BAREKENG: Journal of Mathematics and Its Application
September 2022 Volume 16 Issue 3 Page 787–796
P-ISSN: 1978-7227 E-ISSN: 2615-3017
https://doi.org/10.30598/barekengvol16iss3pp787-796

CALCULATION OF CREDITED INTEREST RATE WITH INVESTMENT YEAR METHOD AND PORTFOLIO METHOD

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Abstract. *The rate of return on investment for unit-linked insurance products in Indonesia is still volatile and depends on the performance of investment instruments. However, the net return on investment that is given to policyholders is projected at the beginning of the year and is used as a benchmark for choosing the right investment instrument, referred to as the credited interest rate. Interest rate movements affect the yield of the credited interest rate. Therefore, the credited interest rate calculation requires appropriate methods to reduce the risk of loss, which are the Investment Year Method and the Portfolio Method. Research shows that the Investment Year Method is more appropriate in an unstable interest rate condition, whereas the Portfolio Method is better utilized in a stabilized environment. In addition, this research also shows the strategy to manage investment instruments with asset rollover to suit the fluctuating credit interest rate.*

Keywords: *Credited Interest Rate, Investment Year Method, Portfolio Method, Asset Rollover.*

Article info:

Submitted: 20th March 2022 *Accepted: 5th July 2022*

How to cite this article:
J. Aryento, F. Kusnadi and D. Lesmono, "CALCULATION OF CREDITED INTEREST RATE WITH INVESTMENT YEAR METHOD AND PORTFOLIO METHOD", *BAREKENG: J. Math. & App.*, vol. 16, iss. 3, pp. 787-796, September, 2022.

1. INTRODUCTION

Interest rates are closely related to the insurance industry. In general, guaranteed interest rate assumption is used to remedy the effects of fluctuating interest rates in the market that heavily affect insurance products [1], [2]. The premium, reserves, yield rates, and other important aspects are calculated using the interest rate assumption. When an insurance company sells an insurance product, it needs to cover initial costs such as agents' commission and acquisition costs. In the next few years, it also has to cover other costs, such as death benefits, capital, and investment returns, which are shared with the policy holders [3].

One of the most well-known insurance products in Indonesia is unit link, which gives protection and investment functions for policy holders. Some of the premium gained is allocated to numerous investment instruments, based on the risk appetite of each policy holder [4], [5]. The investment return from these unit link products is to be shared with the policy holders. Interest rates play an important role in investment returns, and their fluctuations have a significant impact on the performance of the insurance company [6].

Nowadays, insurance companies initially provide fund projections or account values to potential policy holders. These potential customers will then compare the projections to the market. The projection used is the same for every policy holder and is assumed to be level for each year [2], segregated by the market conditions, which could be optimistic, normal, or pessimistic. However, if there is a significant change in the interest rate fluctuation that drastically modifies the investment returns, the account values of each policy holder would diverge from the initial projection. This will surely make policy holders feel disappointed or misguided [7].

Insurance companies need to show a better solution to optimize the initial fund projections that can adapt to the interest rate in the long term. Another benefit that results from this solution is that the investment manager can gradually tailor the rates to produce account values that are not significantly different from the initial projections. Normally, insurance companies and pension funds use guaranteed values as a means to remedy the effects of fluctuating interest rates [2].

The rate is usually calculated using Net Present Value [9]. However, the formula requires historical data as well as the desired investment returns. The method seems ineffective if used for the first time or if there is not enough historical data. Aside from that, the method cannot adapt to market conditions in the long run. Ulm [10] constructs a strategy to set high investment returns in the first year to attract policy holders, then guarantees the minimum return for the consecutive years. However, this method is adequately applied only in low interest rate conditions.

Oliviera et al. [11] suggests utilizing the Gauss-Markov term-structure model and the model developed by Heath et al. [12]. They conclude that the stochastic term structure of interest rate is well applied to interest rate risks in the 2000-2010 German bond market. Another alternative presented is to use the Vasicek model and Cox-Ingersoll-Ross (CIR) model [13]–[15]. However, these stochastic models require complex parameters that require initial estimation and comprehensive data. Thus, in this research, we introduce a simpler and more practical model that does not require an extensive amount of historical data.

We propose a credited interest rate method as the benchmark for selecting the appropriate investment instruments. Hoyt [8] agrees that the credited interest rate is material in valuing the policy performance. In practice, insurance companies overseas usually apply credit insurance rates to universal life products. However, universal life products are not common in Indonesia, where there are only a few Indonesian companies that sell the products. In theory, the credited interest rate can also be applied to unit link insurance products that assume death benefits and other expenses to be level for each year.

As we initially stated, level amounts of benefits and expenses diverge the credited interest rate from the real investment return [16]. Based on Vaaler and Daniel [17], the interest rates need to be immediately valued when the instrument is invested to obtain an objective result. The investment year and portfolio methods are used to evaluate the interest rates throughout the years. The techniques used by both the methods are considered simple, thus eliminating the risks of human error. Therefore, this paper focuses on finding the credited interest rate amounts based on the two methods.

In this research, the theory and the two methods to calculate the credited interest rates are stated in Section 2. Analysis of three different economic conditions that affect the credited interest rate movements as well as investment asset management of the unit link insurance products are discussed in Section 3. The investment instruments used are the Indonesian government bonds with 3 and 5 years maturities as they develop relatively stable and safe cashflow projections that minimize the default risk [18]. Finally, in the last section, conclusions are provided.

2. RESEARCH METHOD

2.1 Credited Interest Rate

Credited interest rate is the net investment return that is given back to policy holders. The return rate is calculated through the sales of policies and is converted to basis points (1 bp = 0,01%). It is usually adjusted to the statutory reserve, which is the funds needed to pay benefits to policy holders. The allocation of investment returns is then credited to policy holder accounts. The pricing spread represents expenses incurred by the company. It represents the present value of all incurred expenses and compensation to issue a policy, which includes employee salary, commission, delivery fees, advertisement fees, and maintenance costs. The resulting credited interest rate formula is shown below.

Credited Interest Rate = Premium – Invesment Fees – Default Expenses – Liquidity Costs – Pricing Spread, with Pricing Spread = Expense Charge + Maintenance Costs + Marketing Fees + Commission Fees + Profit Margin + Capital Expenses. (1)

2.2 Duration and End-of-Year Duration Valuation

The average time of a financial transaction is important to be consider as it values and analyzes the future cashflows. One of the methods that can be used is called the durational method, which calculates a weighted average of the numerous cashflows, where the weights are equal to the present value of each cashflow. The weighted average is also known as the average time value.

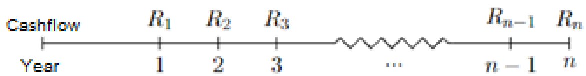

Figure 1. Example of An Asset Cashflow

The formula of the simplest duration method is called the Macaulay duration which is as given [19]:

$$\bar{d} = \frac{\sum_{t=1}^{n} t \cdot v^t \cdot R_t}{\sum_{t=1}^{n} v^t \cdot R_t} \tag{2}$$

with:

- discount rate $v = \frac{1}{1+i}$,
- yield rate i,
- number of cashflows n,
- the time (in year) of a cashflow t, and
- cashflow amount of R_t at time t.

Duration is calculated at the end of year. For example, if an asset has maturity date of n years, then the duration at the end of year k is calculated using the formula as given below:

$$\bar{d}_k = \frac{\sum_{t=1}^{n-k} t \cdot v^t \cdot R_{k+t}}{\sum_{t=1}^{n-k} v^t \cdot R_{k+t}} \tag{3}$$

with the same parameters as in Eq. (2). Note that there is only one of each end-of-year cashflow, and the cashflow at the end-of-year k is not included in Eq. (3) as it already happened at the time of the duration calculation. The formula in Eq. (3) uses the prospective outlook in which it suggests that all past transactions are removed, thus only future transactions are kept.

2.3 Relationship Between Credited Interest Rate and Investment

Credited interest rate is the net yield rate of the investment function of the unit link product that is given back to the policy holders. The credited rate is usually updated on each period. In this research, the credited rate is calculated utilizing the assumption of switching the initial asset to other assets, which is known as asset rollover, and is calculated as $\frac{1}{2\bar{d}}$.

Asset rollover uses the linear interpolation between the renewal credited rate on the valued period (T_p) and the credited interest rate on the previous period. Each time the succeeding credited rate is to be calculated. It is considered the preceding credited interest rate that is adapted by the potential asset return rates in the future. The credited interest rate is calculated at the end of the year, utilizing the end-of-year duration valuation. The greater the duration value, the weight tends to lean towards the renewal credited rate [2].

With the asset rollover assumption, the renewal credited rate for each year is calculated using the formula:

$$Tk_n = Tk_{n-1} \cdot \left\{1 - \left(\frac{1}{2\bar{d}_{n-1}}\right)\right\} + T_p \cdot \left(\frac{1}{2\bar{d}_{n-1}}\right), \quad (4)$$

with Tk_i denotes the credited interest rate in the i^{th} year, renewal credited rate T_p, and end-of-year duration valuation at end of year of $n-1$ is $\bar{d}_{n-1}$.

Credited rate on the first year (Tk_1) is calculated by $Tk_1 =$ yield rate of the 5-year bond $+$ credit spread $-$pricing spread, whereas the renewal credited rate (T_p) is calculated by $T_p =$ yield rate of the 3-year bond $+$ credit spread $-$ pricing spread [2]. On the beginning of the year, premium is invested to asset with return that resembles the initial credited rate (T_1). In the following years, the credited rate is recalculated, a portion of the initial premium and investment return from the previous year are switched to another asset with rate adapted to the renewal credit rate. The switched portion amount equals to the inverse of two times the duration. The remaining portion stays on the current asset and still uses the rate from the initial credited rate or the previous year's credited rate.

2.4 Investment Year Method

The Investment Year Method is an accounting method in which each year's interest rates are recorded in the general ledger based on the inception year that an asset is invested in. This method adjusts the return based on the asset's characteristics, usually at the beginning of the year. The assets owned are then allocated to adequate interest rate groups when the asset is initially purchased. The interest rate group is then well-adjusted into the policy holder's cashflows. This method aligns the real investment rate of return with the credited interest rate, thus showing a more transparent reporting. To determine the account value at the time $y+t$, the formula below is used [17]:

$$x\prod_{j=0}^{t-1}\left(1+i^{y+j}\right) = x(1+i^{y})(1+i^{y+1})\ldots(1+i^{y+t-1}), \quad (5)$$

with x being the nominal account value at beginning of year y and t being the valuation year.

Table 1 shows an illustration of the Investment Year Method. If funds are initially invested on 1999, then the interest rate on the first year is $i_1^{1999} = 4.25\%$, the interest rate on the second year is $i_2^{1999} = 4.35\%$, and so on. If the funds are initially invested on 2001, then the interest rate on the first year is $i_1^{2001} = 4.05\%$, the interest rate on the second year is $i_2^{2001} = 4.04\%$, and so on.

Table 1. Example of Interest Rate with Investment Year Method

Year	Interest Rate with Investment Year Method				
y	1999	2000	2001	2002	2003
i_1^y	4.25%	4.56%	4.05%	4.45%	4.25%
i_2^y	4.35%	4.73%	4.04%	4.15%	4.35%
i_3^y	4.47%	4.75%	4.13%	4.23%	4.55%
i_4^y	4.57%	4.98%	4.17%	4.36%	9.55%
i_5^y	4.70%	4.04%	4.24%	4.44%	5.65%

Someone invests 100 to an account on January 1st, 1999. Using (5), the nominal account value becomes $100(1+4.25\%)(1+4.35\%)=108.7849$ on December 31st, 2000. If someone invests 100 on the account on January 1st, 2000, the nominal account value becomes $100(1+4.56\%)=104.56$ on December 31st, 2000.

2.5 Portfolio Method

The Portfolio Method is an accounting method in which funds are all credited with a value of interest rate at the corresponding year, regardless of when the funds are initially placed. Usually, the rates differ each year. This method uses the same tariff on all policies that are supported by a collection of assets or a certain portfolio segment, regardless of the time in which the policy is bought off. This method produces a simpler calculation procedure and is easier to understand, but it cannot adapt to fluctuations in interest rate changes, especially when there is a significant change. Table 2 provides an example of how to calculate the interest rate using the Portfolio Method.

Table 2. Example of Interest Rate with Portfolio Method

Year	Interest Rate with Portfolio Method
y	i^y
1999	4.50%
2000	5.50%
2001	4.00%
2002	6.50%

As an illustration, someone invests 100 in an account on January 1st, 1999. By using (5), the nominal account value becomes $100(1+4.5\%)(1+5.5\%)=110.2475$ on December 31st, 2000. If someone invests 100 in an account on January 1st, 2000, the nominal account value becomes $100(1+5.5\%)=105.5$ on December 31st, 2000.

By observing the two examples in Tables 1 and 2, there is a significant difference between the Portfolio Method and the Investment Year Method. he Investment Year Method has an advantage if there are several people investing in the account at different time periods. The changes in the interest rate for each person would differ depending on the investment period. However, the Investment Year Method also has its flaws in that the operational cost is rather high.

3. RESULTS AND ANALYSIS

3.1 Duration Calculation

Duration is used to assist in the credited interest rate calculation. The asset used is the Indonesian government-issued bond with serial FR0085. The bond has a maturity date of 10 years and is issued in 2021. The coupon rate is 7.75% per annum before being deducted by taxes of 15% [20]. In practice, the coupon is paid every semester. However, based on this research, the coupon is assumed to be paid every year. We also assumed that the par value is 100. The yield rate assumption used the Indonesian 10-year bond yield curve (6.314%). The coupon payment amounts to $7.75\% \cdot 85\% \cdot 100 = 6.6$. The par value is paid out at the end of the 10 years, thus the cashflow at the end of the 10 years equals to $100 + 6.6 = 106.6$. Overall, the FR0085 bond cashflow projection is seen in Figure 2. By using (3), the resulted end-of-year duration valuation is shown in Table 3.

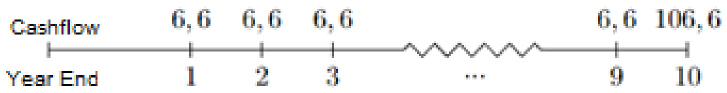

Figure 2. Cashflow Projection of FR0085 Bond

Table 3. End-of-Year Duration Valuation of FR0085 Bond

End-of-Year	Duration
1	7.08759
2	6.48199
3	5.83775
4	5.15225
5	4.42269
6	3.64606
7	2.81911
8	1.64596
9	1.00000
10	1.00000

Note that at the end of the 9^{th} year, the future cashflow is only on the 10^{th} year, therefore the duration equals to 1. The duration at the end of the 10^{th} year is assumed to be 1 as it follows the previous year as there is no more cashflow in the future.

3.2 Credited Interest Rate Calculation Using the Investment Year Method and Portfolio Method

The credited interest rate is calculated using (4). The government bond yield uses the initial credited rate (Tk_1) which is the 5-year government-issued bond yield rate, whereas the renewal credited rate (T_p) uses the 3-year government-issued bond yield rate. The assumptions used are credit spread of 80 bp (0.8%) and pricing spread of 140 bp (1.4%), which are the same for each year [2]. The end-of-year duration valuation used to calculate the credited interest rate follows Table 3. There are three different economic cases in which the credited interest rate is calculated.

3.2.1 Case 1

In the first case, we used the Indonesian bond yield curve on December 13^{th}, 2021, which has the Indonesian 3-year bond yield rate of 4.51% and the Indonesian 5-year bond yield rate of 5.139% [21]. The credited interest rate on the first year is obtained by finding the Tk_1 dan T_p values beforehand. By utilizing (4) and (5), the resulted credited interest rate is shown in Figure 1. Using the Investment Year Method, we calculate the credited interest rate by assuming a different initial credited interest rate, depending on the time of purchase. Thus, the interest rate in the next year for each person will be different. We assume the difference is 0.5%.

Based on Figure 1, if someone purchases an insurance policy with credited interest rate of 4.539% in the first year, then the second-year credited interest rate is charged at 4.49463% and the third-year credited interest rate is 4.44953%. However, if another person buys the insurance policy with credited interest rate of 5.539% in the first year, then the second-year credited interest rate is 5.42408%. Changes in the credited interest rate are evaluated annually as there is an insignificant amount of change in the same year. The greater the amount of initial credited rate, the greater the difference between the credited rate at the beginning of the investment period and the credited rate at the end of the investment period. If the initial credited rate is less than the renewal credited rate (3.539% < 3.91%), then the credited rate in the following years will increase and vice versa.

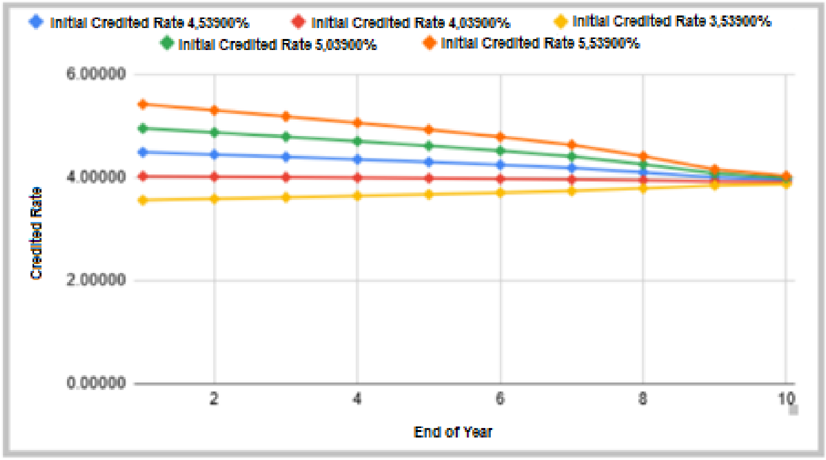

Figure 1. Credited Interest Rate by the Investment Year Method (Case 1)

Note that if the beginning-of-year credited rate is modified, then the end-of-year credited rate for that same year is insignificantly different (less than 0.5%). Compared to the huge incurred costs in the Investment Year Method, the Portfolio Method is better implemented in the Indonesian insurance industry if the economic condition is like the first case. The resulted credited rate from the Portfolio Method is shown in Table 4. If someone buys an insurance policy with an initial credited rate of 4.53900%, then the second-year credited rate is 4.49463% and the third-year credited rate is 4.44953%. If another person buys the same insurance policy with initial credited rate of 4.4963%, then the second-year credited rate is 4.44953% and the third-year credited rate is 4.40332%. The credited rates are valuated and updated every 10 years.

This makes the Portfolio Method easier to understand and requires fewer accounts to be managed, meaning less operational cost. However, the costs are potentially inflated if there is a significant change in interest rates. Therefore, insurance companies need to subsidize stagnant assets, preparing an adequate amount of reserves to cover the difference between investment return and claim payments.

Table 4. Credited Interest Rate by The Portfolio Method (Case 1)

End of Year	Credited Interest Rate
0 (beginning of policy year)	4.53900%
1	4.49463%
2	4.44953%
3	4.40332%
4	4.35545%
5	4.30509%
6	4.25091%
7	4.19044%
8	4.10525%
9	4.00763%
10	3.95881%

3.2.2 Case 2

In this second case, all the assumptions follow those in the first case. However, the interest rate is assumed to be changing significantly, resulting in a difference of 1% in annual interest rates. The renewal credited rate (T_p) is assumed to follow the first case and remain unchanged from the beginning of the term to the end of the term, with a value of 3,91%. The interest rate movement is assumed to change the initial credited rate (Tk_1). Using the same steps as in the first case, the cedited rates are shown in Figure 2.

In this case, if the credited rate at the beginning of the term or the initial credited rate is changed, then there is a significant difference in the credited rates in consecutive years. The difference between the end-of-year credited rate and the different initial credited rates can exceed 0.5%, even approaching 1%. By using the Portfolio Method and assuming that we only take one of the initial credited rates, the insurance company can take on losses. The company's expenses will be huge if the interest rate changes significantly in the next year. As an example, the insurance company adapts the Portfolio Method with credited rates as shown in Table 4. Someone buys policy A with an initial credited rate of 4.53900% at the beginning of 2021 and the interest rates drop by 1% in the next year. By the beginning of 2022, when the interest rates drop, another person who buys the policy A gets the same credited rate as the first person. Then, at the end of 2022, the insurance company incurs credited rate of 4.44953% on them both, even though the second person should have gotten credited rate of 3.5617% if adapted to the interest rate by the time she bought the insurance policy.

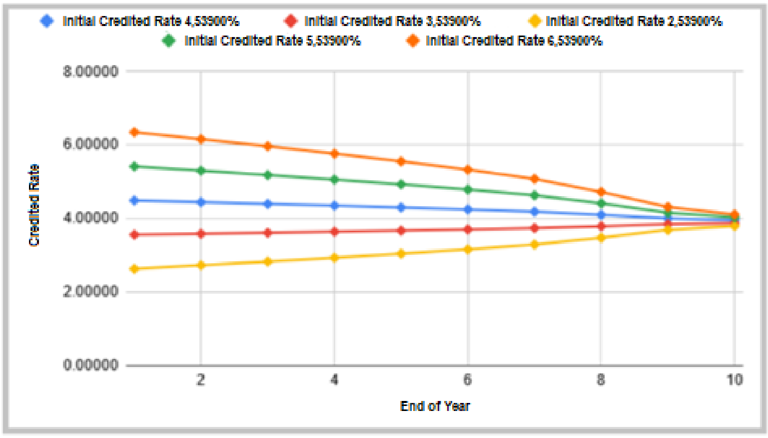

Figure 2. Credited Interest Rate by The Investment Year Method (Case 2)

Because the Portfolio Method typically uses only one account to hold the investment asset, the asset cannot be adjusted to market conditions or interest rate movement. Besides that, when the interest rate is high, the investment yield would potentially increase, so the profits gained would increase as well. This concludes that the Investment Year Method is better implemented when the interest rate is unstable or when the interest rate is high, thus covering the operational costs.

3.2.3 Case 3

In the third case, the initial credite rate still follows the first case, that is $Tk_1 = 4.53900\%$. To calculate the credited rate in the first year, the renewal credited rate (T_p) also follows the first case, which is 3.91%. However, in the next year, the Indonesian market is assumed to have significant growth or when the local or national government gives economic stimulus to the business sectors. This results in raising the 3-year Indonesian government bond yield rate, which leads to the increase of the renewal credited rates by 0.15% each year.

Using the same principles as in the first case, the resulting credited rates is shown in Figure 3. The renewal credited rate keeps on increasing, then the credited rate drops to a certain point and advances upward. For example, at the initial credited rate of 5.53900%, the credited rate keeps on dropping until the end of year 8, then advances upward until the end of year 9. These movements are caused by the weights in the asset rollover, which will be discussed in depth in the next section. Note that the duration values are declining each year, except at the end of year 9. The declining duration value impacts the $\frac{1}{2\bar{d}}$ value increasing because they are invertedly related, thus the weight of the renewal credited rate increases. If the renewal credited rate is larger than the credited rate of the previous year and the preceding year's renewal credited rate, then the latest renewal credited rate increases and vice versa.

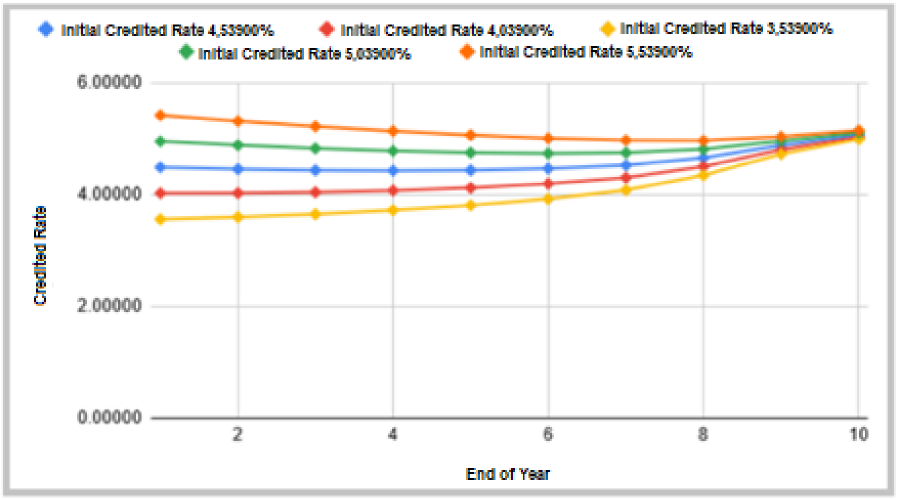

Figure 3. Credited Interest Rate by The Investment Year Method (Case 3)

3.3 Asset Rollover

Taking into account the credited rates, a portion of the initial asset is transported to another form of investment asset. This is called the asset rollover. To adapt to the latest credit rates, this is called the asset rollover. However, this also needs to consider the preceding year's credited year. Therefore, only a portion of the asset is transferred. By using the duration formula as in Section 3.1, the asset allocations are shown in Table 5.

Table 5. Asset Rollover Assumption

End of Year	Duration	Asset Rollover Assumption
1	7.08759	$\frac{1}{2(7.08759)} = 7.05\%$
2	6.48199	7.71%
3	5.83775	8.56%
4	5.15225	9.70%
5	4.42269	11.31%
6	3.64060	13.71%
7	2.81911	17.74%
8	1.64596	30.38%
9	1.00000	50.00%
10	1.00000	50.00%

From Table 5, on the end of the first year, 7.05% of the initial asset is allocated to another investment instrument with an adjusted credited rate on the second year, resulting in the remainder of the first year's asset of $100\% - 7.05\% = 92.95\%$ of the initial asset. Using the same steps, the assumed asset purchase composition is shown in Table 6.

3.4 Yield Rate Approximation

If the credited rate at the beginning of the year and the purchased asset are adjusted based on that table, then the amount of asset at the end of the year is approximated using the asset rollover assumption. If someone purchases a unit-link insurance product with an initial credit rate of 4.53900% and applies the assumptions in Section 3.2.1 and Section 3.3, the annual yield rate follows the credited rates with asset purchase composition adjusted using Table 6.

Table 6. Each Year's Asset Purchase Assumption

End of Year	0	1	2	3	4	5
Asset Purchased on Year 1	100.00%	92.95%	85.78%	78.43%	70.82%	62.81%
Asset Purchased on Year 2		7.05%	6.51%	5.95%	5.38%	4.77%
Asset Purchased on Year 3			7.71%	7.05%	6.37%	5.65%
Asset Purchased on Year 4				8.56%	7.73%	6.86%
Asset Purchased on Year 5					9.70%	8.61%
Asset Purchased on Year 6						11.31%
Asset Purchased on Year 7						
Asset Purchased on Year 8						
Asset Purchased on Year 9						
Asset Purchased on Year 10						
Asset Purchased on Year 11						

End of Year	6	7	8	9	10
Asset Purchased on Year 1	54.20%	44.59%	31.04%	15.52%	7.76%
Asset Purchased on Year 2	4.11%	3.38%	2.36%	1.18%	0.59%
Asset Purchased on Year 3	4.87%	4.01%	2.79%	1.40%	0.70%
Asset Purchased on Year 4	5.92%	4.87%	3.39%	1.69%	0.85%
Asset Purchased on Year 5	7.43%	6.11%	4.25%	2.13%	1.06%
Asset Purchased on Year 6	9.75%	8.02%	5.59%	2.79%	1.40%
Asset Purchased on Year 7	13.71%	11.28%	7.85%	3.93%	1.96%
Asset Purchased on Year 8		17.74%	12.35%	6.17%	3.09%
Asset Purchased on Year 9			30.38%	15.19%	7.59%
Asset Purchased on Year 10				50.00%	25.00%
Asset Purchased on Year 11					50.00%

If the initial asset invested is 1,000,000 IDR, then the asset purchased at the end of year 1 amounts to $1{,}000{,}000 \cdot [1 + 100\% \cdot 4.539\%] = 1{,}045{,}390$. The asset value at the end of year 2 is $1{,}000{,}000 \cdot [1 + 100\% \cdot 4.539\%] \cdot [(1 + 92.95\% \cdot 4.54\%) \cdot (1 + 7.05\% \cdot 4.49\%)] = 1{,}092820$. The same steps are applied until end of year 11 which results in the asset value of 1,607,400 with affiliated yield rate of $\frac{1,607,400-1,000,000}{1,000,000} \cdot 100\% = 60.74\%$.

The yield rate of 60.74% is based on eleven policy years, whereas the annual yield rate amounts to 5.52%. This number is closely related to the yield rate of Indonesian government bonds, for example ORI-19, which was issued in 2021 with a coupon rate of 5.57% per annum [22]. Therefore, the resulted annual yield rate is still reasonable. This yield rate is also higher than the yield rate from deposit accounts [23], thus this investment option is attractive. Note that the analysis in this section pertains to the investment function in the unit link product.

4. CONCLUSIONS

The credited interest rate or credited rate is the net yield rate which is given to insurance policy holders and is calculated using the Investment Year Method or Portfolio Method. The resulted annual yield rate of this unit link product using the asset rollover assumption of 5.52% is closely related to the Indonesian government bond, ORI-19, with yield rate of 5.57%. The resulted yield rate is higher than the yield on the deposit, which makes this attractive to investors. The Investment Year Method is more appropriately used when the interest rates are unstable, whereas the Portfolio is better implemented when the interest rates are stable. Lastly, the asset management strategy using the asset rollover assumption can well adjust the credited rates.

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