserve results. The advantage of prospective calculations is that the calculation process is faster if the premium payment has been paid off. Therefore, we choose a prospective approach.

In this study, researchers will estimate the premium reserves for life insurance products using the GPV method and a prospective approach. The assumption used in this research is to use De-Moivre's law of mortality and the Indonesian Life table IV. There is no specific reason why we choose that assumption because the purpose of this study is to compare two assumptions that have never been compared yet in other papers.

2. Literature Review

Several researchers have published on life insurance premium reserves, including (1) M. Rizki Oktavian et al. (2021), (2) Ihsan Kamil et al. (2021), (3) Yulial Hikmah et al. (2019), and (4) David Eurico, et al. (2021).

The first analysis that became a reference for researchers was "*Kajian Metode Zillmer,* Full Preliminary Term*, dan* Premium Sufficiency *Dalam Menentukan Cadangan Premi Pada Asuransi Jiwa Dwiguna*." This study examines the calculation of prospective and retrospective life insurance premium reserves using the Zillmer, Full Preliminary Term, and Premium Sufficiency methods. As stated in the title, the difference of this study from other papers is estimates and compares the amount of life insurance premium reserves from various methods. However, the Gross Premium Valuation (GPV) method has not been used.

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Kamil et al. in 2021 have also researched the topic of life insurance premium reserves. The research is entitled "*Modifikasi Cadangan Premi Tahunan Retrospektif Pada Asuransi Jiwa Berjangka Kasus* Joint Life *Dengan Metode Zillmer*." The problem in this research is that costs need to be included in calculating premiums. From this problem, the researcher initiated the calculation of life insurance premium reserves using the Zillmer method, which includes costs in calculating premium reserves. The final result or output of the research is the amount of life insurance premium reserves generated through the Zillmer method compared with the amount of net life insurance premium reserves. This research has a background problem similar to the current study. However the difference of this study from other papers, this study's approach and method for finding premium reserves did not use a prospective approach with the Gross Premium Valuation (GPV) method.

In 2019, Hikmah et al. conducted a study on the calculation of life insurance reserves entitled "*Perhitungan Cadangan Premi Asuransi Jiwa Dengan Metode* Gross Premium Valuation (GPV)." The researcher used the same method, which is the Gross Premium Valuation (GPV). However, this study did not use the Indonesian Life table IV nor the De-Moivre distribution as their references, but the Indonesian Life table III and the Modified Company Life table. Then the premium reserves that are generated using the two life tables are compared. This study concludes that the premium reserve is ideal with the Modified Company Life table. However, in their research, Hikmah et al. did not explain why the premium reserve could be said to be ideal. Therefore, in this study, it will not be seen which one is ideal but instead explorative by looking at the results of calculations using TMI IV and De-Moivre's assumptions. Then that can be done for further research find out how the indicators to determine the ideal premium reserve.

Another research that discusses the calculation of reserves is the research conducted by Eurico et al. in 2021. The research departs from the same problem as this research, namely the problem of costs that need to be included in the calculation of life insurance reserves. The methods and approaches used also use the Gross Premium Valuation method with a prospective approach or look at cash flows in the future. In contrast to the research conducted by Hikman et al. (2019), the research conducted by Eurico et al. has used the python programming language to calculate premium reserves. This study will also use Python programming language to help simplify calculations. The basic difference between this research and the research conducted by Eurico et al. in 2019 is that there is a comparison of the number of premium reserves using interest rates of 8% and 7%. This research concludes that the number of reserves generated using an interest rate of 8% is smaller than the gross premium using an interest rate of 7%. The difference of this study from other papers is comparing reserves with the sensitivity of interest rates.

3. Methodology

3.1. Research Algorithm

This research has several steps that the writer must pass to achieve the objective of study. Which is to get the premium reserve amount from each distribution of deaths.

A. De-Moivre and TMI IV

The first thing to do in this study is to determine the assumption of the probability distribution of death to be used. In this research, two assumptions: De-Moivre and TMI IV, will be used for the distribution of the probability of death. The two assumptions about the distribution of deaths will go through the same process to finally get the amount of premium reserves.

B. Calculate the Probability of Death

The next step is to look for the probability of death of an insurance participant which will later be used to calculate the amount of premiums and reserves for each assumed distribution of death. The two assumptions will result in different odds of death.

C. Calculate Net Single Premium & Life Annuity

After obtaining the probability of death, the calculation of the single net premium and life annuity of an insurance participant must be carried out. The single net premium is the amount that must be paid by the insured in order to receive insurance benefits when making a claim. A life annuity is the

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present value of a set of payments that considers the probability of a person's death. Both quantities are actuarial quantities that are essential in the calculation of premium reserves. The calculation formula will be discussed in section 3.4

D. Calculate Gross Premium

Then, we have to calculate the amount of gross premium to be paid by the insured. Gross premium itself is a premium that has included costs in the calculation. Later this gross premium amount will be used in calculating premium reserves using the Gross Premium Valuation method

E. Calculate Benefit Reserve

The last step of this research is to find the amount of premium reserve from the two assumptions of mortality distribution. The two assumptions about the distribution of deaths will result in different amounts of premium reserves.

The research steps above can be described by a flow chart as follows:

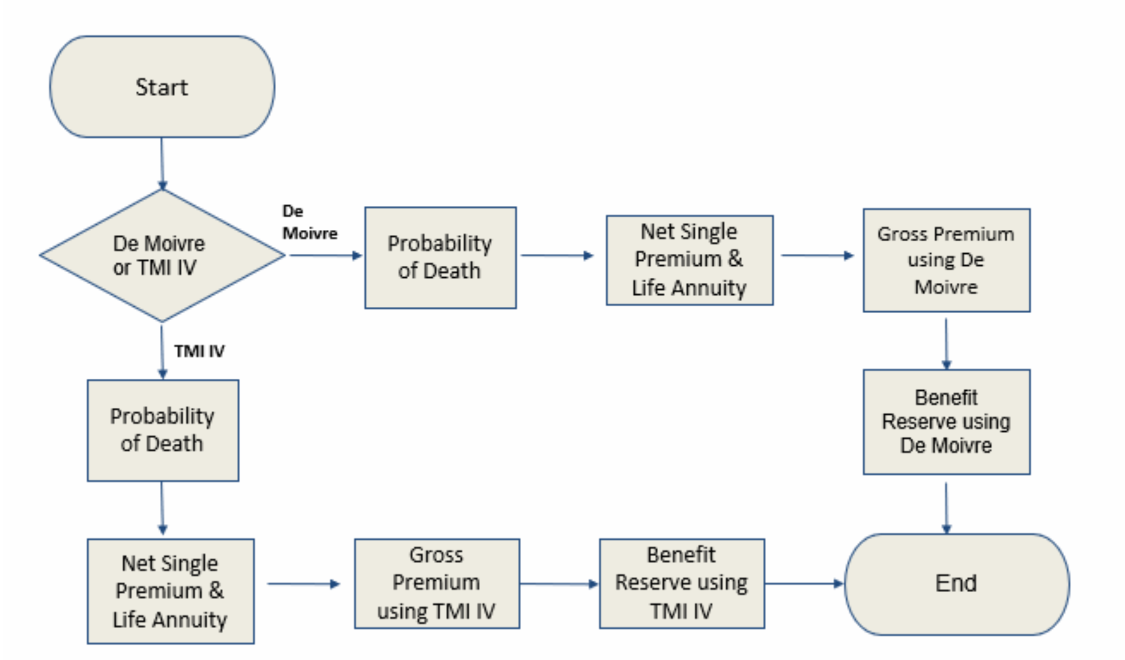

Fig. 1. Flowchart of the research.

All calculations in the process are carried out using the Python programming language, with the following steps:

1) This study uses the Python programming language to estimate GPV reserves. The first step that must be done is to prepare some of the modules needed in the calculation to make the next step easier. One of the required modules is NumPy.
2) Create actuarial function
   The next step is to make the basic function of the assumptions of the De-Moivre law approach. After that, actuarial functions will calculate the discount factor, single net premium, annuity, and insurance equation.
3) Create gross premium equation
   In calculating the GPV reserve, the premium paid is the gross premium, so some costs must be included. Therefore, researchers must make a gross premium equation and function in python to facilitate the calculation of reserves to match the components that have been determined.
4) Calculate the benefit reserve with GPV method
   In this step, the researcher creates a Python function that can calculate the amount of reserves that must be prepared based on general information such as age, benefits, and insurance coverage.

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3.2. Mortality Law *De-moivre*

When calculating benefit reserves using the GPV method, it is necessary to involve the calculation of a life annuity related to the insurance premium. In general, actuarial functions can be calculated using a life table. However, the extension of the method to perform actuarial function calculations can also use the mortality law approach. In estimating premium reserves, the probability of death must be included using a mortality law approach. Some of the mortality laws used for insurance and annuity calculations are the Makeham, Gompertz, Weibull, and De-Moivre mortality laws. This paper used De-Moivre's law to complete the calculation of insurance and annuities. De-Moivre's law was created in 1729 by a scientist named Abraham De-Moivre [4]. De-Moivre's law was acquired from a uniform distribution's probability density function. The uniform distribution has a density function on the interval [a, b], which can be written:

$$\boldsymbol{f(x) = \frac{1}{b-a}, a \leq x \leq b} \tag{1}$$

Bowers et al. [2] gave a statement that the relationship between the survival function and De-Moivre's law is:

$$\boldsymbol{s(x) = 1 - \frac{x}{\omega}} \tag{2}$$

With

x : Insured age when taking insurance

ω : Limiting age of a life table

The probability that the insured at age x will survive to the age of $x + t$ years in the future can be formulated as:

$$\begin{aligned} {}_tP_x &= \frac{s(x+t)}{s(x)} \\ &= \frac{1-\left(\frac{x+t}{\omega}\right)}{1-\left(\frac{x}{\omega}\right)} \\ &= \frac{\frac{\omega-x-t}{\omega}}{\frac{\omega-x}{\omega}} \\ &= \frac{\omega-x-t}{\omega-x} \end{aligned} \tag{3}$$

with

t : time period

${}_tp_x$: The probability of a person age x will live until age $x+t$

Meanwhile, the probability that the insured aged $x + t$ will be able to survive for the next 1 year can be stated as follows:

$$\begin{aligned} P_{x+t} &= 1 - \frac{1}{\omega-x-t} \\ &= \frac{\omega-x-t-1}{\omega-x-t} \end{aligned} \tag{4}$$

Then find the probability that the insured aged x will die in the next t years with the equation:

$$\begin{aligned} {}_tq_x &= 1 - {}_tp_x \\ &= 1 - \frac{\omega-x-t}{\omega-x} \end{aligned}$$

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$$= \frac{t}{\omega - x} \tag{5}$$

with

$_tq_x$: The probability of a person age x will die t year later

So, by (5), the probability that the insured aged $x + t$ will die in the next 1 year can be expressed as:

$$q_{x+t} = \frac{1}{\omega - x - t} \tag{6}$$

with

q_{x+k} : The probability of a person age x+k will die 1 year later

3.3. Life Table

The life table is a benchmark for determining the probability of a person's death. The life table contains the probability of a person dying in one year. Various types of life tables can be used in determining the probability of death, such as the Standard Ordinary Life Table for the Commissioner 1941 (CSO), the Indonesian Life Table III, and the Indonesian Life table IV. However, the researcher will use the Indonesian Life table IV in this analysis.

3.4. Benefit Reserve using GPV Prospective Method

3.4.1. Net Single Premium of Term Life Insurance

Life insurance is an agreement between the insured and a life insurance company. Life insurance companies will bear the risk of death from the policyholder if one day they die by providing compensation to their heirs [1]. To get this compensation, the policyholder must deposit a certain amount of funds to the life insurance company. These funds are commonly referred to as net premiums. The net premium can be paid at once at the beginning, commonly known as a single net premium, or it can also be paid in installments per period. This net premium does not include other costs in the calculation [6]. To calculate the premium and prospective reserves using the GPV method, it is necessary first to calculate the single net premium. For discrete term life insurance, the the net single premium is formulated in [2] as:

$$A^1_{x:\overline{n}|} = \sum_{k=0}^{n-1} v^{k+1} \cdot {}_kp_x \cdot q_{x+k} \tag{7}$$

with

$A^1_{x:\overline{n}|}$: Net single premium of n-year term insurance for a person aged x

n : The period of insurance

x : Insured age when taking insurance

v^{k+1} : Discount factor for year k+1

$_kp_x$: The probability of a person age x will live until age x+k

q_{x+k} : The probability of a person age x+k will die 1 year later

Equation (1) is a single net premium formula for discrete life insurance, which assumes the provision of insurance benefits will be made at the end of the year the insured dies. As for the type of term insurance that assumes immediate benefit payments when the insured dies or commonly known as continuous term life insurance, the formula is written in [2] as:

$$\bar{A}^{\,1}_{x:\overline{n}|} = \int_0^n v^t \cdot {}_tp_x \cdot \mu_{x+t} \tag{8}$$

As formulated Bowers et al. [2].

with

$\bar{A}^{\,1}_{x:\overline{n}|}$	: Continous Net single premium of n-year term insurance for a person aged-x
μ_{x+t}	: Force of mortality

In addition to equation (2), Bowers et al. [2] initiate a formula that assumes a uniform distribution of death (UDD) have the relationship between the single net premium discrete ($A^{1}_{x:\overline{n}|}$) with ($\bar{A}^{\,1}_{x:\overline{n}|}$) continuous is:

$$\bar{A}^{\,1}_{x:\overline{n}|} = \frac{i}{\delta} \cdot A^{1}_{x:\overline{n}|} \tag{9}$$

with

δ	: Force of interest
i	: Interest rate

3.4.2. Discrete Term Annuity

In finding reserves using the GPV method, of course, it is necessary to know the amount of Gross Premium that needs to be paid by the insured on an annual basis. Therefore, it is also necessary to have a life annuity value which is the present value of several life insurance premium payments [9]. For instance, when the premium payments are made at the beginning of each year for m years, then the formula becomes:

$$\ddot{a}_{x:\overline{m}|} = \sum_{k=0}^{m-1} v^{k} \cdot \; {}_{k}p_{x} \tag{10}$$

As written by Bowers et al. [2].

with

$\ddot{a}_{x:\overline{m}|}$	: An m-year discrete life annuity for a person aged x

An alternative to equation (4) in finding the amount of discrete term annuity is to use the relationship between the annuity ($\ddot{a}_{x:\overline{m}|}$) and the single net premium of endowment insurance ($\bar{A}_{\,x:\overline{n}|}$) which can be formulated as:

$$\ddot{a}_{x:\overline{m}|} = \frac{1-\bar{A}_{\,x:\overline{n}|}}{i}(1+i) \tag{11}$$

3.4.3. Premiums of Continuous Term Life Insurance

Premium is the amount the insured should pay to the insurance company so that the insured gets the protection agreed upon between the insured and the insurance company. Premiums can be paid in a lump sum or periodically, depending on the system of each insurance company. Premiums that are paid regularly can be paid annually or monthly within an agreed period. This premium can be determined in various ways, one of which is the concept of equivalence, where the expected value of the present value outflow must be equal to the expected value of the present value inflow. Using this principle means that the expected loss must be equal to zero, which can be mathematically formulated as [3]:

$$E[L] = E[PVOutflow] - E[PVInflow] = 0 \tag{12}$$

3.4.4. Gross Premium Valuation

Gross Premium Valuation is the difference between the present value of future benefits and the present value of the gross premium paid by the insured. A Gross premium is a premium that includes other costs that must be borne by the insured when they are partaking in insurance. The GPV method can be carried out with a prospective and a retrospective approach. A prospective approach is an approach that looks at future cash flows, while a retrospective approach is an approach that looks at past cash flows. Reserves in insurance are made by projecting cash flows using assumptions that actuaries in each insurance company have determined. In this study, researchers used the GPV method with a prospective approach. The formula can be written as:

$$v_t = PV_{FCO} - PV_{FCI} \quad (13)$$

As written in [3].

with

v_t : Benefit reserve in year-t

PV_{FCO} : Present Value Future Cash Outflow

PV_{FCI} : Present Value Future Cash Inflow

4. Results and Discussion

This research was conducted by taking a sample of the man policyholder who is 40 years old. The insurance product promises a sum insured of IDR 500,000,000 will be paid at the time of death with a protection period of 20 years. Insured must pay premiums for ten years at the beginning of each year. The interest rate is assumed to be 6%, while the probability of death for each age is taken from the Indonesian Life Table IV and uses the probability of death function from De-Moivre's law of mortality. It is also assumed that other costs the insured should pay is:

1) Initial fee of IDR100,000 with additional 5% of gross premium..
2) 5% Sales fee of gross premium to be paid annually during the premium payment period.
3) The policy renewal fee is IDR120,000 per year during the premium payment period.

Then, the GPV reserves obtained will be compared with the GPV reserves for the insured but with a different approach, which is the De-Moivre mortality law and the Life Table IV. These values aim to see the difference in the number of reserves against the mortality law approach and the table used.

4.1. Gross Premium

Based on the assumptions used in the case above, it will be necessary to look for the gross premium formula that must be paid by the insured. In the simulation of the insurance product used, some costs must be charged to the insured so that the gross premium equation can be determined using the following steps:

A. Determine Cash In and Cash Out

Cash out is the present value of the costs incurred by the insurance company. Meanwhile, the cash in is the present value of the company's income or the premium paid by the insured to the company. Cash out is as follows:

$$Z_x = \begin{cases} 500.000.\,v^t + 100.000 + 0.05G + (0.05G + 120.000)\ddot{a}_{\overline{\min(K(x),10)}|} \;;\; K(x) = 0,1,2,\dots,10 \le T(x) < 20 \\ 0\,;\,other\ K(x) \end{cases}$$

The next step is to determine the Cash in. Premium payments on term life insurance in this study are discrete, assuming payments are made at the beginning of the year. The series of premium payments use a discrete initial annuity:

$$Y_x = \begin{cases} G\ddot{a}_{\overline{\min(K(x),10)}|}\,;\,K(x) = 0,1,2,\dots 9 \\ 0\,;\,other\ K(x) \end{cases}$$

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B. Define the Loss Function

The loss function can be formulated as the present value of expenditure (outflow) minus income (inflow). The equivalence principle applies to the gross premium and benefit, so the expected loss function must be zero.

$$Loss\ Function = Cash\ Out - Cash\ In$$

The loss function expectations above will later be used to find the gross premium and reserves. The difference is that when looking for gross premium, the time point used is 0th time where the expected loss function is *E[L] = 0* because of the equivalence principle. Meanwhile, at other time points, what is sought is the number of reserves when the value of *E[L]* is not equivalent, so that *E[L] ≠ 0*, except at the end of the year of protection because the product used is term insurance

C. Search the Expectation from Loss Function

The next step is to find the expectation of the loss function. The expectation of the loss function must be 0 in order to fulfill the equivalence principle.

$$0 = E[Z_x] - E[Y_x]$$

It is necessary to find each expectation of the Cash Out and Cash In with the following formulation:

a) Cash Out Expectation

$$E[Z_x] = \left(500.000.000 \ \times \bar{A}^{1}_{40:\overline{20}|}\right) + 100.000 + 0.05G + (0.05G + 120.000)\ddot{a}_{40:\overline{10}|}$$

b) Cash In Expectation

$$E[Y_x] = G.\ddot{a}_{40:\overline{10}|}$$

So, the gross premium formulation for the calculation in this study is:

$$G = \frac{\left(500.000.000 \times \bar{A}^{1}_{40:\overline{20}|}\right) + \left(120.000 \times \ddot{a}_{40:\overline{10}|}\right)}{\left(0.95 \times \ddot{a}_{40:\overline{10}|}\right) - 0.05} \quad (14)$$

Using the Python programming language, the single net premium of term insurance ($\bar{A}^{1}_{40:\overline{20}|}$) using De-Moivre's mortality approach is 0.16635, while the amount of discrete annuity ($\ddot{a}_{40:\overline{10}|}$) obtained is 7.35974. For the TMI IV approach, the single net premium for term insurance is 0.0501482, and the discrete annuity term is 7.728163291919471. Thus, the gross premium obtained using the De-Moivre Mortality Law approach in this research is IDR12,123,296.33. Meanwhile, for the Indonesian Mortality Table IV approach, the gross premium generated was IDR3,579,590.30. From these results, it is found that the gross premium value with the De-Moivre mortality approach is greater than the gross premium value with the TMI IV approach.

4.2. GPV Reserve and Visualization on Python

After getting the gross premium formula, the researcher can estimate the number of reserves using the GPV method. The calculation steps using the Python programming language have been explained in section 3.4.5. Some of the input values are adjusted to the assumptions that have been determined in this study. Below is the calculation in estimating the amount of reserves for year *t*:

$$E[v_t] = \begin{cases} 0\,; t = 0 \\ \left(500.000.000 \ \times \bar{A}^{1}_{40+t:\overline{20-t}|}\right) + (0.05G + 120.000)\ddot{a}_{40+t:\overline{10-t}|} - G.\ddot{a}_{40+t:\overline{10-t}|}; 1 \le t \le 10 \\ 500.000.000 \ \times \bar{A}^{1}_{40+t:\overline{20-t}|}\,; 10 < t \le 20 \end{cases} \quad (15)$$

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By using equation (15) with the Python programming language, the amount of reserves each year until the protection period expires is:

Table 1. GPV Reserve Estimation

Year	GPV Reserve using De-Moivre	GPV Reserve using TMI IV
0	IDR0	IDR0
1	IDR4,139,255	IDR2,295,002
2	IDR9,245,587	IDR4,925,987
3	IDR14,631,678	IDR7,603,332
4	IDR20,317,944	IDR10,321,054
5	IDR26,326,520	IDR13,062,928
6	IDR32,681,421	IDR15,817,058
7	IDR39,408,717	IDR18,566,075
8	IDR46,536,737	IDR21,296,775
9	IDR54,096,281	IDR24,000,259
10	IDR62,120,864	IDR26,667,179
11	IDR58,364,679	IDR25,782,726
12	IDR54,188,801	IDR24,603,897
13	IDR49,553,677	IDR23,085,257
14	IDR44,415,890	IDR21,177,549
15	IDR38,727,746	IDR18,842,193
16	IDR32,436,812	IDR16,037,056
17	IDR25,485,404	IDR12,746,426
18	IDR17,810,003	IDR8,968,355
19	IDR9,340,608	IDR4,716,260
20	IDR0	IDR0

The GPV Reserve column in tables (1) shows the number of reserves the company must prepare in each period. For example, in year 5, if the calculation uses the De-Moivre Mortality Law approach, the company must provide reserves for IDR26,326,520. Meanwhile, if the company use the Indonesian Life Table IV approach, the reserves that the company must prepare are IDR13,062,928.

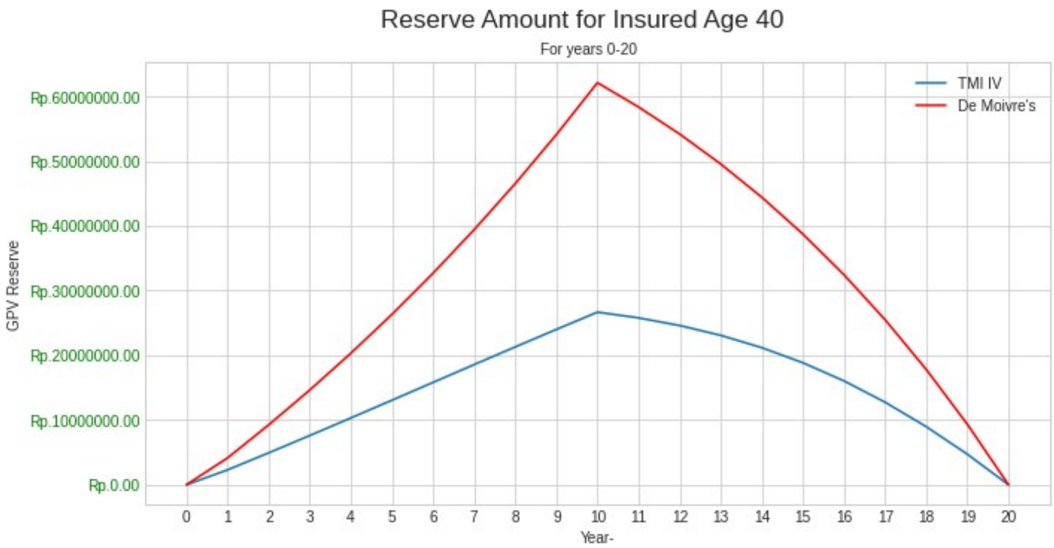

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Fig. 2. GPV reserve estimation in graph.

Fig. 2 shows a graph of the estimated reserves of the De-Moivre Mortality Law approach and the Indonesian Life Table IV. It can be seen that the estimated reserves during the premium payment period tend to increase until the 10th year. Meanwhile, after the 10th year, the estimated reserves tend to decrease. Then at the end of the year of protection, the reserve is 0.

4.3. Explanatory text

The amount of reserves generated from the two approaches to the law of mortality is undoubtedly different. Using the Indonesian Life Table IV, the gross premium and the resulting reserves tend to be smaller than the reserves produced using the De-Moivre assumption. The De-Moivre assumption has a larger reserve affected by the single net premium of term insurance value. It can be seen in Fig. 2 that with the two assumptions, the reserves will only have the same value in the 0 and 20 protection years, while for the other years, the reserves generated are different.

4.4. Discussion

After estimating the number of reserves from each approach, it can be concluded that the two approaches produce different reserves. This output is in line with the researchers' expectations. The magnitude of the different reserves is because the two approaches have a different probability of death, so it becomes one of the essential elements in calculating reserves.

5. Conclusion

After estimating reserves using the GPV method, it can be concluded that both De-Moivre's mortality law and Life Table IV have 0 reserves at the beginning of the first year. This means that the life insurance company does not need to prepare a reserve at the beginning of the year the insured joins the insurance because they receive a premium from the insured. The premium can be used to pay the required costs. Meanwhile, it can be seen that the reserves will continue to grow along with premium payments every year, and when they have been completed, the output will decrease. This happens because the protection period will decrease. Then when the protection period has ended, or in this case is in the 20th year, the reserve will be worth 0 because the insurance company has no obligation to protect the insured.

In comparison, the gross premium that must be paid by a 40-year-old male insured with a 20-year protection period and a ten-year premium payment period manages to have an enormous reserve when using the De-Moivre Mortality Law than the TMI IV approach. In addition, reserves for death benefits using the De- Moivre Mortality Law also tend to be more expensive than the TMI IV approach, so it can be concluded that the result of gross premium and benefit reserve with De-Moivre's Mortality Law will have a greater value in the GPV method.

For future research, the author hopes there will be a deeper study of life insurance premium reserves with other types of insurance, such as endowment insurance, whole life insurance, and pure endowment insurance. Future researchers can also use other approaches that were not used in this study, such as a retrospective approach and the Mortality Law approach of Makeham, Gompertz, or Weibull.

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