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RESERVES FOR SHARIA LIFE INSURANCE CONTRIBUTIONS USING THE GROSS PREMIUM VALUATION (GPV) METHOD BASED ON VASICEK MODEL

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ABSTRACT

Determining reserve for life insurance contributions has factors that influence it, such as contributions developed by participants and operational costs. Based on the financial services authority Number 71 of 2016, related to the company's financial health, one of which is that sharia insurance companies can make reserves for contributions. In this study, we discuss the calculation of the contribution of the initial value of return on investment which is sensitive and different calculations for the technical calculation of the contribution of sharia life insurance using the gross premium assessment method (GPV) by applying the Monte-Carlo simulation and using the vasicek model in calculating the discount factor so that with this method can recommend several possible contributions and contributions reserve from sharia life insurance products.

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1. INTRODUCTION

Currently, Indonesia is faced with the separation of sharia-based work units into a stand-alone sharia company, including sharia insurance which is still the main company as a work unit. The impact of this, of course, is that more experts in the field of sharia are needed, as well as field techniques who understand the concept of sharia, in insurance, there is an actuary profession that calculates related calculation concepts such as premiums and premium reserves. In Islamic insurance, the premium is also called a contribution. Unlike conventional insurance, where the premiums that go into the company are owned by the company, contributions to sharia insurance companies have two elements of "funds," namely *tabarru* and *ujrah*. Tabarru is funds used as grants from insurance participants if at any time it will be used to pay claims or insurance benefits. While *ujrah* is a fee given to managers for services in managing participants' *tabarru* funds. Therefore, there is a separation of *tabarru* and *ujrah* funds in the financial management of sharia insurance companies. In addition, there is a savings fund which is a deposit from sharia insurance participants and will receive an allocation for the results of the net investment income earned every year. Savings funds, along with profit sharing allocations, will be returned to participants if participants submit claims, either in the form of cash value claims or insurance benefit claims **[1]**.

The insurance company, in determining the amount of contribution that must be paid by the participant, needs to pay attention to the amount of *ujrah* as a participant fund management service which is also known as contributions. Not only the amount of contribution that is taken into account, but insurance companies also need to take into account the reserving for contributions because life and general insurance companies must meet the requirements for financial soundness based on Financial Services Authority Regulation Number 71 of 2016, namely solvency level, reserves, investment adequacy, equity, funds guarantees, and other provisions related to financial health so that the insurance company must prepare a certain amount of funds to pay its obligations in the event of risk in the future. In fact, insurance companies do not always make a profit. Therefore, insurance companies must be able to properly manage the company's finances **[2]**. Research conducted by **[3]** uses the Gross Premium Valuation (GPV) method in calculating premium reserves. Calculation of premium reserves from endowment life insurance using the gross premium reserve model approach can also use applications based on the Python programming language as designed by **[4]**. In addition to premium reserves, the company must also calculate the benefit reserve as the insurance company's obligation to pay a number of funds that must be prepared by the company, as was done by **[5]** determine the minimum and maximum benefit reserve value of whole life and term life insurance. Sharia insurance companies must avoid *riba*, *gharar*, *maysir* and *qimar* **[6][7]**, so that in calculations such as determining the amount of contribution, they must eliminate the element of interest as done by **[8]** calculating premiums with Islamic sharia principles, namely replacing the concept of interest with return on investment. And other research that replaces the concept of interest rate with investment can be seen in this article **[9][10]**. Furthermore, calculating term life insurance premium funds based on sharia principles with the concept of interest being replaced with Return on Investment (ROI) which changes stochastically following the Langevin type model and applying the Monte-Carlo simulation **[11]**. Another study that discusses the determination of premiums using the vasicek model and the cox-ingersol-ross model was conducted **[12]** where the vasicek model is a model that predict interest rate movements for the next time by looking at the previous interest rate movements. And another study that uses the vasicek model **[13]** which is used to calculate pension funds. The principle of the vasicek model is that follows the mean reverting phenomenon, namely the interest rate will always move towards the equilibrium point **[14]**.

Based on the description above, this study discusses the calculation of the contributions reserve using the GPV method with the concept of interest being replaced by ROI which changes stochastically following the vasicek model and applying the Monte-Carlo simulation.

2. RESEARCH METHODS

This study will discuss the calculation of the contribution and technical allowance of contributions from sharia life insurance by applying the Monte-Carlo simulation with male participants aged 35 years with an agreed period of 5 years and the amount of benefit of Rp. 100,000,000 and using the Indonesian Mortality Table (TMI) 2011. The simulation steps for calculating contributions and contributions reserve as follows:

1. Determine the age of the participant, the initial ROI value, the term of the agreement, and the amount of benefit.

2. Determine parameter values from the vasicek interest rate model.
3. Generate a random number distributed $\boldsymbol{N(0,1)}$ for five years with as many as 200 simulations.
4. Calculate ROI $\boldsymbol{r(t)}$ for five years of the agreement with 200 simulations with initial ROI values of 6% and 9%.
5. Calculate the single contribution of sharia life insurance for the duration of the agreement.
6. Calculate the sharia life insurance annuity for the duration of the agreement.
7. Calculate net contribution and gross contribution.
8. Calculate the contribution reserve every year.

3. RESULTS AND DISCUSSION

In determining the contribution that must be paid by sharia life insurance participants in this study, the age of the participants is 35 years old male with the term of the agreement is five years. The benefits that will be obtained by participants are assumed to be Rp.100.000.000. The vasicek model was used to determine $r(t)$ (ROI) with an initial $r(0)$ of 6% and 9%, respectively. The parameters for the ROI of the vasicek model are assuming $\theta = 0.06, \alpha = 0.5$ and $\sigma = 0.15$ [8], so we can determine $r(t)$ for each year by applying a Monte-Carlo simulation.

3.1. The Contribution Reserve

In determining the contribution that must be paid by sharia life insurance participants in this study, the age of the participants is 35 years old male with the term of the agreement is five years. The benefits that will be obtained by participants are assumed to be Rp.100.000.000. The vasicek model was used to determine $r(t)$ (ROI) with an initial $r(0)$ of 6% and 9%, respectively. The parameters for the ROI of the vasicek model are assuming $\theta = 0.06, \alpha = 0.5$ and $\sigma = 0.15$ [8], so we can determine $r(t)$ for each year by applying a Monte-Carlo simulation.

In this study, the life insurance product discussed is a term life insurance product where this product provides death compensation if the insured dies during the insurance period. Insurance participants must pay a sum of money to the company to be managed called a premium or in sharia life insurance referred to as a contribution so that if there is a death during the insurance period, the participant will get benefits from the insurance. The following mathematical equation is used to calculate the net contribution,[15]

$$P^n = \frac{A_{x:n}}{\ddot{a}_{x:n}} \tag{1}$$

with a discount factor that the expected financial benefits or costs of a future year into the present value expressed by

$$v_t = \prod_{s=1}^{t} \frac{1}{1+r(s)} \ , r(t) > -1, \forall s \tag{2}$$

where $r(t)$ is ROI, and assumes $v_0 = 1$. The present value of the n-year term life insurance benefit is denoted by Z, i.e.

$$Z = b_{t+1} v_{t+1} \tag{3}$$

The net single contribution for n-year term sharia insurance that provides 1 unit at the end of the year of death is expressed by

$$A_{x:n} = \sum_{t=0}^{n-1} \sum_{s=0}^{t} v_{s+1} \, {}_tp_x q_{x+t} \tag{4}$$

where ${}_tp_x = \frac{l_{x+t}}{l_x}$ [8].

Furthermore, to calculate the technical allowance for contributions in this study, use the formula below to calculate the gross contribution. Gross contribution is the contribution paid by insurance participants in the presence of operational costs, which are denoted by (acquisition cost), (maintenance cost), and (claim fee) meaning that the gross contribution has a greater value than the net contribution.

$$P^B = \frac{(1+\gamma) \times P^n}{(1-\beta) - \frac{\alpha}{\ddot{a}_{x:\bar{n}}}} \tag{5}$$

by using **Equation (1)**, **Equation (2)**, and **Equation (4)**, the contribution of sharia life insurance with male participants aged 35 years with an agreed period of 5 years and a simulated benefit of Rp100,000,000 is obtained as follows:

Table 1. Contribution of sharia life insurance male aged 35 years

	$r(0)$	Contribution
Min	6%	Rp343.549
	9%	Rp342.643
1st Qu	6%	Rp371.551
	9%	Rp370.417
Median	6%	Rp381.425
	9%	Rp380.407
Mean	6%	Rp380.790
	9%	Rp378.796
3rd Qu	6%	Rp390.965
	9%	Rp390.166
Max	6%	Rp419.506
	9%	Rp418.755

Based on **Table 1.** with two initial ROI values, namely 6% and 9%, the contribution to the initial ROI value of 6% is greater than the contribution to the initial ROI of 9%. Thus, the higher the initial ROI value, it can affect contributions that must be paid by participants. From the illustration, it can be seen that the average contribution for the initial 9% ROI is Rp. 380,407, while the average contribution with the initial ROI of 6% is Rp. 381,425. Thus, the income from the investment has an effect on the amount of the contribution that must be paid by the participants. The following is the contribution interval of male participants aged 35 to 40 years with an initial ROI value of 6% from 200 simulations.

Table 2. Contribution of male sharia life insurance participants 35-40 years

Age	Contribution Interval
35	Rp343.549-Rp418.755
36	Rp376.857-Rp482.980
37	Rp425.060-Rp547.342
38	Rp479.444-Rp617.259
39	Rp539.765-Rp693.341
40	Rp606.866-Rp778.656

3.2. Contribution of Sharia Life Insurance

Gross Premium reserve (GPV) is a calculation method based on the difference between the actuarial present value of future benefits and costs and the present value of premium and other income, and is formulated as follows:

$$V_t = PV_{FCO} - PV_{FCI} \tag{6}$$

Furthermore, the contribution reserve for term sharia life insurance will be calculated from male participants aged 35 years with an agreed period of 5 years with a contribution of Rp418.755 per year. The life insurance benefit is Rp100.000.000 with acquisition costs of 11.66%, maintenance costs of 2.57%, and claims costs of 3%. In calculating the contribution reserve using the GPV method, there is an inflow,

$$\begin{aligned} PV_{FCI} &= \text{kontribusi} \times a_{x+t:n-t} \\ &= \text{Rp}418.755 \times a_{x+t:n-t}, \end{aligned}$$

and the outflow is

$$\begin{aligned} PV_{FCO} &= \text{benefit} \times A_{x+t:n-t} + \text{acquisition costs} \times \text{contribution} \\ &\quad + \text{maintenance costs} \times \text{contribution} \times a_{x+t:n-t} \\ &\quad + \text{claim costs} \times \text{benefit} \times a_{x+t:n-t} \\ &= \text{Rp}100.000.000 \times A_{x+t:n-t} + 11.66\% \times \text{Rp}418.755 \\ &\quad + 2.57\% \times \text{Rp}418.755 \times a_{x+t:n-t} \\ &\quad + 3\% \times \text{Rp}100.000.000 \times a_{x+t:n-t} \end{aligned}$$

So, based on **Equation (6)**, the contribution reserve for sharia life insurance can be obtained as follows:

Table 3. **Sharia life insurance contribution reserve with $r(0) = 6\%$**

Year	1	2	3	4
Min	-37303	-45630	-45809	-27961
1st Qu	-34632	-41045	-41935	-25499
Median	-33583	-40240	-41097	-24443
Mean	-33292	-39670	-40862	-24285
3rd Qu	-32549	-38834	-40007	-23480
Max	-24000	-22768	-34240	-15491

Table 4. **Sharia life insurance contribution reserve with $r(0) = 9\%$**

Year	1	2	3	4
Min	-37281	-45443	-45619	-28037
1st Qu	-34632	-40967	-41859	-25629
Median	-33616	-40181	-41035	-24600
Mean	-33290	-39618	-40794	-24451
3rd Qu	-32593	-38793	-39956	-23665
Max	-24187	-23056	-34280	-15985

Based on **Table 3.** and **Table 4.** the maximum contribution reserve is negative. Therefore, with the assumed operating costs, the cash inflows have a greater value than the cash outflows, and the mean with an initial value of $r(0) = 9\%$ is greater than the mean of $r(0) = 6\%$. So that the greater then $r(0)$, the greater the contribution reserves. In year 1 to year 3, mean sharia life insurance contribution reserve has decreased and in year 4 has increased.

4. CONCLUSIONS

The calculation of the contribution reserve using the GPV method with the model used is that the contribution reserves each year is negative. This shows that the model used does not cover all aspects of cash flow. So that further research can apply the concept of a more accurate calculation. The Monte-Carlo simulation method in this study can be used as a recommendation in determining contributions and reserves because this method provides an overview of the possibilities that can occur from contributions or reserves. Sensitivity from the initial ROI value has an influence on the contribution to be paid to Islamic life insurance companies and provides a scheme for determining contributions depending on risk exposure at the same age.

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