Determining net single premium for credit life insurance at civil servants cooperative of State Polytechnic of Bali

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Abstract. Credit life insurance is a kind of term life insurance, which is the debtor's life is insured and the amount of coverage is limited by the value of the loan. This study aims to calculate the value of single net premiums, where things that taken into account are mortality and interest rates. This research was conducted in the unit of savings and loan of Civil Servant Cooperative at State Polytechnic of Bali (KPN PNB). In the calculation of premiums, there are two systems of payment of benefits, namely the system of instantaneous payment at death (continuous) and at the end of the year of death (discrete). This study links the two systems by analyzing the value of Actuarial Present Value (APV). The rate of interest is referring to the Bank of Indonesia rate of 6.5%. The results of the calculation analysis showed, by sex, the value of female APV is lower than men this is due to the probability of death of men greater than women. The higher the age, the increased chance of death. Women are considered to have better insurance risk than men. The age factor and the loan term affect the value of a single net premium.

1. Introduction

Savings and Loans Cooperative is one non-bank financial institution that serves to provide services to the community in the form of loans and also as a place of money savings. In general, the scope of business activities of savings and credit is the collection of funds and channeling of funds in the form of loans. Therefore, lending is the main source of income, in the form of service income (interest).

Cooperatives is one form of non-Bank micro finance institutions (LKM) that plays an important role in efforts to increase economic growth in Indonesia. In general, one of the factors in the success rate of developing LKMs in Indonesia is the the capacity of micro borrowers to payback thier credit on time (or zero non-performing loan) [12]. An LKM is vulnerable to the risk or a condition that results in damage or loss. The risk of financial loss of a Micro-entrepreneurs identified their primary concerns as the financial losses associated with death, illness and injury, natural disasters, theft or property damage [2].

In the Savings and Loans unit of the Civil Servant Cooperative of State Polytechnic of Bali (KPN PNB), the most serious risk is the death of the borrower (member of the cooperative) which has an impact on loan repayment or bad credit. There are many ways that co-operative protect themselves from the death risks of their clients, which are expect the group to repay and write off the loan [2]. One of the ways in which KPN PNB to overcome the problem of loan repayment due to the risk of death from cooperative customers is to pass on the additional expenses to clients in the form of a higher fee, which they place in a reserve fund. If a client dies, the balance is written off and deducted from the fund or, otherwise, implements credit life insurance.

The readiness of the KPN PNB's savings and loan unit to self-manage the insurance fund is based on the consideration of human resources in State Polytechnic of Bali (PNB), where the age of the customer is considered still healthy and able to work and have a relatively low chance of mortality. Besides, the financial health of the Cooperative is considered good because there are no arrears on loan repayment and no claims to date. In this case the risk is considered low. Self-managing the insurance fund is also one of the strategies to maximize the benefits of cooperatives. Therefore the determination of the cost of credit insurance premium is the most important part of this credit insurance. If the premium set is too low this will be detrimental to the finances of the cooperative. But if the price is set too high, then the cooperative is not competitive and bring disadvantages to customers.

The insurance premium applicable to the KPN PNB's savings and loan unit is currently only based on the loan period, so the premium value for all ages is the same. The KPN PNB's unit of savings and loan in determining the premium does not take into account the mortality factor of the debtor. This study tested the calculation of credit insurance premiums on the unit of savings and loans of KPN PNB by looking at the mortality factor (chance of death) and the loan period. A person who has an older age will have a higher risk of death so that the premiums charged will vary by age. Because the risk used is the risk of mortality of the debtor and the difficulty of predicting a person's mortality, this study uses the analysis of actuarial survival and mortality tables in search of a person's chance of death. Survival analysis is a statistical method used to analyze survival data, such as preliminary data of patients infected with the disease to death or cure of patients. Mortality census becomes the most important part in the calculation of insurance premiums. A mortality table contains the annual probabilities of death at each age and sex for a given population [2]. The mortality table is based on the characteristics of the population.

For example the South African mortality table prepared by the Actuarial Society of South Africa (ASSA) which estimates the mortality rates from all causes, including HIV/AIDS, smoking is also associated with mortality rates which will form a mortality model as in the testing of the difference in mortality rates in some developed countries based on smoking prevelence [5]. The majority of interstate variation in mortality among white working-age adults in the United States is associated with a combination of mortality and obesity, substance abuse and rural/ urban residence [13]. The mortality table in Indonesia has undergone several changes that are adapt to the situation and the condition of the population, whether in terms of health, mortality rate, the existence of urbanization and other factors. The mortality table currently used in Indonesia is the mortality table III (2011) which is a change from mortality table II (2009). The mortality table III (2011) was prepared by the Indonesian Life Insurance Association (AAJI) and Society of Actuaries of indonesia (PAI). Completion of mortality table is as a reference to help the insurance company in the determination of the right premium rate. The premium value will be different according to the mortality table.

. The credit life insurance is essentially a life insurance product [9], where the borrower is liable to the life of the debtor / borrower and the sum insured is limited to the principal amount of the loan. The right of claim arises if the debtor dies within the coverage period that is equal to the remaining outstanding debt in accordance with the repayment schedule, so the credit elimination insurance is also a term life insurance. An n year term life insurance provides for a payment only if the insured dies within the n year term of an insurance commission at issue [1].

Determination of single premium net credit removal insurance in this study using term life insurance concept by analyzing Actuarial Present Value (APV). APV is the present value of the money that must be paid to obtain the same amount of value at the time of death within a period of time up to t years [1]. The mortality and interest rate tables have an effect on the calculation of APV values. This study uses the Indonesian Mortality Table of 2011, and the interest rate is assumed with reference to Bank of Indonesia interest rate of 6.5%. The APV result is used in finding a single net premium value. APV value is the most important part in determining a single net premium. Therefore it is necessary to formulate with both mortality and interest rates to get the right premium value.

2. Research Methodology

The objective of this research is to calculate insurance premium for credit abolition in KPN PNB's savings and loan unit. The approach used in calculating these premiums is the 2011 Indonesian Mortality Table and the actuarial survival model in determining the chance of death. The factors affecting mortality are age and gender. Single net premiums are calculated based on the concept of actuarial values, i.e actuarial present value of term life insurance of n-years.

The stages in determining the single net premium rate in this research are collecting information, tabulating the data, determining the calculation method and calculating the value of APV. The study was conducted at the Savings and Loans Unit of The State Polytechnic of Bali's Civil Servant Cooperative (KPN PNB). The type of data used is the data of Civil Servants of Polytechnic Bali (PNB) of year 2016 which is obtained from PNB staffing, borrower age data, loan term, and data of loan amount obtained from KPN PNB. Borrowers/ loaners data are using loan transaction data from 2013 to 2016.

The survival model is used in the probability analysis of death, where the survival model indicates a person's chances of surviving over a certain time [1]. A Survival model is a probability distribution for a special kind of random variable [6]. The survival model which is related to the survival time, obtained from survival events such as failure, death, recurrence of a disease etc, is a random variable. The survival analysis was used in the study of mortality rate of HIV AIDS patients following antiretroviral therapy in Ethiopia, the time of survival used was the time from antiretroviral therapy to the time of death of HIV / AIDS patients where the reduction of death rate due to HIV / AIDS through timely therapy and treatment regularly [10]. The survival analysis was also used to determine the contribution of low birth weight to neonatal mortality in Indonesia, the time of child survival is the time of survival. The result is, children born in low birth weight and born from younger mothers had higher risk of neonatal mortality [11].

The distribution of survival time is indicated by three functions, namely the Survival function, the probability density function and the hazard function. If the random variable we are considering here, called T, is defined to be the time of failure of the entry known to exist at time t = 0, and is therefore frequently called the failure time random variable. Now if T is the time of failure, than the probability of still functioning at time t is the same as the probability that the failure time is later than the value of t. Probability that failure (death) will occur after time t. [6]. Another point, probability that failure (death) will occur after time t as explained in the model as in equation (1).

$$S(T) = \Pr(T > t) = 1 - \Pr(T \leq t) = 1 - F(t) \tag{1}$$

The probability density function is defined as the derivative of F (t) [6]. In the actuarial survival model, the symbol (x) is used to denote a life-age-x and X is age (x) at death, then the future lifetime of (x), Xx, is denoted by T (x). So with the survival model obtained as in equation (2) and equation (3).

$$_t q_x = \Pr\left[T(x) \leq t\right], t \geq 0 \tag{2}$$

$$_t p_x = 1 - {_t q_x} = \Pr\left[T(x) > t\right], t \geq 0 \tag{3}$$

$_t q_x$ Probability that a life observed at age x will die between ages x and x+t, meanwhile $_t p_x$ state the probability that (x) will atain age x+t

[7] Hazard function as in equation (4).

$$\lambda(t) = \lim_{\Delta t \to 0} \frac{\Pr(t \leq T \leq t + \Delta t \mid T \geq t)}{\Delta t} \tag{4}$$

Declared a mortality rate or a temporary failure at time t up to the subject observed for life t. the hazard function of the actuarial survival model is also called force of mortality denoted by $\mu(x)$.

The chances of a person's death can be sought even when the death is not known with certainty so that the amount of death benefit that will be paid can be known. The expected value of the random variable is the present value *E[Z]* called *actuarial present value* (APV). Insurance payable at the moment of death (continue) is denoted by $\bar{A}_{\underset{x:n\rceil}{1}}$, with Z as a fungction of T. Insurance payable at the

end for the year of death (discreet) denoted with $A_{\frac{1}{x:n}}$ with Z is the function of K [1]. Each formula is as in equation (5) and equation (6).

$$\overline{A}_{\frac{1}{x:n}} = E[Z] = \int_0^\infty z_t f_T(t)dt = \int_0^n v^t {}_t p_x \mu_x(t)dt = \int_0^n e^{-\delta t} {}_t p_x \mu_x(t)dt \qquad (5)$$

$$A_{\frac{1}{x:n}} = E[Z] = \sum_{k=0}^{n-1} v^{k+1} {}_k p_x q_{x+k} \qquad (6)$$

[4] Where v is a discount function as in equation (7).

$$v = \frac{1}{1+i} \qquad (7).$$

Duration will affect the value of APV, the longer the time period will be the higher the value of APV. As in calculation of APV retirement programs, where longer tenure shows higher APV scores [3]. APV value is also influenced by interest rate. On the calculation of continuous life annuities for life insurance using life table with uniform assumption, seen increasing of interest rate cause lower APV value [8].

On the principle of calculating a single net premium, the obligations of the insurance company are equal to the rights received by the customer. The net single premium equation as equation (8).

$$b_t \overline{A}_{\frac{1}{x:n}} \qquad (8)$$

3. Result and Discussions

In this study the data used is employee data with the status of Civil Servants (PNS), because the special conditions of loaners in the KPN PNB is as civil servants. Based on the data obtained at the Bali State Polytechnic (PNB) staff, the number of civil servants (staff and lecturers) in PNB in 2016 is 535 people. Based on tabulation results of civil servant's age data at the PNB as shown in Figure 1, the lowest age is 26 years and the highest age is 65 years, with the most age of 53 years with 39 people.
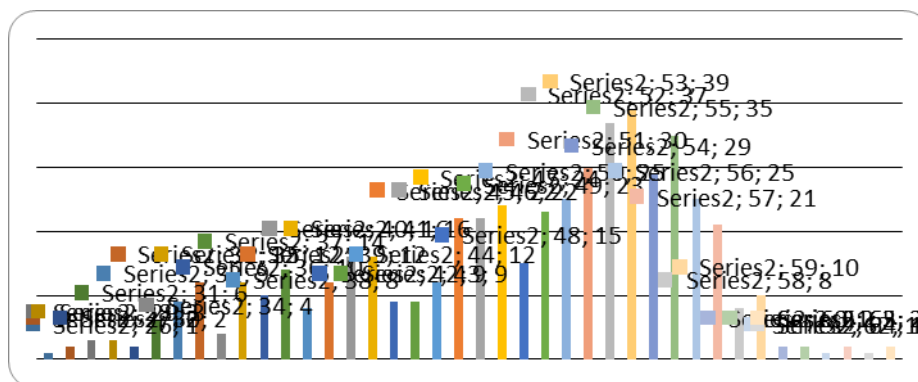

Figure 1. Bali State Polytechnic's Civil Servants Age Graphic

The result of data analysis of loan transaction from year 2013 until 2016, obtained the age of debtor in KPN PNB is 26 years to 60 years, as seen in the Figure 2, shows the percentage of the number of debtors by age group. The largest age group of borrowers performing loan transactions is aged 46 to 55 years with 44%, followed by ages 56 to 65 years by 36%, age group 26 to 45 by 16% and age group 26 to 35 years with 26%.
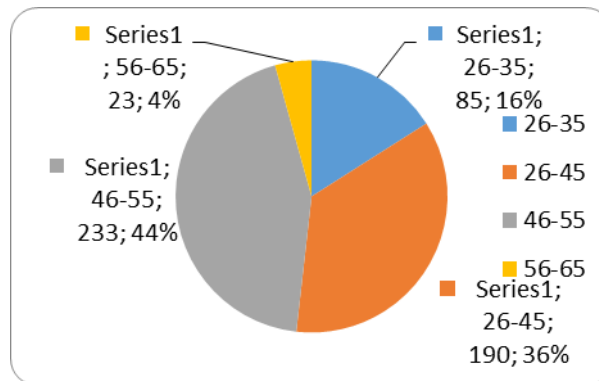
Figure 2. Percentage of Data of Debtor Age of KPN PNB

Based on the loan period, shown in Figure 3, the longest loan period is 15 years. The most time borrowed is 10 years.
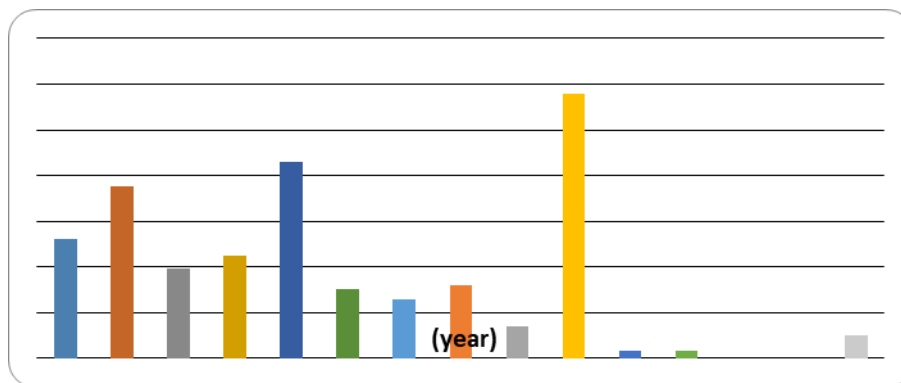

Figure 3. Graph of Loan Time Data

From the analysis of this data is known age range of debtors is aged 26 to 60 years. Referring to the Indonesian mortality table 2011, for ages 26 to 60 years by sex, the chances of male deaths greater than women. Women are considered to have better insurance risk than men. In credit insurance with mortality risk, in addition to mortality factor, loan term factors also affect the amount of premium. For example, a person is more likely to die for a period of 10 years than for 1 year.

In the 2011 mortality charts, seen from the age factor, the higher the age, the chances of death are increases or life opportunity decreases. So it can be assumed that the life chance denoted by linear function, where assumptions for fractional age can use the uniform distribution assumption, with linier interpolation as equation (9) [1].

$$S(x+t) = (1-t)S(x) + t \cdot S(x+1), \, 0 \le t \le 1 \tag{9}$$

The respective equations obtained for mortality, life chances and the acceleration of mortality are as in equation (10), equation (11) and equation (12).

$$_t q_x = 1 - {}_t p_x = 1 - \frac{S(x+t)}{S(x)} = \frac{S(x) - S(x+t)}{S(x)} = t \cdot q_x \tag{10}$$

$$_t p_x = \frac{_{x=t} p_0}{_x p_0} = \frac{S(x+t)}{S(x)} = 1 - t \cdot q_x \tag{11}$$

$$\mu(x+t) = \frac{-S'(x+t)}{S(x+t)} = \frac{q_x}{1 - t \cdot q_x} \tag{12}$$

$$q_{x+t} = \frac{q_x}{1 - t \cdot q_x}, \tag{13}$$

The relationship between instantly paid insurance at the time of death (continuous) and insurance paid at the end of the year of death (discrete) can be obtained by analyzing the value of Actuarial Present Value (APV). In some life insurance cases, the most important information can be obtained from the discrete opportunity distribution T which is expressed as an opportunity distribution of K, so that the relation analysis of continuous and discrete model benefit payments is as equation (14).

$$\overline{A}_{\overset{1}{x:1\rceil}} = \int_0^1 v^t q_x dt = q_x \int_0^1 e^{-\delta t} dt = \frac{i}{\delta} v q_x = \frac{i}{\delta} A_{\overset{1}{x:n\rceil}} \tag{14}$$

Interest rate (*i*) used in this study refers to Bank of Indonesia (BI) rate. The latest BI rate for July 21, 2016 is at 6,50% [14]. Force of interest $\delta = -\ln v = 0,063$. APV scores for each age vary by age and loan period, for 45 years of age (female) with a 5-year loan term will be different from the age of 50 years.

$$\overline{A}_{\overset{1}{45:5\rceil}} = \frac{i}{\delta} A_{\overset{1}{45:5\rceil}} = \frac{i}{\delta} \sum_{k=0}^{5-1} v^{k+1}{}_k p_{45} q_{x+45}$$

$$= \frac{i}{\delta} \left(v^1{}_0 p_{45} q_{45} + v^2{}_1 p_{45} q_{46} + v^3{}_2 p_{45} q_{47} + v^4{}_3 p_{45} q_{48} + v^5{}_4 p_{45} q_{49} \right)$$

$$= 0,010216$$

$$\overline{A}_{\overset{1}{50:5\rceil}} = \frac{i}{\delta} A_{\overset{1}{50:5\rceil}} = \frac{i}{\delta} \sum_{k=0}^{5-1} v^{k+1}{}_k p_{50} q_{x+50}$$

$$= \frac{i}{\delta} \left(v^1{}_0 p_{50} q_{50} + v^2{}_1 p_{50} q_{51} + v^3{}_2 p_{50} q_{52} + v^4{}_3 p_{50} q_{53} + v^5{}_4 p_{50} q_{54} \right)$$

$$= 0,018027$$

With the same step obtained the value of APV 45 years and 50 years for men, ie for the age of 45 years and for the age of 50 years. If it is assumed that the loan amount is Rp. 20.000.000, - then based on equation (8) obtained a net premium value as in Table 1.

Table 1. Comparison of Single Net Premium Value

Age	APV		Net Single Premise	
	Female	Male	Female	Male
45	0,010217	0,015463	204.328	309.251
50	0,018027	0,029257	360.543	585.136

Single net premium value will be charged to the debtor with loan amount of Rp. 20,000,000, - with 5-year loan period, when viewed by age 45 and 50 years old, 50 years old is subject to a higher premium than the age of 45, male or female. Based on gender, it is also seen that the premiums charged to male debtors are higher than female debtors. Both of these are due to differences in APV values where female APV is lower than male and so does the value of APV at age of 45 years is lower than the age of 50 years. This calculation based on rate imposed by KPN PNB at recent time it will have different value.

KPN PNB in determining the premiums imposed on the debtor does not take into account the factors of age and gender, so the premium value for all age and sex is the same, as in Table 2, age of debtors 45 and 50 years with loan value Rp. 20.000.000, - 5 year period the premium value is Rp. 306,600, - while for actuarial calculation, there are different net premium value according to age, gender and loan period.

Table 2 Comparison of Premium Value at KPN PNB and Actuarial Calculations

Age	KPN PNB	Actuarial Calculations	
		Female	Male
45	306.600	204.328	309.251
50	306.600	360.543	585.136

4. Conclusions and Recommendations

The calculation of a single net premium value using actuarial concepts consists of several stages. First determine the chances of survival and mortality based on mortality table and survival analysis. Further determining the interest rate, in this case using the interest rate of Bank of Indonesia and calculating Actuarial Present Value (APV)

The results of the calculation analysis showed, by sex, the value of female APV is lower than men this is due to the probability of death of men greater than women. The higher the age, the increased chance of death. Women are considered to have better insurance risk than men. In term of loan term, the risk of mortality of debtor is also higher with the length of loan period. The older a person and the longer the loan period, the greater the value of a single net premium.

The single net premium calculation in this study has different results at the age, gender and loan term. Unlike the case with the current premium in KPN PNB. KPN PNB in determining the premiums imposed on the debtors only on the basis of the loan period does not take into account the factors of age and gender, so the value of premiums for all ages and sex the same.

In this study the calculated premium is a single net premium so that only the mortality and the interest rate are calculated. Single net premiums are only enough to pay benefits, but not enough for operational costs. For further research, it is expected to develop this research with pay attention to load factor to cover other expenses incurred by cooperative.

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