



Determination of Life Microinsurance Premium Using the Commercial Rate Method

Azizah Rini Widyani^{1*}, Riaman², Sukono³

¹*Mathematics Undergraduate Study Program, Faculty of Mathematics and Natural Science, Universitas Padjadjaran, Jatinangor, Indonesia*

^{2,3}*Faculty of Mathematics and Natural Science, Universitas Padjadjaran, Jatinangor, Indonesia*

*Corresponding author email: azizah19001@mail.unpad.ac.id

Abstract

Microinsurance is insurance that is intended for people who have low incomes which is made with the aim that all levels of society can have insurance with affordable prices. Life insurance is a protection program for families in the event of unwanted things, such as death or permanent disability, to policy holders. This study aims to determine the life microinsurance premium. The data sample used is data on claim and benefit paid by life insurance company obtained from the official website of Otoritas Jasa Keuangan (OJK) Indonesia, which is assumed to have a log-normal distribution. The research method is to test the distribution of claims from the sample data using the Kolmogorov-Smirnov test. Then determine the value of the claim distribution parameter, and then calculating life microinsurance premium using the Commercial Rate method. The results obtained in the form of premium for life microinsurance that are payable by low-income people.

Keywords: Microinsurance, life insurance, life microinsurance, log-normal distribution, kolmogorov-smirnov, commercial rate method.

1. Introduction

Microinsurance in Indonesia is an insurance product intended for the lower class of society with an income of less than IDR 2,500,00.00. McCord (2007) and Africa et al. (2009) concluded on their research that life microinsurance products are the most sold in the microinsurance market. According to Bock & Ontiveros (2013) although the impact of microinsurance in the world varies, it seems to provide positive results with certain condition.

There are already many insurance companies that offer microinsurance products in Indonesia. One of the research on the determination of life microinsurance premiums has been conducted in Brazil by Silva & Afonso (2013) using the Commercial Rate method, where the price of the premium is differentiated based on the income of the lower class of society which is divided into 4 categories.

In this study, the determination of life microinsurance premiums was carried out using data on claims and benefits paid by life insurance companies in Indonesia for the period January 2019 to December 2022 which has a log-normal distribution. Low-income people here refer to the Otoritas Jasa Keuangan (OJK) Indonesia which categorizes them in one category only, namely people whose monthly income is less than IDR 2,500,000.00.

2. Literature Review

2.1. Life Microinsurance in Indonesia

Microinsurance was created with the aim that all levels of society can have insurance at affordable prices. Quoting Surat Edaran OJK Number 9 SEOJK.05/2017 concerning microinsurance products and marketing channels for microinsurance products, the characteristics of microinsurance products include simple, easy, economical, and immediate. Therefore, this insurance is packaged in a simple way, from features to administrative processes, as well as providing the fastest possible completion of compensation.

Microinsurance is not a strange thing in Indonesia, in fact, many insurance companies have included microinsurance as one of their products. Based on the 2017 OJK press release, microinsurance in Indonesia is growing rapidly with

premium values increasing by 80% and since 2013 OJK has implemented a series of programs to encourage the development of microinsurance.

2.2. Log-Normal Distribution

The probability density function of X with a log-normal distribution is defined in the following equation (Walpole et al., 2012)

$$f(x) = \begin{cases} \frac{1}{\sqrt{2\pi}x\sigma} \exp\left(-\frac{1}{2}\left(\frac{\ln(x) - \mu}{\sigma}\right)^2\right), & 0 < x, -\infty < \mu < \infty, \sigma > 0 \\ 0 & \text{lainnya} \end{cases} \quad (1)$$

with

μ : mean

σ : standard deviation

The cumulative distribution function for the log-normal distribution is defined in equation below.

$$F_X(x) = \Phi\left(\frac{\ln(x) - \mu}{\sigma}\right) \quad (2)$$

with Φ is the cumulative distribution function for normal distribution.

Expectations for a log-normal distribution are defined in equation below.

$$E(X) = \exp\left(\mu + \frac{1}{2}\sigma^2\right) \quad (3)$$

Variance for a log-normal distribution are defined in equation below.

$$Var(X) = \exp(2\mu + 2\sigma^2) - \exp(2\mu + \sigma^2) \quad (4)$$

2.3. Maximum Likelihood Estimator (MLE) Method

The maximum likelihood method is the best method for estimating the point of a parameter (Hogg et al., 2013). The likelihood function (likelihood function) of a random sample is as follows.

$$L(\theta) = L(\theta; x) = \prod_{i=1}^n f(x_i, \theta), \quad \theta \in \Omega \quad (5)$$

with

n : amount of data

θ : parameter

Ω : parameter space

Next is to form the logarithm of the function, which is denoted by the following equation.

$$l(\theta) = \ln(L(\theta)) = \sum_{i=1}^n f(x_i, \theta), \quad \theta \in \Omega \quad (6)$$

The parameter θ is estimated by finding a solution to the following equation.

$$\frac{\partial L(\theta)}{\partial \theta} = 0 \Leftrightarrow \frac{\partial l(\theta)}{\partial \theta} = 0 \quad (7)$$

2.4. Kolmogorov-Smirnov Test

The Kolmogorov-Smirnov test is a goodness of fit test, which means it tests the degree of suitability between certain theoretical distributions (Charavart et al., 1967). The hypothesis to be tested is:

H_0 : data with a log-normal distribution

H_1 : data is not log-normally distributed

Test statistics used:

$$D = \max_{t \leq x \leq u} |F_n(x) - F^*(x)| \quad (8)$$

with

$F_n(x)$: sample cumulative frequency distribution function

$F^*(x)$: theoretical cumulative distribution function

Decision:

H_0 is accepted if the value $D < D_{tabel}$

2.5. Pricing of Life Microinsurance with the Commercial Rate Method

The process begins by determining the Risk Rate or Mathematical Risk Value with the following equation (Silva et al., 2013).

$$q_x = \frac{NS}{NR} \quad (9)$$

with

q_x : Risk Rate

NS : average number of claims

NR : number of insurers

Then calculate the Pure Rate by entering the free Statistical Load which is defined in equation below (Silva et al., 2013).

$$TP = q_x(1 + \beta) \quad (10)$$

with

TP : Pure Rate

β : Statistical Load

Next, calculate the Commercial Rate by including two additional cost components, namely Commercial Load, which serves to cover administration costs, trading costs, and insurance company margin profits, and the second component is Employees' Profit Participation Program and Social Contribution on Billings or commonly called PIS/COFINS. For life insurance, the PIS/COFINS rate is 4.65%. Commercial Rate is defined in equation below (Silva et al., 2013).

$$TC = \frac{q_x(1 + \beta)(1 - PIS/COFINS)}{(1 - \gamma - PIS/COFINS)} \quad (11)$$

with

TC : Commercial Rate

$PIS/COFINS$: Employees' Profit Participation Program and Social Contribution on Billings

γ : Commercial Load

The next stage is the calculation of the Gross Rate which is calculated by including the cost of Encargos and Financial Operations Tax (FOT). In microinsurance, Encargos fees are assumed to be zero and the Financial Operations Tax rate for life insurance is 0.38%. The gross rate calculation is shown by the following equation (Silva et al., 2013).

$$TB = (TC + Encargos)(1 + FOT) \quad (12)$$

with

TB : Gross Rate

$Encargos$: costs

FOT : Financial Operation Tax

The last is to calculate the Gross Premium which is defined in the following equations (Silva et al., 2013).

$$PB_{Death} = CM \frac{q_x(1 + \beta)(1 - PIS/COFINS)}{(1 - \gamma - PIS/COFINS)} (1 + FOT) \quad (13)$$

$$PB_{Funeral} = CF \frac{q_x(1 + \beta)(1 - PIS/COFINS)}{(1 - \gamma - PIS/COFINS)} (1 + FOT) \quad (14)$$

$$PB_{Total} = PB_{Death} + PB_{Funeral} \quad (15)$$

3. Materials and Methods

3.1. Materials

The purpose of the research is to determine the premium of life microinsurance using the Commercial Rate Method. The data used is secondary data on claims and benefits paid by life insurance companies in Indonesia in the period January 2019 to December 2022. The data is based on the Otoritas Jasa Keuangan (OJK) Indonesia Insurance Statistics obtained from the official OJK website.

3.2. Methods

The steps taken in this research, namely:

- Determine the data used.
- The data is assumed to be log-normal distribution so it needs to be tested using the Kolmogorov-Smirnov goodness of fit test which refers to equation (8).
- After the data is proven to have a log-normal distribution then the parameters are estimated using maximum likelihood method which refers to equation (5) and (6) by inputting the probability density function of log-normal distribution which refers to equation (1). By maximizing $\ln L$ we get

$$\hat{\mu} = \frac{\sum_{i=1}^n (\ln(x_i))}{n} \quad (16)$$

and

$$\hat{\sigma}^2 = \frac{\sum_{i=1}^n \left(\ln(x_i) - \frac{\sum_{i=1}^n (\ln(x_i))}{n} \right)^2}{n} \quad (17)$$

for estimating parameter μ and σ .

- The determination of the life microinsurance premiums using the commercial rate method which refers to equation (9) – (15).

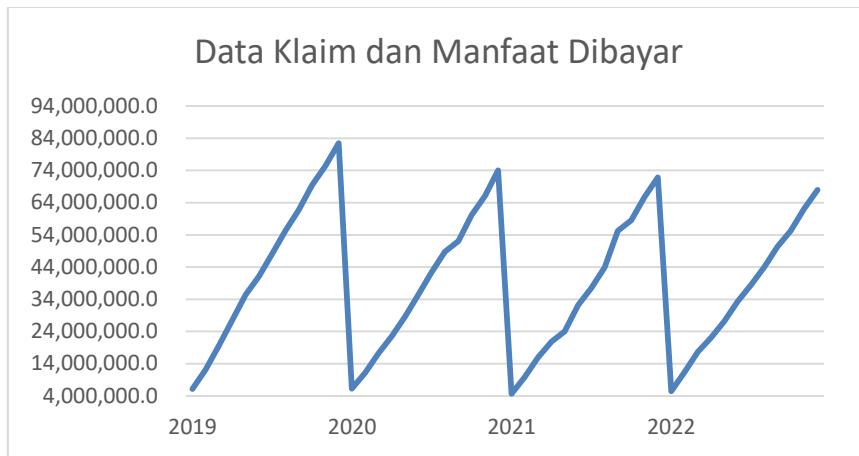
4. Results and Discussion

The following are the data on claims and benefits paid by life insurance companies in Indonesia in the period January 2019 to December 2022.

Table 1: Data on claims and benefits paid

	2022	2021	2020	2019
January	IDR5,422,498.00	IDR4,640,683.00	IDR6,211,122.00	IDR6,138,092.50
February	IDR11,289,741.00	IDR9,801,659.00	IDR11,256,495.00	IDR12,070,427.00
March	IDR17,713,301.00	IDR16,000,948.00	IDR17,168,825.00	IDR19,618,639.10
April	IDR22,087,449.00	IDR20,830,839.00	IDR22,538,036.00	IDR27,450,740.70
Mei	IDR27,187,594.00	IDR24,052,733.00	IDR28,667,387.00	IDR35,360,382.20
June	IDR33,252,729.00	IDR32,155,592.00	IDR35,444,654.00	IDR41,085,575.40
Jul	IDR38,475,634.00	IDR37,453,848.00	IDR42,481,254.00	IDR48,108,352.70
August	IDR43,940,175.00	IDR43,936,331.00	IDR48,797,286.00	IDR55,327,111.60
September	IDR50,326,895.00	IDR55,232,973.00	IDR52,083,104.00	IDR61,656,889.50
October	IDR55,243,475.00	IDR58,487,133.00	IDR60,146,074.10	IDR69,419,760.30
November	IDR62,066,193.00	IDR65,658,242.00	IDR66,080,389.00	IDR75,351,294.60
December	IDR67,936,278.30	IDR71,863,897.00	IDR74,028,101.00	IDR82,435,925.50

From Table 4.1 it can be described the graph presented in Figure 1 below.

**Figure 1:** Claims and benefits paid data

Testing the assumptions of the claim probability distribution model with $\alpha = 0.05$ is presented in Table 2 below.

Table 2: Kolmogorov-Smirnov Test Result

Lognormal					
Kolmogorov-Smirnov					
Sample Size	48				
Statistic	0.12946				
α	0.2	0.1	0.05	0.02	0.01
CriticalValue	0.1513	0.17302	0.19221	0.21493	0.23059
Reject?	No	No	No	No	No

Based on Table 2, the D statistical value of the sample data with a log-normal distribution is 0.12946. It can also be seen that the D_{table} value for the significance level $\alpha = 0.05$ is 0.19221. Because $D < D_{table}$, the H_0 hypothesis is accepted, meaning that the sample data is log-normal distribution with an error tolerance of 5%.

Because the assumption test proves that the sample data is log-normal distribution, the expectation from the log-normal distribution is used to calculate the average number of claims so we need to estimate the μ and σ parameters. Using the equation (16) and (17) as follows:

$n: 48$

$$\hat{\mu} = \frac{828.137}{48} = 17.253$$

$$\hat{\sigma} = \sqrt{\frac{27.7615}{48}} = 0.7605$$

The premium is calculated using the equation (9) – (15) as follows:

$\beta: 0.05$

$\theta: 0.05$

PIS/COFINS: 4.65%

FOT: 0.58%

$$q_x = \frac{\exp\left(17.253 + \frac{1}{2}(0.7605)^2\right)}{85,051,000.00} = 0.488419$$

$$TP = 0.488419(1 + 0.05) = 0.51284$$

$$TC = \frac{0.51284(1 - 0.0465)}{(1 - 0.05 - 0.0465)} = 0.541221$$

$$TB = (0.541221 + 0)(1 + 0.0038) = 0.543277$$

Based on DKI Regional Regulation (Perda) Number 1 of 2015 concerning Regional Retribution, the maximum price for public funerals in Jakarta is IDR 275,000.00. Therefore, it is assumed that funeral coverage costs (CF) are generalized, namely IDR 275,000.00. Coverage costs for death from any cause (CM) are also assumed to be equal to IDR 500,000.00.

$$PB_{Death} = (500,000)(0.543277) = 271,638.70$$

$$PB_{Funeral} = (275,000)(0.543277) = 149,401.30$$

$$PB_{Total} = 271,638.70 + 149,401.30 = 421,040.00$$

5. Discussion

Based on the Table 1, there are 48 data obtained with the minimum is IDR 4,640,683.00 and the maximum is IDR 82,435,925.50. Based on the Table 2, the test results of the proven assumption that the sample data is log-normal distribution. This shows that the amount of claims and benefits paid by life insurance companies in Indonesia is always positive.

Based on Figure 1 the number of claims and benefits paid by life insurance companies in Indonesia increases every year. However, there was a decrease from 2019 to 2022. The price of the life microinsurance premiums that calculated using commercial rate method is IDR 421,040.00.

6. Conclusion

The study has proposed microinsurance products providing coverages for death due to any cause and coverage for funeral expenses. Based on the calculation of the premiums using the commercial method, life microinsurance premiums obtained is IDR 421,040.00 monthly is quite low for those low income below IDR 2,500,000.00. It is recommended that future studies add additional calculation stages, for example, calculation of premium reserves for life microinsurance and sensitivity analysis.

References

Bock, O. de, & Ontiveros, D. U. (2013). Literature review on the impact of microinsurance. *International Labour Office, Geneva*, (35), 1–15.

Chakravart, N., Laha., & Roy, B. (1967). *Handbook of methods of applied statistics*. New York: John Wiley and Sons.

Hogg, R. V., McKean, J. V., & Craig, A. T. (2013). *Introduction to mathematical statistics*. United States: Pearson Education.

Mccord, M. J. (2007). *The landscape of microinsurance in the world 's 100 poorest countries*. Wisconsin: In Practice.

Matul, M., Mccord, M. J., Phily, C., & Harms, J. (2009). The landscape of microinsurance in Africa. *International Labour Organization*, 1–8.

Silva, K. R., & Afonso, L. E. (2013). A study on life microinsurance in Brazil. *Brazilian Business Review*, 10(3), 130–155. doi: 10.15728/bbr.2013.10.3.6.

Walpole, R. E., Raymon, H. M., Shaton, L. M., & Keing, Y. (2012). *Probability and statistics for engineers & scientists*. 9th edn. Boston: Pearson Education, Inc.