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Article

Review on Pricing Models for Long-term Care Insurance

Muhammad Syakir Asrulsani [1], Mazlynda Md Yusuf [2]

[1] *Faculty Science & Technology, Universiti Sains Islam Malaysia (USIM), Bandar Baru Nilai, 71800, Nilai, Negeri Sembilan, Malaysia*
E-mail: syakirasrulsani@gmail.com

[2] *Faculty Science & Technology, Universiti Sains Islam Malaysia (USIM), Bandar Baru Nilai, 71800, Nilai, Negeri Sembilan, Malaysia*
E-mail: mazlynda@usim.edu.my

Abstract— **Funding for long-term care costs among elderly people is a critical matter, especially due to high costs and an unexpected length of time. Placement for long-term care that is funded under Jabatan Kebajikan Masyarakat (JKM) is very limited, hence, the next option is through private nursing homes. However, the cost could be up to RM 2,000 a month for each person. Therefore, Long-Term Care Insurance is an alternative to fund for Long-Term Care costs as it is expected to reduce financial burden during old age. It is a risk protection mechanism for an insured that needs health and financial protection when an individual is unable to do activities of daily living (ADL) or supports in instrumental activities of daily living (IADL). This paper reviews three models that have been used in pricing long-term care insurance. All three models use the equivalent principle of premium to price the insurance policy. However, the probability and assumptions used for each model differ, depending on the insured's needs and profile.**

Keywords— **long-term care insurance; actuarial pricing models; Basic Model; General Markovian Model; Pitacco Model.**

I. INTRODUCTION

Malaysia's aging population and increasing trend in life expectancy have resulted in urgency to cater to long- term care for the elderly. This is due to the unknown condition and magnitude that will be faced since elderly care could take days or even years (Othman, 2012). To make matters worse, the current situation for many Malaysian retirees is insufficient for a sustainable future due to these uncalculated risks such as longevity risk, medical costs, and inflation (Noordin, 2016).

According to Bond (2007), the barrier to life fulfillment for older people is not the age but rather the environment they are living in. Therefore, these elderly people that need special care in long-term care institutions should provide a comfortable environment to improve their overall health and wellbeing. However, the declining number of family members caring for their elderly members (Ong, 2002) proves the need for long-term care services which then leads to financial commitment or funding by the individuals, families, and government.

II. LITERATURE REVIEW

A. *Long-Term Care*

Life expectancy in Malaysia for the years 2000 and 2019 is 72.67 and 74.50 years old respectively, however Malaysian healthy life expectancy for the years 2000 and 2019 is 64.6 years old and 66.8 years old respectively (DOSM, 2019). This shows that an individual is exposed to a higher risk of being sick or disable from 67 years old to 75 years old. The main concern with higher life expectancy is the deterioration of health and physical status which in turn may have adverse effects such as chronic diseases and disabilities (Ramesh, D., 1997). Disability is a condition where a person needs support in Activities of Daily Living (ADL), such as bathing, dressing, and feeding, and the Instrument of Daily Living (IADL), such as shopping, transportation, and housekeeping.

Therefore, this leads to the need for long-term care, to assist them with their daily living activities. However, without proper planning, this will create a huge impact not only financially but may also result in emotional distress among the elderly and their family members (Ibrahim et al., 2013).

B. *Long-Term Care Insurance*

The World Bank has outlined the multi-pillar taxonomy for social protection (Holzmann & Hinz, 2005), and following this, Malaysia has identified its schemes under five different pillars (Ong & Hamid, 2010) and these five pillars mainly cover social protection including pension schemes, Employees Provident Fund (EPF) and personal savings. However, the Employees Provident Fund (EPF) has reported that almost 80% of employees reaching age 55 would have savings below the poverty line that is RM 830 a month (Sheridan M., 2015). Additionally, with the increasing cost of living and the desire to have a comfortable living during old age, a long-term care insurance plan is one of the alternatives to fund the long-term care cost that may occur in the future.

According to B. Levikson (1993), long-term care insurance is purposely designed to provide financial assistance if the insured requires care; he or she is dependable to others daily to perform activities of daily living (ADL). The main concept of long-term care insurance is as long as the insured is in a healthy condition, he or she pays a fixed annual or monthly premium and once the insured becomes in need of care, he or she starts to collect benefits that depend on the level of care he or she needs and does so as long as he or she requires care.

In Germany, long-term care insurance (LTCI) was established in 1995. As per the law, people will earn benefits from the LTCI if they need care due to an illness or disability (Gerhard Backer, 2017). The coverage for this insurance has three completely different arrangements a recipient can choose from; care allowance, home care (in-kind), and residential care. The definition of "in need of care" is prime for eligibility and also the level of advantages received. Since 1995, the LTCI has distinguished between 3 levels of care that supported the severity of the health condition. Level 1 care indicates a person that needs the care of at least once a day, and an average of at least 90 minutes of help every day of the week. Level 2 is for the individual that requires help a minimum of 3 times daily and needs a minimum of 180 minutes of help each day of the week. The thirds care Level 3 indicates a person desires day-and-night help daily and needs an average of at least 300 minutes of help daily of the week. The benefits provided by the insurance policy is a care allowance, outpatient care, and inpatient care. Therefore, all care levels can be used accordingly depending on the needs of nursing care.

In Japan, the insurance company has a pooling mechanism at the national level to balance the variations in their demographic structure (Ikegami, N 2015). The benefits are focused on institutional care (including respite care) in geriatric hospitals and units of general hospitals designed for the older, Hess, nursing homes, and cluster homes for those with dementia. It additionally includes home-help services, most nurse services, daycare, loan of devices (such as wheelchairs), and money help for improving the house (such as creating it to be accessible for wheelchairs). Physicians' services can usually be enclosed within the comprehensive payment created for institutional care (note that physicians are either administrators or used by hospitals and Hess). In-home care, a monthly medical management fee is going to be paid to the attending physician, which would cover the price of one home visit. However, nursing care in physicians' offices and hospitals, physicians' extra home visits, also as acute care normally can still be covered by this insurance system.

C. Long-Term Care Insurance Pricing Models

As previously discussed, a certain amount of cost is needed to cater to their needs and also to sustain these long-term care costs, which is crucial especially for those who are living alone. Malaysia's social security provision for older people can be considered as uncertain compared to another middle-income country, therefore the level of health and welfare investment is needed as the number of the aging population is expected to increase significantly. With the insufficient funds projected for retirement, Malaysian citizens must have an alternative mechanism that is long-term care insurance to cater for the increasing medical costs. Such urgency is called upon to improve the current system to avoid the increasing dependency ratios and reduce the burden on healthcare and pension systems (Tobi et.al, 2017).

Currently, three models have been used by previous studies in pricing long-term care insurance; i) The Basic Model, ii) The General Markovian Model, and iii) The Pitacco Model. Based on all three models mentioned, the feature of long-term care insurance and coverage have similar actuarial pricing principles. Firstly, the feature of this insurance for all models cover a healthy insured at age x pays an amount of premium, P_x as long as the insured remain healthy and become in need of care at age $x+t$ will receive benefits, B until the insured dies. A schematic representation is shown below:

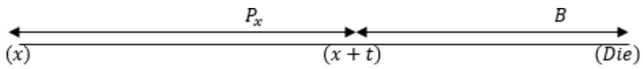

Fig. 1 Basic Feature of Long-term Care Insurance

Secondly, these pricing models use the multiple state model that consists of three states and transitions that indicate the movement between states. The states are:

a = healthy
i = need for care
d = died
and the possible movement between states are:
$a \rightarrow i$ = entering need of care state from a healthy state
$a \rightarrow d$ = die from a healthy state
$i \rightarrow d$ = die from the need of care state

The transitions lead to one state only. If the insured becomes in need of care, this means a healthy insured enters the need of care state, the insured is assumed to remain in that state until the insured dies as there will be no recovery. A schematic representation is shown below:

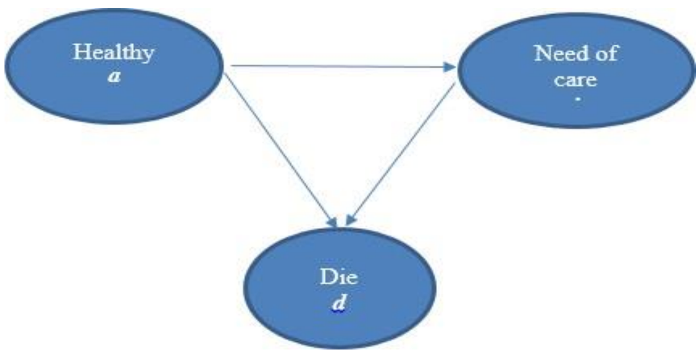

Fig. 2 Schematic Presentation of the Long-Term Care Model

The third similar principle among these three models is the concept of pricing insurance using the equivalent principle of premium. The equivalent principle of premium takes into consideration of outgo benefit payment only in net premium calculation. Thus, expenses are not part of the premium calculation. The equivalent principle of premium stated that the Present Value of Future Premium (PVFP) is equal to the Present Value of Future Benefit (PVFB). The Present Value of

Future Premium (PVFP) is a premium paid discounted to the present value for a stream of P_x consideration v as the discount factor. The Present Value of Future Benefit (PVFB) is a benefit paid by the insurer to the insured discounted to the present value for a stream of. B Considering the discount factor v and the benefits, B the insured will collect when the need for nursing care services until the insured dies. B is considered as random variables depending on the needs and wants of the insured. The equivalent principle of the premium formula is shown below:

$$PVFP = PVFB$$

$$P_x \,.\, PVFP = B \,.\, PVFB$$

$$P_x = \frac{B \,.\, PVFB}{PVFP} \tag{1}$$

However, apart from the similarities holds under these three pricing models in long-term care insurance, there is a component in all these models that holds different assumptions between these models.

III. PRICING MODELS

A. *The Basic Model*

The Basic model was previously discussed by Munich Re Report (1991) and by Haberman (1987) for the disability model. In this model, there is only one care level, and recovery is not allowed. Thus, first, the insured stays a random time at the lively state, then he either dies or will become in need of long term care. If the latter occurs the insured receives the insurance benefit for or for the maximal duration of the contract. This model used the equivalent principle of premium to price long-term care insurance as stated that the Present Value of Future Premium (PVFP) is equal to the Present Value of Future Benefit (PVFB).

The premium payment is paid by an active individual until the individual becomes invalid. Thus, the Present Value of Future Premium (PVFP) is shown below:

$$PVFP = \ddot{a}^{ai}_{x:\overline{T_x}|} = \frac{N^{ai}_x}{D^{ai}_x} = \sum_{k\geq 0}^{T_x} \frac{l^{ai}_{x+k}\, v^t}{l^{ai}_x} \tag{2}$$

where T_x is the time an active individual aged x spends and pays premium before the individual becomes invalid?

The benefit of an insurance contract will be paid to an active individual age, x who become invalid at age $x+1$ until the individual dies. Thus, the Present Value of Future Benefit (PVFB) is shown below:

$$PVFB = \ddot{a}^{ai}_{x+T_x:\overline{T_y}|} = \sum_{k\geq 0}^{T_y} \frac{l^{ai}_{x+k}}{l^{ai}_x}\, i_{x+k} \frac{l^{i}_{x+T_x+k+1}}{l^{i}_{x+k+1}}\, q^{i}_{x+T_x+k+1} \tag{3}$$

where T_y is the time an individual receives benefit when the individual becomes invalid until the individual dies?

For this model, the probabilities used in the model are explained below:

q^{ai}_x = *probability of an active individual aged x die within the next year*
i_x = *probability of an active individual aged x become invalid within next year*
q^{ai}_x = *probability of an active individual aged x remain active within next year*
q^{i}_x = *probability of an ivalid individual aged x die within the next year*

The life table functions:

$$l^{a}_x = \textit{number of active individuals aged } x$$
$$l^{i}_x = \textit{number of invalid individuals aged } x$$

Therefore, based on the assumptions above, the net annual premium calculated under The Basic Model is derived as below:

$$PVFP = PVFB$$

$$P_x \,.\, \ddot{a}^{ai}_{x:\overline{T_x}|} = B \,.\, \ddot{a}^{ai}_{x+T_x:\overline{T_y}|}$$

$$P_x = \frac{B \,.\, \ddot{a}^{ai}_{x+T_x:\overline{T_y}|}}{\ddot{a}^{ai}_{x:\overline{T_x}|}}$$

$$P_x = \frac{\sum_{k\geq 0}^{T_y} \frac{l^{ai}_{x+k}}{l^{ai}_x}\, i_{x+k} \frac{l^{i}_{x+T_x+k+1}}{l^{i}_{x+k+1}}\, q^{i}_{x+T_x+k+1}}{\sum_{k\geq 0}^{T_x} \frac{l^{ai}_{x+k}\, v^t}{l^{ai}_x}} \tag{4}$$

B. *The Genaral Markovian Model*

The General Markovian model was also studied by Munich Re Report (1991) and by Haberman (1987) for the disability model and stated that the insurance benefit varies depends on the degree of severity of disable. The pricing of long-term care insurance by this model using an averaging three benefits in terms of 0.4, 0.7, and 1.0. The benefit given by the insurer is in terms of percentage depends on which care level the insured purchased. The feature of the insurance is similar to The Basic Model insurance feature that is a healthy insured pays premium for a certain amount of time until the insured disable it, and the insurance benefit will be provided to the insured until the insured dies. Apart from that, another similarity between The Basic Model and The General Markovian Model is that both models use the same method to price long-term care insurance that is the equivalent principle of premium using the Present Value of Future Premium (PVFP) and the Present Value of Future Benefit (PVFB).

This model used the same actuarial values as The Basic Model used. However, the benefits given by the insurer is different than other models. The insurance benefit for The Basic Model and The Pitacco Model is in terms of financial assistance only. The insurance benefit for The General Markovian Model is also in terms of financial assistance but slightly different than other models as the benefit is divided into three care levels that indicate the number of activities unable to perform as well as financial support. The insurance benefit for this model depends on the need for support in activities of daily living (ADL). The activities that consider as activities of daily living (ADL) are shown below:

a) transferring from bed to chairs;
b) dressing and undressing;
c) eating and drinking;
d) bathing, combing, and shaving
e) using the toilet;
f) walking.

Care Level	Number of activities unable to perform	Financial, $
I	3	0.4
II	4 or 5	0.7
III	6	1.0

Table 1: Level of care

The insurance companies assume that those paying premiums are healthy and will stop paying premiums as soon as the insured becomes in need of care. Thus, the Present Value of Future Premium (PVFP) is shown below:

$$PVFP = P_x \cdot \ddot{a}^{ac}_{x:\overline{T_x}|} = P_x \cdot \sum_{k\geq 0}^{T_x} \frac{l^{ac}_{x+k} v^t}{l^{ac}_x} \quad (5)$$

The insurance companies also assume that those receiving the insurance benefits are those that enter the need of care state from a healthy state until the insured dies. Thus, the Present Value of Future Benefit (PVFB) is shown below:

$$PVFB = \ddot{a}^{ac,D}_{x+T_x:\overline{T_y}|} = \sum_{j\geq 0} \frac{l^a_{x+j}}{l^a_x} \cdot v^{j+\frac{1}{2}} \cdot [{}^{ac}i^{I}_{x+j} \ddot{a}^{I,D}_{x+j+\frac{1}{2}} + {}^{ac}i^{II}_{x+j} \ddot{a}^{II,D}_{x+j+\frac{1}{2}} + {}^{ac}i^{III}_{x+j} \ddot{a}^{III,D}_{x+j+\frac{1}{2}}] \quad (6)$$

where:

$$\ddot{a}^{I,D}_n = 0.4\ddot{a}^I_n + \sum_{m\geq 0} \frac{l^I_{n+m}}{l^I_n} \cdot v^{m+\frac{1}{2}} \cdot [\, {}^{I}i^{II}_{n+m} \ddot{a}^{II,D}_{n+m+\frac{1}{2}} + {}^{I}i^{III}_{n+m} \ddot{a}^{III,D}_{n+m+\frac{1}{2}}] \quad (7)$$

$$\ddot{a}^{II,D}_z = 0.7\,\ddot{a}^{II}_z + \sum_{t\geq 0} \frac{l^{II}_{z+t}}{l^{II}_z} \cdot {}^{II}i^{III}_{z+t} \cdot v^{t+\frac{1}{2}} \quad (8)$$

$$\ddot{a}^{III,D}_y = \sum_{k\geq 0}\left(\sum_{t=0}^{k} v^t\right) \cdot \frac{l^{III}_{y+k} - l^{III}_{y+k+1}}{l^{III}_y} \quad (9)$$

Based on the assumptions above, therefore the net annual premium calculated under The General Markovian Model is derived as below:

$$PVFP = PVFB$$

$$P_x \cdot \ddot{a}^{ai}_{x:\overline{T_x}|} = B \cdot \ddot{a}^{ai,D}_x$$

$$P_x = \frac{B \cdot \ddot{a}^{ai,D}_x}{\ddot{a}^{ai}_{x:\overline{T_x}|}}$$

$$P_x = \frac{\sum_{j\geq 0} \frac{l^u_{x+j}}{l^a_x} \cdot v^{j+\frac{1}{2}} \cdot [{}^{ai}i^{I}_{x+j} \ddot{a}^{I,D}_{x+j+\frac{1}{2}} + {}^{ai}i^{II}_{x+j} \ddot{a}^{II,D}_{x+j+\frac{1}{2}} + {}^{ai}i^{III}_{x+j} \ddot{a}^{III,D}_{x+j+\frac{1}{2}}]}{\sum_{k\geq 0}^{T_x} \frac{l^{ai}_{x+k} v^t}{l^{ai}_x}} \quad (10)$$

C. The Picasso Model

An insurance company takes into consideration the use of probabilities in some conditions. The probabilities and the transition probabilities used in this model are divided into two different age-based probabilities.

For a healthy insured age x, the one-year transitions probabilities involved are:

p^{aa}_x = probability of being healthy at age $(x+1)$
p^{ai}_x = probability of become in need of care at age $(x+1)$
q^{aa}_x = probability of dying before age $(x+1)$ from healthy state
q^{ai}_x = probability of dying before age $(x+1)$ from need of care state
q^{a}_x = probability of dying before age $(x+1)$
ω_x = probability of become in need of care before age $(x+1)$

For insured who in need of care state age, x the one-year transitions probabilities used are:

p^{i}_x = probability of being alive and in need of care at age $(x+1)$;
q^{i}_x = probability of dying before age $(x+1)$.

The relationship among the transition probabilities mentioned above are obviously hold:

$$q^a_x = q^{aa}_x + q^{ai}_x \quad (11)$$

$$p^{aa}_x = 1 - q^{aa}_x - \omega_x \quad (12)$$

$$p^i_x = 1 - q^i_x \quad (13)$$

$$\omega_x = p^{ai}_x + q^{ai}_x \quad (14)$$

$$q^{ai}_x = \omega_x \frac{q^i_x}{2} \quad (15)$$

$$p^{ai}_x = \omega_x \left(1 - \frac{q^i_x}{2}\right) \quad (16)$$

The n-year transitions probabilities are derived as:

$${}_k p^{aa}_x = \prod_{h=0}^{k-1} p^{aa}_{x+h} \quad (17)$$

$${}_k p^{i}_x = \prod_{h=0}^{k-1} p^{i}_{x+h} \quad (18)$$

$$ {}_{k}p_x^{i} = \sum_{h=1}^{k} [{}_{k-h}p_x^{aa} \cdot p_{x+k-h}^{ai} \cdot {}_{h-1}p_{x+k-h+1}^{i}] \tag{19} $$

$$ {}_{0}p_x^{aa} = 1,\ {}_{0}p_x^{i} = 1, and\ \ {}_{0}p_x^{ai} = 0 $$

An insurance company assumed that premium payment is paid by those that are still alive and are in a healthy condition. Thus, the actuarial value is defined as:

$$ \ddot{a}_{x:\overline{r}|}^{aa} = \sum_{j=0}^{r-1} v^{j} \cdot {}_{j}p_x^{aa} \tag{20} $$

A temporary life annuity of a healthy insured age (x) provides a benefit of one monetary unit annually that is payable until the individual dies while the insured is healthy.

An insurance company also assumes that benefit will pay to the insured as soon as the insured become in need of care until the insured dies. Thus, the actuarial value is defined as:

$$ a_x^{ai} = \sum_{j=1}^{\infty} {}_{j-1}p_x^{aa} \cdot p_{x+j-1}^{ai} \cdot v^{j} \cdot \ddot{a}_{x+j}^{i} \tag{21} $$

A life annuity of a healthy insured provides a benefit of one monetary unit annually that is payable until the insured die while the insured requires care.

$$ \ddot{a}_{x+j}^{i} = \sum_{h=j}^{\infty} v^{h-j} \cdot {}_{h-j}p_{x+j}^{i} \tag{22} $$

A life annuity of a healthy insured $(x+j)$ age provides a benefit of one monetary unit annually that is payable until the insured die while the insured requires care.

Thus, the Present Value of Future Premium (PVFP) is a premium paid discounted to the present value for a stream of P_x considering v as the discount factor and the formula is shown below:

$$ PVFP = P_x \cdot \ddot{a}_{x:\overline{T_x}|}^{aa} = P_x \cdot \sum_{j=0}^{T_x-1} v^{j} \cdot {}_{j}p_x^{aa} \tag{23} $$

where T_x is the time a healthy insured aged x spends and pays premium before the insured becomes in need of care.

The Present Value of Future Benefit (PVFB) is a benefit paid by the insurer to the insured discounted to the present value for a stream of B. Considering v the discount factor and B the benefits, the insured will collect when the need for nursing care services until the insured dies. B is considered as random variables depending on the needs and wants of the insured. The Present Value of Future Benefit (DVFB) is shown below.

$$ PVFB = B \cdot a_{x+T_x:\overline{T_y}|}^{ai} = B \cdot \sum_{j=1}^{T_y} {}_{j-1}p_{x+T_x}^{aa} \cdot p_{x+T_x+j-1}^{ai} \cdot v^{j} \cdot \ddot{a}_{x+T_x+j}^{i} \tag{24} $$

where T_y is the time an insured receives the benefit as soon as the insured becomes in need of care until the insured dies.

Therefore, based on the assumptions above, the net annual premium calculated under The Pitacco Model is derived as below:

$$ PVFP = PVFB $$

$$ P_x \cdot \ddot{a}_{x:\overline{T_x}|}^{aa} = B \cdot a_{x+T_x:\overline{T_y}|}^{ai} $$

$$ P_x = \frac{B \cdot a_{x+T_x:\overline{T_y}|}^{ai}}{\ddot{a}_{x:\overline{T_x}|}^{aa}} $$

$$ P_x = \frac{\sum_{j=1}^{T_y} {}_{j-1}p_{x+T_x}^{aa} \cdot p_{x+T_x+j-1}^{ai} \cdot v^{j} \cdot \ddot{a}_{x+T_x+j}^{i}}{\sum_{j=0}^{T_x-1} v^{j} \cdot {}_{j}p_x^{aa}} \tag{25} $$

IV. CONCLUSIONS

Long-term care insurance is a mechanism that can reduce the burden borne by the insured or their family that becomes disabled at any period after the policy takes effect. There are many methods to price for long-term care insurance using the main concept of insurance pricing that is the equivalent principle of premium. There are some similarities and differences between the three pricing models. Based on the review, it can be concluded that the most recommended method that can be used by the insurance company to price long-term care insurance is The Pitacco Model if the insured requires financial assistance as an insurance benefit. However, if the insured requires insurance benefits in terms of care level, the most recommended pricing method for long-term care insurance is by using The General Markovian Method.

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