International Journal of Advances in Scientific Research and Engineering (ijasre)

E-ISSN : 2454-8006

DOI: 10.31695/IJASRE.2025.4.3

Volume 11, Issue 4
April - 2025

Study and Analysis of Credit Life Insurance Premiums for Loans with Flat and Effective Interest Rate

I Nyoman Widana[1], Ni Luh Putu Suciptawati [2], & Sulma[3]

[1,2] Department of Mathematics, Faculty of Mathematics and Natural Science, Udayana University

[3] Department of Actuarial Science, Faculty of Science and Technology

Muhammadiyah University of Bulukumba[3]

Indonesia

ABSTRACT

Credit life insurance is a type of life insurance designed to pay off a borrower's remaining debt in the event of their death. It is a collaborative product between a bank and an insurance company, offering the benefit of loan repayment to the bank in the event of the death of the borrower (debtor). The repayment includes the outstanding debt and accrued interest. This study aims to analyze credit life insurance premiums for loans with flat and effective interest rates, and explore how the borrower's age and loan term affect these premiums. The bank offers loans with a fixed interest rate of 1.25% per month (15% per annum). The effective interest rate is 2.4% per month (28.8% per annum) for a loan term of 24 months. The method used is a quantitative approach, and uses the principle of equality so that the company's obligations are equal to the rights received by participants. The results show that credit life insurance premiums for flat and effective interest rates are almost the same. However, the premium increases significantly as the participant's age increases and further increases as the loan term progresses.

Key Words: Credit life Insurance, Flat Interest Rates, Effective Interest Rates, Equivalence Principle, Insurance Premiums.

1. INTRODUCTION

Banks play a crucial role in boosting socio-economic development by supplying financial resources that enable individuals and businesses in numerous ways [1]. Through the provision of credit, banks contribute significantly to economic growth and the improvement of people's living standards [2]. However, extending credit also involves the risk of borrowers failing to meet their obligations, which can negatively impact bank profits and the quality of their credit portfolios, resulting in a rise in non-performing loans. During the credit period, borrowers may encounter challenges that prevent them from meeting their debt repayment obligations, with one of the most significant risks being the death of the debtor.

To mitigate the risks associated with borrower defaults, banks often include credit life insurance in their lending processes [3, 4]. This type of insurance provides a safety net for both lenders and borrowers by guaranteeing that any remaining debts are settled in the event of the borrower's death. Through the collaboration between banks and insurance companies, financial risks are managed more effectively, reducing potential losses for both parties. Credit life insurance guarantees that the remaining loan balance will be repaid to the bank, safeguarding its financial stability. The implication for borrowers is that they are required to pay a premium for this insurance, with the premium's cost varying based on the loan type—

whether it follows a flat or effective interest rate structure. Understanding how these premiums are calculated is crucial for both financial institutions and borrowers, as it directly influences the affordability and overall cost of the loan [5, 6].

Despite the significance of credit life insurance, limited research exists that compares premium calculations for loans with different interest rate structures, such as flat interest rates and effective interest rates. This study aims to analyze credit life insurance premiums on loans with flat and effective interest rates. It focuses on credit life insurance premiums for both types of loans and explores how the borrower's age and loan term affect these premiums. The findings of this study will benefit financial institutions in pricing credit life insurance more accurately and help borrowers understand the cost implications of their insurance options.

2. LITERATURE SURVEY

In this section, several previous references are given that examine aspects such as credit life insurance premiums in commercial banks [3], the role of flat and effective interest rates in determining installment/credit payments [7], as well as several supporting references regarding interest rates, premiums, and insurance.

a) Interest Rates Structures in Loans

A flat interest rate is a method of calculating interest on a loan where the interest amount is fixed based on the initial principal amount throughout the entire loan period. The formula for calculating the monthly installment using a flat interest rate is as follows [7, 8].

$$\text{A Principle Payment/Month} = \frac{L}{T}$$

$$\text{Interest Installment/Month} = L \times \frac{i_f}{12}$$

$$\text{Total Installment/Month} = \frac{L}{T} + L \times \frac{i_f}{12}$$

Where

L = Loan Principal

T = Loan Term (in month)

i_f = Flat Interest Rate per Annum

The effective interest rate is a method of calculating interest on a loan where the interest is charged only on the outstanding balance of the principal. The method used to calculate it [9], [10]:

$$\text{A Principle Payment/Month} = \frac{L}{T}$$

$$\text{Interest Installment/Month} = OL \times \frac{i_f}{12}$$

Where

OL = Outstanding Loan Priciple

i_e = effective interest rate per annum

DOI: 10.31695/IJASRE.2025.4.3

The relationship between the flat interest rate and the effective interest rate is as follows:

$$\text{Efektif Interest Rate per annum} = i_e = \frac{2\, i_f \times T}{T+1}$$

b) The Future Lifetime Random Variable

Consider an individual who is currently x years old. The exact time of death for this person is uncertain and may occur at any point in the future. The remaining lifetime of this individual, represented by T_x, is modeled as a continuous random variable. The cumulative distribution function (CDF) of T_x denoted T_x is defined as [11], [12], [13]:

$$F_x(t) = \Pr[T_x \le t] \qquad \text{--------- (1)}$$

This function represents the probability that the person's remaining lifetime is less than or equal to t years.

The future lifetime of an individual aged x years is represented as a discrete random variable within an actuarial framework, denoted by K_x. This random variable follows the probability function:

$$Pr[K_x = i] = Pr[i < T_x \le i+1] = {}_ip_x\, q_{x+i} = {}_{i|}q_x,\ i = 0,1,2,\ldots \qquad \text{----- (2)}$$

Here, $K_x = i$ signifies that the individual will pass away between ages $x+i$ and $x+i+1$ [10], [12]. This actuarial model provides a structured approach to estimating the probability distribution of future lifetime events.

c) Life Tables and Terms Insurance

Mortality tables are essential tools in actuarial science, providing key functions such as l_x, q_x and p_x. Her, l_x indicates the number of individuals alive at age x.. The function q_x represents the probability that an individual aged x will pass away before reaching age $x+1$, whereas p_x denotes the likelihood of surviving to age $x+1$. Furthermore, the probability that an individual aged x will die before attaining age $x+n$ is denoted as ${}_nq_x$, which can be calculated using the appropriate formula [12]:

$${}_nq_x = 1 - {}_np_x = \frac{l_x - l_{x+n}}{l_x} \qquad \text{----- (3)}$$

Futhermore, the uniform distribution of deaths assumption is the most widely used approach for fractional age estimations. It can be expressed in two equivalent forms, as follows: For an integer x and for $0 \le s < 1$, it is assumed that ${}_sq_x = sq_x$ [12].

A term insurance policy for an individual aged x, offering a benefit of 1 unit, guarantees a payment of 1 at the end of the policy year in which death occurs, provided the death happens within a specified term of n years [11], [12]:

$$A^1_{x:\overline{j}|} = \sum_{j=0}^{n-1} v^{j+1}\ {}_jp_x\, q_{x+k} = \sum_{j=0}^{n-1} v^{j+1}\ {}_jp_x\ {}_{j|}q_x \qquad \text{----- (4)}$$

If a death benefit of 1 unit is paid at the end of a $1/m$ -year term in which death occurs, provided it happens within n years, the expected present value is represented by [14]:

$$A^{1(m)}_{x:\overline{n}|} = \sum_{k=0}^{nm-1} v^{(k+1)/m}\ {}_{k/m|1/m}q_x$$

DOI: 10.31695/IJASRE.2025.4.3

d) Premium

Determining the premium for an insurance policy is crucial for insurance companies. Important factors affecting the premium include the policyholder's age, the length of the coverage period, and the benefit amount to be paid by the insurer. Premiums paid by policyholders contribute to a fund that the insurance company uses for benefit payouts, administrative expenses, operational costs, and other expenses. The equivalence principle is a common method for calculating premiums, represented by the equation [10]:

$$E[L] = 0 \quad \text{---} \quad (6)$$

where the insurer's loss, $\boldsymbol{L}$, is a random variable defined as the cash value of the benefit minus the random annuity value of the premiums paid by the policyholder.

3. OBJECTIVE OF RESEARCH

This research focuses on credit life insurance premiums for both types of loans and explores how borrower age and loan tenure affect these premiums. The findings from this study will benefit financial institutions in pricing credit life insurance more accurately and helping borrowers understand the cost implications of their insurance choices.

4. RESEARCH METHODOLOGY

This study adopts a quantitative approach to compare premiums at different interest rate structures and uses the equivalence principle so that the obligations of the company are equal to the rights received by participants. The equivalence principle emphasizes that the expected present value of the premium is equal to the expected present value of the insurance benefit. Data is sourced from a bank that provides loans with flat and effective interest rates." This bank offers loans with a fixed interest rate of 1.25% per month (15% per year). The effective interest rate is 2.4% per month (28.8% per year) for a loan term of 24 months. In addition, the mortality table used is TMI 2019. The Python programming language was used to calculate the premium based on a 5% interest rate [15].

5. RESULT AND DISCUSSION

This section outlines the model utilized to determine credit life insurance premiums. Premium calculations are carried out using the equivalence principle, equation (6), In this case, the expected present value of the premiums equals the expected present value of the insurance benefit. In this model, it is assumed that the debtor is x years old with an initial loan amount of P_0 and a loan term of n years (or 12n months). The insurance company will pay the remaining principal plus interest to the bank if the debtor dies. Let $P_1, P_2, P_3, \cdots, P_{12n}$ each represent the amount of benefits that the insurance company will pay to the bank if the debtor's death occurs in the 1^{st}, 2^{nd}, 3^{rd} month, and so on until the 12^{th} month. For single premium payments, the premium amount is:

$$Premium = \sum_{t=1}^{12n} P_t \, v^{\frac{t}{12}} \, \frac{l_{x+\frac{t-1}{12}} - l_{x+\frac{t}{12}}}{l_x} \quad \text{-------} \quad (7)$$

with $= \frac{1}{1+i}$, i represents the interest rate per year. l_x denotes the number of individuals who are x years old.

Furthermore, for loans that use fixed (flat) interest of i_f per year and using the uniform distribution of death for fractional age assumption then equation (7) can be written in the form

DOI: 10.31695/IJASRE.2025.4.3

$$Premium = \frac{1}{l_x}\sum_{t=0}^{n-1}\frac{l_{x+t}-l_{x+t+1}}{12}\sum_{j=1}^{12} v^{\frac{j}{12}+t}\left(P_0 - \frac{P_0}{12n}(j-1+12t) + P_0\frac{i_f}{12}\right) \quad \text{----- (8)}$$

On the other hand, for loans that apply an effective interest, i_e then equation (7) can be written in the form

$$Premi = \frac{1}{l_x}\sum_{t=0}^{n-1}\frac{l_{x+t}-l_{x+t+1}}{12}\sum_{j=1}^{12} v^{\frac{j}{12}+t}\left(P_0 - \frac{P_0}{12n}(j-1+12t)\right)\left(1+\frac{i_e}{12}\right) \quad \text{------ (9)}$$

A Python-based application was created to calculate the premium value, as shown in equations (8) and (9). Using equation (8) for an initial principal P_0 of 100 million rupiah, a loan term of $n = 8$ years, and ages x=30,35,40,45,50 years, the results are presented in The Figure (1).

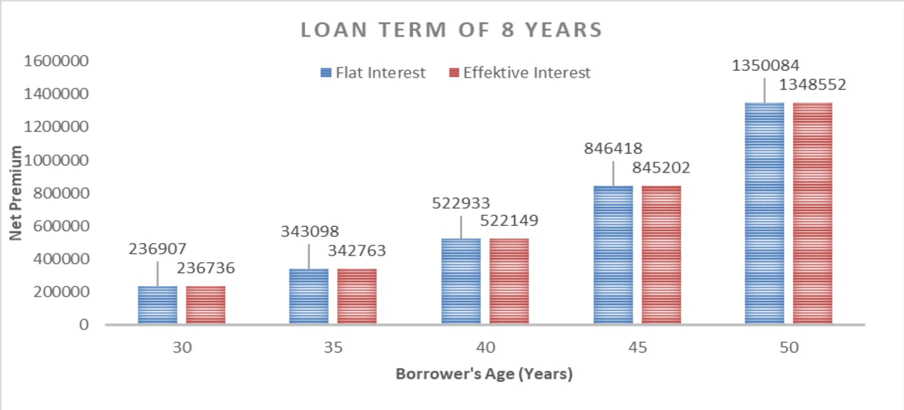

Figure 1. Credit life insurances premiums for flat and effective interest rate with the loan amount of 100 million rupiah and debtor age 50 years

Figure 1 shows that at age 30 years , the net premium is almost the same for both interest types: flat interest is 236,907 IDR and effective interest is 236,736 IDR, for a loan amount of 100 million IDR and a loan term of 8 years. The same pattern is observed for other ages. Futhermore, the net premium increases significantly with the borrower's age for both flat and effective interest rates, with minimal differences between the two. The trend shows that as the borrower's age increases, the premiums rise, particularly for older borrowers.

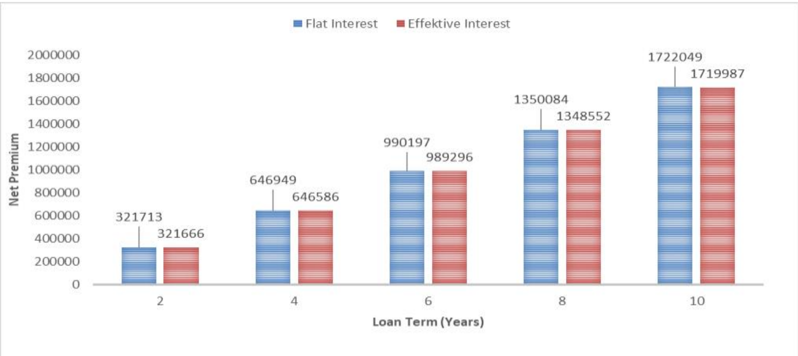

Figure 2. Credit life insurances premiums for flat and effective interest rate with the loan amount of 100 million rupiah and debtor age 50 year

Figure 2 compares the net premiums for credit life insurance across different loan terms (ranging from 2 to 10 years) for both flat and effective interest rates. The net premium values are represented on the y-axis, while the loan terms in years are displayed on the x-axis. The net premiums for flat and effective interest rates are very close to each other across all loan terms, with only slight differences. This aligns with the study's finding that credit life insurance premiums for both interest types are nearly identical. Furthermore,

DOI: 10.31695/IJASRE.2025.4.3

the premium amount increases significantly the loan term lengthens. For example: At a 2-year loan term, the net premium is around 321,713 (flat) and 321,666 (effective). At a 10-year loan term, the net premium has risen to approximately 1,722,049 (flat) and 1,719,987 (effective). This trend suggests that loan duration has a significant impact on premium costs, regardless of the interest type. Overall, the chart demonstrates that while the choice between flat and effective interest rates has minimal effect on premiums, the length of the loan term strongly influences the premium amount.

6. CONCLUSION

The study finds that credit life insurance premiums for flat and effective interest rates are almost identical. However, premiums increase significantly with the participant's age and further increase as the loan term extends.

REFERENCES

[1] H. E. Hamdaoui dan M. Cancelo, “The Influence of the Banking Sector on Economic Growth and Commodity Prices: A Panel Data Analysis of Spain, France, and Romania,” *Commodities*, vol. 3, no. 2, hlm. 168–181, Apr 2024, doi: 10.3390/commodities3020011.

[2] D. A. S. Bhegawati dan M. S. Utama, “The Role of Banking in Indonesia in Increasing Economic Growth and Community Welfare,” *South East Asia Journal of Contemporary Business, Economic, and Law*, vol. 22, no. 1, hlm. 83–91, 2020.

[3] N. L. R. Damayanthi, I. N. Widana, dan K. Sari, “Penentuan Premi dan Cadangan Manfaat Asuransi Jiwa Kredit pada Bank Umum,” *MTK*, vol. 12, no. 1, hlm. 57, Jan 2023, doi: 10.24843/MTK.2023.v12.i01.p400.

[4] M. Markonah, “The Influence of Reinsurance Rate, Loan Interest Rate and Bank’s Fee Based Income Against the Premium Rate on Credit Life Insurance (Case Study: Credit Life Insurance’s Policy Holder Of Pt Indosurya Life In 2018),” *DIJMS*, vol. 2, no. 5, hlm. 724–740, Jun 2021, doi: 10.31933/dijms.v2i5.867.

[5] R. Adam dan S. Anwar, “Kedudukan Tertanggung dalam Asuransi Jiwa Kredit,” *LS*, vol. 5, no. 1, hlm. 84, Mar 2021, doi: 10.24269/ls.v5i1.2181.

[6] Rahma Selina Yustika Yanti dan Arief Suryono, “Analisis Yuridis Tanggung Jawab Perusahaan Asuransi Terhadap Asuransi Jiwa Kredit: Studi Putusan Nomor 3079K/PDT/2019,” *Terang*, vol. 1, no. 1, hlm. 192–203, Feb 2024, doi: 10.62383/terang.v1i1.83.

[7] Dimas Arza Nugraha, Nova Oktavia Sitinjak, dan Rini Sartika, “Penentuan Nilai Bunga Flat, Efektif, dan Anuitas pada Salah Satu Leasing Motor di Kota Binjai,” *JURRIMIPA*, vol. 3, no. 1, hlm. 33–51, Des 2023, doi: 10.55606/jurrimipa.v3i1.2222.

[8] I. A. P. Beang, “Penerapan Suku Bunga Tetap (Flat Rate Method) dalam Rancang Bangun Sistem Administrasi Pada Koperasi Karya Samaturu Kendari,” *Jurnal Matematika*, vol. 3, no. 1, hlm. 303–312, 2023.

[9] J. Budiman dan Y. F. Susanty, “Analisis Komparatif Penerapan Suku Bunga KPR Bank di Batam,” *Jurnal Manajemen*, vol. 14, no. 1, hlm. 97–124, 2014.

[10] I. Indahwati, “Bunga efektif (Eff*) dan bunga flat,” *jbfe*, vol. 3, no. 2, hlm. 196–208, Des 2022, doi: 10.32585/jbfe.v3i2.3437.

[11] N. L. Bowers, H. U. Gerber, J. C. Hickman, D. A. Jones, dan C. J. Nesbitt, *Actuarial Mathematics*. 2017.

DOI: 10.31695/IJASRE.2025.4.3

[12] D. C. M. Dickson, M. R. Hardy, dan H. R. Waters, *Actuarial Mathematics for Life Contingent Risk*, Second Edition. New York: Cambridge University Press, 2013.

[13] L. Gajek dan K. M. Ostaszewski, *Financial Risk Management for Pension Plans*. Emerald Group Publishing Limited, 2004.

[14] T. Futami, *Matematika Asuransi Jiwa Bagian I*. Jakarta: Incorporated Foundation Insurance Cultural Development Center, 1994.

[15] A. Justica, S. Kezia, D. Eurico, A. A. P. Priyambudi, R. A. S. Anees, dan A. Z. Soleh, "Perhitungan Cadangan Asuransi Tahunan dengan Metode Gross Premium Valuation menggunakan Bahasa Pemrograman Python," *jmi*, vol. 18, no. 1, hlm. 53, Mei 2022, doi: 10.24198/jmi.v18.n1.35796.53-62

DOI: 10.31695/IJASRE.2025.4.3