Application of Point to Point Method in Determining Participation Rate for Unit Linked Product with Minimum Guarantee

[1]Tamara Putri Andini, [2]Bona Christanto Siahaan

Abstract— The investment results of unit link products with stock investment strategies produce higher returns but tend to have higher investment risk as well. To avoid the investment risk, this study discusses insurance contracts with Equity Indexed Annuity (EIA) using a point to point method that provides a minimum guaranteed interest rate by taking into account the participation rate of the insured that determines the amount of profit sharing from investment so that the insured and insurance companies both benefit considering the condition of stock price movements in Indonesia. This study shows that the higher the guaranteed interest rate given to unit link contracts, the lower the participation rate at the policy. This study also show that higher stock volatility provides a lower participation rate. The higher the minimum guaranteed interest rate given to the product, the lower the level of participation of the insured. When the risk-free rate is higher than the minimum guarantee, the participation rate generated is higher and tend to be the same for each age and guaranteed interest rates. The participation rates for male and female insured tend to be the same for younger ages, but different for older ages.

Index Terms— Point to Point Method, EIA, Minimum Guarantee, Participation Rate, Life Insurance, BSM, Investment

———————————————————— ◆ ————————————————————

1 INTRODUCTION

Unit link life insurance contracts connect the number of benefits with a financial asset, can be in the form of stock indices, foreign currencies, and others (Bacinello and Persson, 1998). According to the Financial Services Sector Consumer Protection Study: Unit Link (2017), currently unit link insurance products have become one of the mainstay products of life insurance companies in Indonesia. Throughout 2017, data from the Indonesian Life Insurance Association (AAJI) noted that the premium portion of unit link life insurance products reached 53.1%. The trend of unit link insurance products from 2013 to the end of 2017 has always increased with an average increase of around 14.2%.

One method of calculating the premium for unit link products is Equity Indexed Annuity (EIA). EIA guarantee a minimum accumulated rate of return from the premium paid by the insured. Determining the size of unit link life insurance premiums that guarantee a minimum rate of return is influenced by the level of participation (Gaillardetz and Lakhmiri, 2011) because the participation rate determines the amount of profit sharing from the investment that will be received by the insured. Calculation of the participation rate determines the amount of profit sharing from investment in unit link life insurance products so that the insured and insurance companies both benefit. Some common forms of insurance with the EIA design are the point to point method, annual ratchet method, and high water mark method (Zhang, 1998). In the point to point method, investment returns are calculated based on the difference between the stock price at maturity and the stock price at the time of the policy contract so that stock price fluctuations between the beginning and end of the policy contract period are ignored (Hardy, 2003). Also, this method provides a higher participation rate than the other two methods, so that when the performance of the stock price rises it will provide more significant benefits for policyholders.

This study aims to calculate the optimum participation rate by using the point to point method for several unit link products in Indonesia with stock investment strategies. This study analyzes how the minimum guarantees, stock volatility, risk-free rates, and mortality rates affected by age and gender of the insured affect the participation rate in the policy, so that the optimum participation rate can be determined for the company to guarantee the minimum rate of return on unit link products, taking into account the condition of the movement of stocks in Indonesia.

2 LITERATURE REVIEW

2.1 Unit Link Contract with Equity-Indexed Annuity (EIA)

In unit link life insurance contracts with EIA, there is a determined participation rate to guarantee the minimum rate of return (Gaillardetz and Lakhmiri, 2011). EIA protects against losses when stock performance decreases, with 100β percent of premium guaranteed by the company and a minimum guarantee of a return rate of g percent in stock investments (Gaillardetz and Lakhmiri, 2011). The calculation results using the EIA method use the basis of Black Scholes Merton theory. In determining the participation rate in an insurance contract with the EIA method, the variables included in the calculation are guarantee interest rates, risk-free interest rates, and mortality rate.

In discussing Equity-Indexed Annuities (EIA), especially the point-to-point method, there are many previous studies which were previous developments. Brennan & Schwartz (1976) conducted a study of premium pricing or determination using the Black Scholes method with a guaranteed minimum benefit and set the price of asset guarantees on risk-free life insurance products. In 1997, Boyle & Hardy examined options for annuities that

were guaranteed and the comparison between financial and actuarial approaches that were in line with market conditions. Furthermore, Lin & Tan (2003) developed a more general model for Equity-Indexed Annuity (EIA). Gaillardetz & Lakhmiri (2011) conducted a study of a new premium principle for EIA which calculate the participation rate of EIA and reduce financial risk and mortality risk. In Indonesia, Hendrawan (2012) conducted a study of determining unit-linked contract premiums which concluded that there was a significant relationship between the length of payment and the number of premiums. Perdana (2013) researches determining participation rates for unit-linked contracts using the annual ratchet method. Dewi (2016) compared the simple ratchet and compound ratchet methods for determining the participation rate. Hayati (2015) conducted a study on determining the participation rate in unit link product using the point to point method based on one stock investment of the product.

2.2 Unit Link Participation Rate with Point to Point Method

Assuming the value $S_0 = 1$ unit, the investment returns obtained at time t with the point to point method can be written as follows:

$$H_t = \frac{S_t - S_0}{S_0} = \frac{S_t - 1}{1} = S_t - 1 \qquad (1)$$

The benefit structure of an investment at time t uses the point to point method with a minimum guarantee of g is:

$$D_t = maks[\min[1 + \alpha H_t, (1 + c)^t], \beta(1 + g)^t] \qquad (2)$$

The investment value of the D_t benefit structure in the above equation is expressed as $\Pi(t, n)$ obtained through expectations of the D_t benefit structure and the discount function with risk-free interest rate r, at $0 \leq t \leq n$ is as follows (Gaillardetz and Lakhmiri, 2011):

$$\Pi(t,n) = e^{-r(n-t)}[(1-\alpha)\Phi(C) + (\beta(1+g)^n\Phi(-C) + \alpha S_t\Phi(C + \sigma\sqrt{n-t})] \qquad (3)$$

where

$$C = \frac{\left(r - \frac{1}{2}\sigma^2\right)(n-t) - \ln\left(\frac{\beta(1+g)^n - (1-\alpha)}{\alpha S_t}\right)}{\sigma\sqrt{n-t}}$$

and Φ is the density function of the Standard Normal distribution.

Calculation of optimum participation rates is obtained with the assumption that the present value of unit link life insurance is one monetary unit at $t = 0$ (Gaillardetz and Lakhmiri, 2011):

$$\sum_{k=0}^{n-1} \Pi(0, k+1) \, {}_kp_xq_{x+k} + \Pi(0, n) \, {}_np_x = 1 \qquad (4)$$

3 METHODOLOGY

In calculating the participation rate of unit link products, the factors are risk-free interest rates, volatility, guaranteed interest rates, and mortality rates (age and gender). This research begins by determining unit link products, assumptions, and limitations in calculations. The products to be analyzed are PRIME and EXLNT from PT ABC which are unit link products with stock investment strategy. The data sample used is secondary data, namely the daily closing price data for one year in the period January 1, 2017, to January 1, 2018, totaling 255 data of each five stocks with most significant weight in both products. The data tested for normality assumption and used to calculate the rate of return and volatility. Mortality rates were calculated using the Indonesian Mortality Table (TMI 2011) published by the Indonesian Life Insurance Association (AAJI) for each male and female. The participation rate is calculated using the point to point method, using R software.

4 RESULTS AND DISCUSSION

4.1 Product Investment Allocation, Data Normality Test, and Volatility Calculations

The allocation of investment in stocks for PRIME and EXLNT products is 96.73% and 94.05% respectively.

The five stocks with the most significant allocation of the product in January 2018, namely for PRIME products are 9.59% BBCA, 9.38% BBRI, 8.89% HMSP, 8.62% UNVR, and 8.35% TLKM, and for EXLNT products is 8.95% CPIN, 7.19% CTRA, 6.87% LPPF, 5.82% PWON, and 5.36% BSDE.

The results of the normality test with the Kolmogorov-Smirnov test show that the log-return of both products are following the normal distribution. Furthermore, the volatility of the two products is calculated from the portfolio log-return data of the five stocks mentioned above.

Table 1: Log Return Data Normality Test

Uji Kolmogorov-Smirnov			
	Statistic	df	Sig.
PRIME	0.056	254	0.051
EXLNT	0.051	254	0.200

Table 2: Product Volatility Calculations

	$\bar{R}_t$	Variansi	Jumlah Data (m)	Volatilitas (σ)
PRIME	0.001178	0.00005721	255	12.01%
EXLNT	-0.000347	0.0001769	255	21.11%

The risk-free interest rate assumption of the 3-month SPN is based on the Bank Indonesia auction system as of July 20, 2018, which is 5.2183%, and the risk-free interest rate is based on the fair yield of government bonds for the 10-year tenor of 8.1743%. Guaranteed interest rates as the lower limit of the rate of return used to meet non-forfeiture law, which is greater than or equal to 3% (Gaillardetz and Lakhmiri, 2011) and in this study are limited to 6%. The analysis of the level of participation based on age begins with the age of entry into the workforce in Indonesia, which is 15 years, up to the age of 90 years.

4.2 Participation Rate: PRIME

The results of the calculation of participation rates for

policies with guaranteed interest rates $(g) = 3\% - 6\%$, volatility $(\sigma) = 12.01\%$, and risk-free interest rate assumption $(r) = 5.2183\%$ for male and female insured are shown in the graph below:
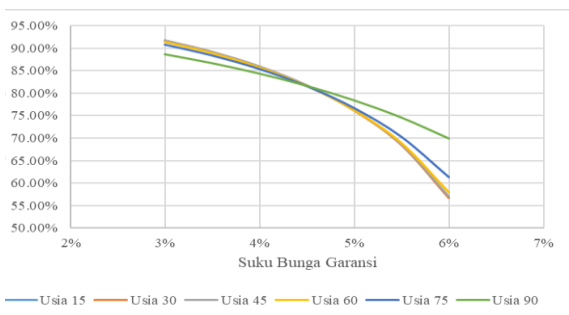

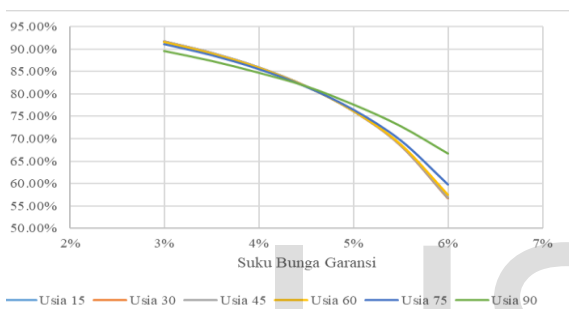Figure 1: Change in PRIME Participation Rate for Male Insured

Figure 2: Change in PRIME Participation Rate for Female Insured

Age and gender affect the participation rate produced, due to differences in mortality rates for each age of male and female. Based on TMI 2011, at an old age, women have different life probability than men. The participation rates generated for both sexes tend to be the same for younger ages, but different for older ages. The older the age of the insured, the smaller the difference in changes in the participation rates produced.

The results of the calculations of participation rates for the same policy using the assumption of a risk-free interest rate $(r) = 8.1743\%$ for female insured is as follows:
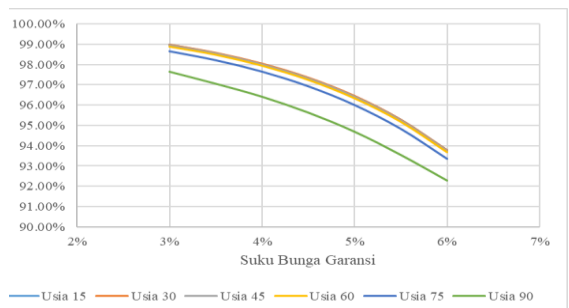

Figure 3: Change in PRIME Participation Rate for Female Insured Based on Government Bond Rate

For calculations based on a risk-free interest rate of 3 months SPN which is equal to r = 5.21833%, when the guaranteed interest rate approaches or higher than the risk-free interest rate, the older the age the higher the participation rate for g = 5%

-6%. Whereas at g = 3% -4%, the older the age, the smaller the level of participation of the insured. For calculations based on government bond risk-free interest rate r = 8.1743%, where the risk-free interest rate is higher than the minimum guarantee given, the participation rate is higher and the difference is small for each age and guarantees interest rate.

4.3 Participation Rate: EXLNT

The results of the calculation of participation rates for policies with guaranteed interest rates $(g) = 3\% - 6\%$, volatility $(\sigma) = 21.11\%$, and risk-free interest rate assumption $(r) = 5.2183\%$ for male and female insured are shown in the graph below:
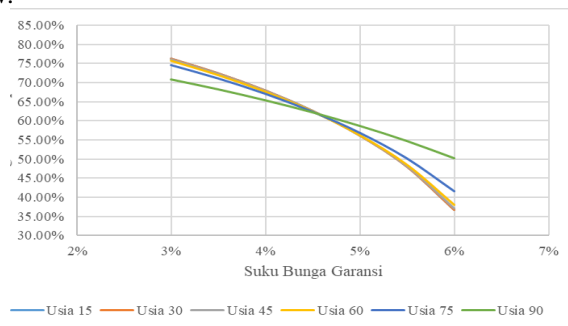

Figure 4: Change in EXLNT Participation Rate for Male Insured
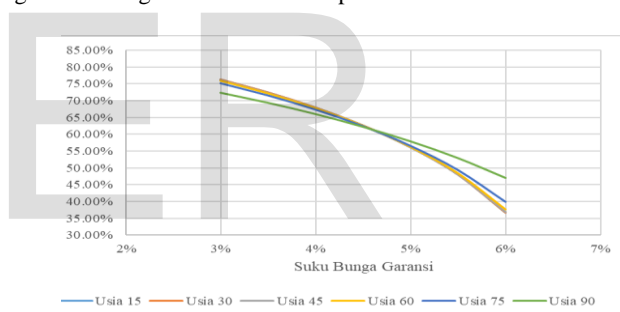

Figure 5: Change in EXLNT Participation Rate for Female Insured

While the results of the calculations of participation rates for the same policy using the assumption of a risk-free interest rate $(r) = 8.1743\%$ for female insured is as follows:
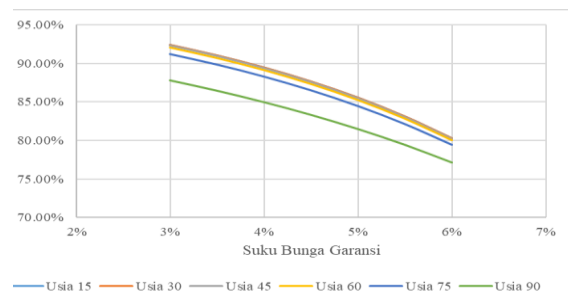

Figure 6: Change in ELXNT Participation Rate for Female Insured Based on Government Bond

The participation rates determine the amount of profit sharing from investment in unit link life insurance products so that the insured and the insurance company both benefit. The higher the minimum guarantee of the rate of return given to the

product, the lower the level of participation or the proportion of the investment profit that will be obtained by the insured. The high guarantee interest rate can protect the insured if there is a decline in the value of the investment, and the insurance company benefits if the investment performance is good with the participation rate or profit proportion. Of the two unit link products with different volatility, it was found that higher volatility products, namely EXLNT, resulted in lower participation rates compared to lower volatility products, namely PRIME. High volatility can be interpreted as the more significant the profit an insurance company can get, but also with greater investment risk. The range of differences in participation rates for each age and guarantee interest rates are more significant for products that have higher volatility.

Table 3: Comparison of Participation Rates for PRIME and EXLNT Products

| Age | Interest Rate Guarantee | | | | | | | |
| | 3% | | 4% | | 5% | | 6% | |
	PRIME	EXLNT	PRIME	EXLNT	PRIME	EXLNT	PRIME	EXLNT
15	91.67	76.22	85.88	67.89	76.14	56.13	56.72	36.71
20	91.67	76.21	85.88	67.89	76.14	56.13	56.75	36.74
25	91.67	76.21	85.88	67.89	76.14	56.13	56.75	36.74
30	91.67	76.21	85.88	67.89	76.14	56.13	56.76	36.75
35	91.66	76.20	85.88	67.88	76.14	56.14	56.79	36.78
40	91.65	76.17	85.87	67.87	76.15	56.15	56.87	36.86
45	91.62	76.12	85.85	67.84	76.17	56.17	57.02	37.02
50	91.57	76.03	85.82	67.80	76.19	56.20	57.28	37.30
55	91.52	75.93	85.79	67.74	76.23	56.25	57.60	37.63
60	91.44	75.79	85.74	67.67	76.27	56.30	58.01	38.06
65	91.32	75.57	85.67	67.55	76.34	56.40	58.65	38.73
70	91.12	75.20	85.54	67.36	76.47	56.55	59.69	39.80
75	90.76	74.56	85.34	67.03	76.68	56.81	61.35	41.52
80	90.20	73.56	85.02	66.53	77.05	57.25	63.79	44.02
85	89.45	72.23	84.65	65.92	77.63	57.87	66.81	47.09
90	88.69	70.87	84.37	65.38	78.39	58.65	69.86	50.14

5 CONCLUSION

The higher the minimum guarantee of the rate of return given to the product, the lower the participation rate. The minimum guarantee eliminates the risk of the insured losing money due to a decrease in investment returns, while the participation rate provides a proportion of profits for the company when investment performance is excellent.

Of the two unit-linked life insurance products with different volatility, it was found that products with higher volatility resulted in lower participation rates. The range of differences in participation rates is more significant for products that have higher volatility. It was also concluded that the calculation uses risk-free interest rates based on government bonds r = 8.1743%,

where the risk-free interest rate is higher than the minimum guarantee given, resulting in a higher participation rate and a small difference for each age and guarantee interest rate, compared to the calculation uses risk-free interest rates based on the 3-month SPN which is equal to r = 5.2183%.

The participation rates for male and female insured tend to be the same for younger ages, but different for older ages. This is due to differences in mortality rates in this study using the Indonesian Mortality Table 2011.

REFERENCES

[1] Asosiasi Asuransi Jiwa Indonesia. *AAJI Daily News.* <http://aaji.or.id/Berita/> (13 July 2018).
[2] Bacinello, Anna Rita, Persson, Svein-Arne. *Design and Pricing of Equity-Linked Life Insurance under Stochastic Interest Rates.* 1998. Bank Indonesia. *Lelang Sertifikat BI.* <https://bi.go.id/id/moneter/operasi/suku-bunga-sbi/> (2 October 2018).
[3] Bingham, N. H. dan Kiesel, Rudiger. (2004). *Risk Neutral Valuation: Pricing and Hedging of Financial Derivatives* (2nd Edition). Springer Finance.
[4] Bodie, Kane, Marcus. (2014). *Investments, Asia Global Edition.* McGraw Hill Education.
[5] Bowers et al, (1997). *Actuarial Mathematics* (2nd Edition). The Society Of Actuaries.
[6] Dewi, Christina. (2016). *Aplikasi Metode Annual Ratchet dalam Penentuan Premi dan Manfaat Asuransi Jiwa Dwiguna Partisipasi dengan Garansi Suku Bunga Minimum pada Perusahaan ABC.* Tesis Program Studi Manajemen Aktuaria. Universitas Indonesia, Jakarta.
[7] Dickson, Hardy, Waters. (2009). *Actuarial Mathematics for Life Contingent Risks* (1st Edition). USA: Cambridge University Press.
[8] Easton, A. E. & Harris, T. F. (2007). *Actuarial Aspects of Individual Life Insurance and Annuity Contracts* (2nd edition). USA: ACTEX Publications, Inc.
[9] Gaillardetz, Patrice dan Joe Youssef Lakhmiri. (2011). "A New Premium Principle For Equity Indexed Annuities". *The Journal of Risk and Insurance* 78, No 1.
[10] Hardy, Mary. *Investment Guarantees: Modelling and Risk Management for Equity-Linked Life Insurance.* USA: John Wiley & Sons, Inc, 2003.
[11] Harrison, J. Michael dan Pliska, Stanley. (1981). "Martingales and Stochastic Integrals in the Theory of Continuous Trading". *Stochastic Processes and Their Applications* 11, 215-260.
[12] Hayati, Erna. (2015). Penentuan Tingkat Partisipasi pada Asuransi Jiwa Unit Link dengan Metode *Point to Point. Jurnal Ilmu Sosial dan Humaniora*, Vol 3 No 2.
[13] Indonesia Bond Pricing Agency. *Harga dan Yield Wajar Obligasi Pemerintah Indonesia Seri Benchmark.* <http://www.ibpa.co.id/ > (diakses 3 Desember 2018).
[14] Knopf, Peter dan Teall, John. *Risk Neutral Pricing and Financial Mathematics.* USA: Elsevier. 2015.
[15] Kontan. *Produk Unit Link Strategi Investasi Saham dengan Return Tertinggi* <https://keuangan.kontan.co.id/> (9 August 2018).
[16] Nachrowi, Nachrowi dan Usman, Hardius. *Pendekatan Populer dan Praktis Ekonometrika untuk Analisis Ekonomi dan*

Keuangan. Jakarta: Lembaga Penerbit Fakultas Ekonomi Universitas Indonesia.

[17] Otoritas Jasa Keuangan. *Kajian Perlindungan Konsumen Sektor Jasa Keuangan: Unit Link*. Jakarta: Departemen Perlindungan Konsumen OJK, 2017.

[18] Perdana, Hendra. *Penentuan Tingkat Partisipasi untuk Kontrak Asuransi Jiwa Dwiguna Unit Link dengan Menggunakan Metode Annual Ratchet*. Tesis Program Studi Matematika. Universitas Gadjah Mada, Yogyakarta.

[19] Pindyck, Robert S dan Rubinfeld, Daniel. (1991). *Econometric Models & Economic Forecasts (3rd Edition)*. McGraw Hill Education: International Editions.

[20] Zhang, P. G. (1998). *Exotic Options* (2nd Edition). Singapore: World Scientific Publishing.

IJSER