

**Long-Term Care (LTC) Insurance Application**  
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**Abstract**

Due to an aging population and the rapid growth of long-term care (LTC) expenses, it is important to understand the welfare effects of purchasing LTC insurance on the quality of life for the elderly. We must understand how individuals make decisions and which factors are most strongly considered by these individuals when making those decisions. This study provides a calibration exercise to determine whether rational consumers should buy LTC insurance and, also, to estimate the optimal timing of the LTC insurance application. The utilized Rand Health and Retirement Survey allow me to obtain good measures of each individual's demographic information by age. I show how individuals would react, based on the data calculated from the means, to LTC insurance application decision. That is, I have collected general data from each age group, rather than specific information on individual cases. The results show that individuals do not tend to apply for an LTC insurance policy when they have a less than 15% chance of entering a nursing home during their retirement years. The probability of staying in a nursing home plays a major role in an individual's choice as to whether to apply for an LTC insurance policy.

**Keywords:** long-term care insurance, nursing home, life cycle model, option value model

## Introduction

Due to the aging population and the rapid growth of long-term care (LTC) expenditures in the United States, it is important to understand what welfare effects purchasing an LTC insurance policy have on the quality of life for the elderly. According to the Administration on Aging (2000), from 1980 to 2000, the elderly population over the age of 65 increased by 36%. During the same period, the number of elderly over the age of 85 doubled. The Administration on Aging's 2002 prediction suggests that by the year 2030, the total elderly population will reach 70 million in the United States. Table I shows the population growth pattern for individuals over the age of 65.

In addition, the elderly<sup>1</sup> population in the United States is the largest demographic group to face a high medical risk of being disabled or having chronic diseases and, therefore, need LTC services. For example, individuals over the age of 65 may have at least a 40% lifetime risk of being admitted to a nursing home. Approximately 10% of those who enter a nursing home will stay there for at least five years (The Department of Health and Human Services, 2002; American's Health Insurance Plan (AHIP), 1999). Approximately 47% of individuals from ages 50 to 64 have different types of chronic diseases, whereas approximately 83% of individuals over the age of 85 have chronic diseases, disabilities and accompanying functional limitations (The MetLife Market Survey on Nursing Home and Home Care Cost, 2002; American Association of Retired Persons (AARP), 2002).

As LTC is for those individuals who have chronic diseases or need assistance conducting activities within their daily lives, the rapid increase in LTC expenses is understandable. The

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<sup>1</sup> An individual whose age is over the age of 65 is called the elderly in this study.

Congressional Budget Office (CBO) (2005) indicates that the total LTC expenditure<sup>2</sup> for seniors was \$183 billion in 2003 and \$211.4 billion in 2004. Also, the CBO states that this number is expected to grow to \$540 billion (2.3% of the GDP) by the year 2040. The growth of the total nursing home and home care costs from 1960 to 2004 is displayed in Table II.

The national average price of a semiprivate room in a nursing home service was \$169 a day in 2004 (see Table III). Additionally, based on a study conducted by Alexih (2006), the average length of such a stay was 2.4 years and the median length of such a stay was 1.3 years in 2004. Therefore, in 2004, a nursing home stay would cost an elderly person \$148,044 ( $\$169 \times 365 \times 2.4$ ) on average, or \$80,190.50 ( $\$169 \times 365 \times 1.3$ ) at the median level. Such an expense would be a heavy burden for an elderly individual and his family.

According to the CBO (2004) and the Health, United States (2006), the distribution of the payment sources for LTC policies has been quite uneven. Table IV shows the distribution of nursing home expenditures by funding source. In 2004, 44% of LTC expenses were paid for by Medicaid plans, 33% were paid for by family sources (individual out-of-pocket payments) and 4% were paid for by private LTC insurance companies. This table implies that only few individuals have held LTC insurance policies. Also, Brown and Finkelstein (2004) point out that only 10% of the elderly have held LTC insurance policies.

An interesting question then attracts researchers' attention- If the LTC expenditure is so expensive for individuals, why do they not apply for an LTC insurance policy to relieve their financial burden? Brown and Finkelstein have several studies that explain this limited size of the LTC insurance market. Their 2004 study implies that the supply-side market imperfections, including administrative costs, imperfect competition, asymmetric information and aggregate

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<sup>2</sup> The LTC expenditure includes nursing home, home care, community-based services, assisted living facilities, adult day-care centers, informal care and hospice care.

risk, are not the major causes of the limited size. Instead, the limited size is driven by the demand side factors. For example, Brown and Finkelstein state that Medicaid may be a substitute for private insurance. Such a result has lead researchers to the conclusion that in order to better understand the LTC market, they must first understand the demand patterns that affect the market.

Brown and Finkelstein (2004b) examine how Medicaid explains the lack of private LTC insurance purchases. The theoretical results show that even at the actuality fair premium, as long as Medicaid exists in the market, individuals would prefer to not purchase a private LTC insurance policy at all wealth levels. Therefore, Medicaid has a major crowd-out effect on the private LTC insurance market. This crowd-out effect is attributable to the fact that, compared to the cost of Medicaid, individuals need to spend a large portion of their wealth on coverage premiums if they purchase private LTC insurance. A complement paper written by Brown, Coe and Finkelstein (2006) agree with the above findings.

Recent literature on the LTC insurance issue has also focused on finding explanations to illustrate the determinants for the LTC insurance purchasing decision and choosing LTC coverage. For example, Cohen, Kumar and Wallack (1992) compile LTC insurance purchasing behavior information from six LTC insurance companies (see Table V for details) by studying selected purchasers age 50 and above, and find that individuals who do not want to rely on their children, believe the government will not cover the LTC for them, face a higher medical risk, are female or who have a higher education level are more likely to buy LTC insurance. Cohen, Kumar and Wallack (1992) also report that in 1990, the average age for an individual to purchase LTC insurance was 68.

Meier (1999) suggests three reasons why younger individuals wait to purchase LTC insurance until they retire. First, younger individuals prefer not to face deadweight losses in terms of the fixed loading costs. Second, the coverage does not fit their current disability cost needs. Third, an individual with a lower risk of becoming disabled may buy LTC insurance later in life in order to avoid the expected income loss. Meier then recommends that a policy-maker should create an LTC insurance policy that younger individuals will not be included as contributors in the system.

A study conducted by Stern (1995) reports that the characteristics of children, especially gender and proximity, are important determinants in a parent's decision regarding LTC insurance. For instance, daughters are more likely than sons to take care of their parents as are children who live close to their parents. In addition, if a child plans on taking care of his parents, then the child would often move closer to his parents or have his parents move closer to him. In such cases, the parents may not need to purchase LTC insurance policies.

Furthermore, Mellor (2001) examines whether parents, in their old age, trust informal care, such as that given by their own children, and has different results from the study of Stern (2005). He uses the 1999 Asset and Health Dynamics survey and the Panel Study of Income Dynamics in order to explain informal care as a substitute for LTC insurance. Mellor assumes that the presence of an informal caregiver reduces an older individual's desire to purchase LTC insurance, or willingness to extend his LTC insurance coverage. However, his findings show that the presence of an informal caregiver does not have a significant effect on the LTC insurance purchase decision. Instead, education, income and assets have significant positive relationships in regard to the decision.

A study conducted by Finkelstein and McGarry (2006) demonstrate the existence of private information in the LTC insurance market. The authors conclude that both an individual's personal medical risk and preference for insurance have an effect on the purchase of LTC coverage and nursing home use. McNamara and Lee (2004) find that the complex nature of LTC insurance policies, and, therefore, the difficulty in understanding the policies, as well as a lack of information about medical risks of being disabled or having chronic diseases may be critical elements in explaining why the insured individuals drop the LTC coverage few years after they have purchased it.

Brau, Bruni and Pinna (2004) and Brau and Bruni (2006) analyze the determinants of both public and private demand for covering LTC expenditures. They study how an individual makes a decision of purchasing public or private LTC insurance, and what factors affect his willingness to pay for LTC coverage. Do the factors that influence interests in buying LTC insurance differ from those that determine the quantity of LTC coverage? The results then show that, a prior positive experience with LTC will determine an individual's willingness to buy LTC insurance, and, on average, public insurance programs are preferred. On the other hand, the socioeconomic variables, such as income, have an influential effect on the LTC coverage decision.

Unfortunately, no research exists on the optimal timing of the LTC insurance application or answers the question: "Should rational consumers purchase LTC insurance?" The timing of the LTC insurance decision affects an individual's welfare level. For example, if an individual purchases LTC insurance at a young age, he will have a lower payment, but for a longer period of time than if he purchased the insurance later in his life. Therefore, the individual may lose wealth on a service that he is unsure that he will need in the future. However, when an individual purchases LTC insurance at older age, especially shortly after retirement, he may not be able to

afford the costly premium. Therefore, it is important to know the best time to apply for LTC insurance.

In addition, the probability of being placed in and the length of a stay in a nursing home are critical factors that affect the demand for LTC insurance and the timing of an individual's application. For example, an individual who believes that he has a high risk of being placed in or will spend a lot of time in a nursing home during his retirement years may prefer to apply for an LTC insurance policy before retirement in order to reduce his financial burden on LTC services.

The real interest rate is another factor that has a substantial effect on the LTC purchasing decision. If an individual expects to have a high real interest rate in the future, which means that the current value will be more expensive than the future dollar, then the individual may postpone his decision due to the fact that, with a high real interest rate, the price of the LTC policy will be cheaper in the future. Individuals can save more now and apply for LTC insurance later.

During this study, using the general information (survival probabilities, income level, out-of-pocket medical expenses, nursing home costs, LTC insurance premiums, LTC insurance coverage and the probability of entering a nursing home) that an individual may face in his lifetime, I will answer two questions: (1) Should rational consumers purchase LTC insurance? and (2) What is the optimal timing of the LTC insurance application? In addition, I explain how the changes in the probability of nursing home utilization, length of a nursing home stay and real interest rate affect an individual's decision.

Additionally, within this study, I will use the option value model<sup>3</sup> to analyze a variety of individuals' decisions in regard to their LTC insurance purchases. In order to conduct this

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<sup>3</sup> The option value model compares the maximum expected values of the utility within the decision set in order to find the highest expected value of the utility. It was first utilized by Stock and Wise (1990). They argue that, using this model to solve discrete choice problems is less complicated and performs better in empirical terms than the dynamic programming model.

analyzes, I have developed a simple seven-period life cycle model and constructed the data at an average or median level in order to solve each individual's maximum problems under the following assumptions: (1) individuals live a time span of seven periods, (2) individuals face uncertain longevity, (3) individuals face the probability of a nursing home stay in each period except for period one, (4) individuals can apply for LTC insurance only in the beginning of each period, (5) individuals cannot drop or change the LTC policy once it has been purchased, (6) the premium will be constant in nominal dollars after the individual applies (i.e. the insurance company cannot change the premium because the individual ages or his health diminishes), (7) only one LTC insurance plan type exists for individuals to choose from,<sup>4</sup> (8) the insurance company will only ask the insured individual to satisfy the waiting period (the period an individual must exceed before receiving benefits) once in his lifetime, (9) the approval rate of the LTC insurance application is 100%; and (10) insurance companies will not deny any feasible claims once insured individuals need the LTC services.

In accordance with the general individual information that I compute from the 1994 - 2004 Rand Health and Retirement Survey (HRS), I discover that individuals would prefer to not purchase any LTC insurance throughout their whole life. This result coincides with the current situation in the LTC insurance market where only 10% of the elderly over 65 years old have LTC coverage (Brown and Finkelstein, 2004). However, when an individual believes that he has a high chance of entering a nursing home during his old age, he is more likely to purchase an LTC insurance policy during his 40s.

If an individual has a high probability of entering a nursing home, then the real interest rate becomes an important element that affects the LTC application decision. A low real interest rate can cause an individual to have an early application. An individual would prefer to purchase

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<sup>4</sup> See Section 4's explanations of the LTC policies for more information.



an LTC insurance policy at a younger age, such as 30s. In addition, when an individual believes that he has a high probability of, after a certain age (e.g. after 60), entering and staying in a nursing home for a long period of time, he is more likely to purchase the LTC coverage in his 60s. So that, he has the financial support to pay for the LTC expenses at the time he needs the assistance.

This study is constructed as follows. In Section 2, I describe the LTC insurance payment sources and policies. The model is described in Section 3. Section 4 describes the data and statistics. Section 5 contains the results and Section 6 contains the conclusion.

## **2. LTC**

### **2.1. LTC Payment Sources**

Family sources, Medicare, Medicaid and LTC insurance are the four main funding sources for LTC service expenses. Individuals and their family members may pay the costs of the LTC out of their own savings, investments or assets. However, since the expense of LTC service is one of the most costly medical expenses, an individual or his family's income may not be enough for the individual to support this expense.

The elderly may also pay their LTC expenses through the Medicare program. In fact, the elderly who turn the age of 65 will automatically enroll in the Medicare hospital insurance plan. However, the Medicare hospital plan only covers the full LTC cost for the first 20 days. Then, the individual must pay the co-pay for the next 80 days<sup>5</sup> and, finally, pay all of the expenses after 100 days.

The third method to pay for LTC services is to be eligible for the Medicaid program. This program pays for the cost of the nursing home care, home health care and community-based

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<sup>5</sup> In 2007, Medicare paid \$124 per day. The expected payment in 2008 is \$128.

services for individuals who qualify. However, there are some requirements for an individual to qualify for this program (See Table VI for the information about income and asset limits). Most of the elderly persons need to spend down their income first in order to be eligible for the Medicaid program.

Purchasing private LTC insurance is the final way to cover an individual's LTC expenses. Private LTC insurance coverage can pay up to 100% of an individual's expenses depending on what type of policy or coverage the individual chooses. The more policies an individual holds, the more expensive premium he needs to pay for.

## **2.2. LTC Insurance (Policies and Premiums)**

Based on the 2006 Federal LTC Insurance Program guideline information, the main options<sup>6</sup> for LTC insurance are the following. (1) Coverage: A facility-only or comprehensive plan. The facility-only plan covers the expenses of the nursing home care, assisted facilities, hospice and respite care. The comprehensive plan, on the other hand, covers the nursing home expenses, assisted facilities, hospice services, respite care and home health services. The comprehensive policy is more expensive than the facility-only plan.

(2) Daily Benefit Amount. This amount is the daily amount of an individual's benefits in dollars that an insurance company will pay to an insured individual when he stays in a nursing

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<sup>6</sup> Other LTC insurance policies include the following. (1) Waiver of Premium. This type of policy is standard on many policies; however, some companies still include this policy as an additional option. This waiver allows an insured individual to not pay the premium while he is receiving the benefit. (2) Restoration of Benefit. As long as an insured individual does not need long-term care during certain periods (i.e. such as within six months after their policy has paid for the individual's previous care), this option can keep the maximum benefit amount of insured people as same as they first purchase. (3) Premium Refund at Death. With this policy, insurance companies pay the insured individual's family the premiums that the individual paid minus any benefits that the individual received. In order to utilize this option, the insured individual must die at a certain age and/or have paid his premiums for a certain number of years. (4) Downgrades. This policy allows an insured individual to pay less for his premium when he is not able to afford the original premium. However, the individual's coverage will be less comprehensive during the lower premium periods.

home or needs home health care services. The more daily benefit amount an individual desires, the more expensive premium he needs to pay for.

(3) Benefit Period. This period is the length of time that an individual can receive his benefits. If the payment does not exceed the insured individual's daily benefit amount or if the individual does not need the LTC services every day, then the benefit period will last longer.

A longer benefit period will cause an increase in the individual's premium, because the longer benefit period an individual chooses, the longer period the insurance company needs to cover the costs of the LTC services for him. The company then will require the individual to pay a higher premium.

In addition, an individual's maximum lifetime benefit is the product of the daily benefit amount and the benefit period in days. This maximum lifetime benefit is the total lifetime amount that an insurance company will pay to the insured individual. For example, if an individual chooses \$150 as his daily benefit amount and has chosen 3 years as his benefit period, his maximum lifetime benefit will be \$164,250 ( $\$150 \times 365 \times 3$  years), and also, this benefit is the total lifetime amount that the insurance company will cover for him.

(4) Waiting Period (or Elimination Period). This period is the number of days that an individual must pay for the LTC costs himself before the insurance company begins to pay. If an individual chooses a longer waiting period, then he will pay a lower premium. In addition, some companies ask individuals to satisfy this waiting period each time that they need the LTC services, while others require individuals to only satisfy the waiting period once in their lifetime.

(5) Inflation Protection (Automatic Inflation Option or Future Inflation Option). Under an automatic inflation protection option, the insured individual's daily benefit amount increases by 5% each year in order to keep the premium constant. Conversely, with the future inflation option,

the benefit and premium are adjusted according to the medical Consumer Price Index (CPI) every two years by the insurance company. Obviously, the automatic inflation option is a better choice because it ensures that the individual's cost will be constant, while at the same time, the individual will be receiving an increase in benefits. However, the premium for this option is more expensive than that of the future inflation option. If an individual chooses to forgo both options, then his daily benefit amount and premium will not change throughout the course of his coverage.

### **3. The Model**

Suppose that individuals make their own decisions about when to apply for LTC insurance after they reach the age of 21. Also, consider that individuals live for a time span of seven periods in which each period represents a decade. Each individual will die with certainty at the end of period seven, which corresponds to the age of 90.

In the interim, each individual faces the uncertainty of longevity and incurs some probability of entering a nursing home after period one. I have constructed a simple life-cycle model in order to explain an individual's decisions and evaluate the optimal timing of purchasing LTC insurance.

I assume that the rate of accepting the LTC applications is 100% and suppose insurance companies will not deny any insured individual's reasonable claims. Also, the premium is a fixed nominal payment only determined at the time of purchase. It can be paid periodically (weekly, monthly or annually). In this study, the premium will be paid in 10 annual payments.

At the start of each period, each individual chooses current and future consumption levels and makes a decision on whether to apply for the LTC insurance in period  $t$  ( $t=1,2,3,\dots,7$ ) in

order to maximize his expected discounted lifetime utility. Therefore, the maximum problem of an individual is the following:

$$\text{Max}_{\{c_t\}_{t=1}^7} E \left\{ \sum_{t=1}^7 \beta^{t-1} \pi_{t+1|t} \log c_t \right\} \quad (1)$$

$$\text{s.t.} \quad \left\{ \begin{array}{l} c_1 + a_1 = w_1 - o_1 - d_1 m_1 \quad a_1 \geq 0 \\ c_t + a_t = (1+r) a_{t-1} + w_t - o_t - p_t [n_t - d_t \min(n_t, q_t)] - d_t m_t \quad t = 2,3,4,5,6 \\ c_7 = (1+r) a_6 + w_7 - o_7 - p_7 [n_7 - d_7 \min(n_7, q_7)] - d_7 m_7 \end{array} \right. \quad (2)$$

where  $\beta$  is the discounted factor that captures the consumer's time preference and  $\pi_{t+1|t}$  is the individual's probability of surviving into period  $t + 1$ , which is contingent on having survived to period  $t$ .

The utility function for each period is only a function of the consumption expenditures  $c_t$ . Using a logarithmic form has the advantage of producing a closed form solution. My purpose here is to analyze how uncertain nursing home costs affect an individual's decision on when to apply for and whether to purchase the LTC insurance.

I define  $r$  as the constant annual real interest rate. It is the growth rate of purchasing power derived from an individual. Also, let  $a_t$  refer to the individual's assets at the beginning of each period. I assume that no initial assets exist and that no bequests can be given after an individual dies. Therefore, each individual begins to accumulate his assets as savings within the first period and will spend all of the money that he has during the last period. In the case that an individual dies before the last period, I presume that their income and assets would be taken by the government. The income level,  $w_t$ , in each period occurs either from labor earning while

working or a pension or social security payment while retired.  $o_t$  is defined as an individual's out-of-pocket medical expenses without considering the cost of nursing home care at time  $t$ .

In addition, in order to develop a decision rule related to the LTC insurance application, I denote  $d_t$  as an indicator (dummy) variable. This variable is equal to one if the individual purchases the LTC insurance in period  $t$  and zero if he does not apply for the LTC insurance at time  $t$ . Assuming that once an individual has decided to purchase the LTC insurance at time  $t$ , he will be covered by the LTC insurance policy to the end of his lifetime. For example, if an individual applies for an LTC insurance policy in period three, then for his seven-period budget constraint, the indicator variable will become  $d_t = (d_1 \ d_2 \ d_3 \ d_4 \ d_5 \ d_6 \ d_7) = (0 \ 0 \ 1 \ 1 \ 1 \ 1 \ 1)$ .

Let  $m_t$  be the premium in period  $t$ . The premium will depend upon a person's age. The older an individual is, the higher of a premium he facts when purchasing the insurance. Moreover, according to the Federal LTC Insurance Program guideline, insurance companies cannot increase an individual's premium as he gets older and his health diminishes after he has purchased the policy.<sup>7</sup> That is, the premium will be constant in nominal dollars over time.

LTC insurance is also guaranteed to be renewable, therefore, I assume that each individual would keep the same policy at each renewal period. This assumption allows me to keep the premium constant over the time periods after the original purchase. For instance, if an individual purchases LTC insurance in period four,  $m_1 = m_2 = m_3 = 0$ , and  $m_5$ ,  $m_6$  and  $m_7$  would be the same price as  $m_4$  in nominal terms.

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<sup>7</sup> The insurance companies may be able to change the premium for an entire class of policy or individuals. Therefore, if a company so desired, it could raise the premium for all individuals over the age of 70. However, I do not take this variable into consideration during this study.

Next, beginning with period two, an individual faces a cost of nursing home services,  $n_t$ , with some probability  $p_t$ .  $q_t$  represents the LTC insurance coverage in my study. The LTC policies used in this study are the (1) Facility-only, (2) Daily benefit amount: \$150,<sup>8</sup> (3) Benefit period: 3 years, (4) Waiting period: 90 days and (5) Inflation protection: Automatic compound inflation, which will maintain a premium consistent in nominal dollars, while the daily benefit amount increases by a fixed percentage (5%) each year.

Finally, the terms  $p_t[n_t - d_t \min(n_t, q_t)]$  in the budget constraints describe that in period  $t$ , an individual will have  $p_t$  chance to enter a nursing home. If he enters a nursing home, then the nursing home costs will be  $n_t$  when he does not apply for LTC insurance ( $d_t = 0$ ). An individual only pays the difference between the nursing home expenses and the coverage amount, if he has LTC insurance. However, when the coverage is greater than or equal to the nursing home expenses, then the expenses will be fully covered by the LTC policy. Thus, the expense of the nursing home care in such a situation would be zero.

In order to solve this model, one must suppose  $s$  denotes the actual period in which an individual purchases LTC insurance. The individual must either choose to purchase LTC insurance at time  $t$  ( $s = t$ ) or not to purchase LTC insurance in period  $t$  ( $s > t$ ). He will make the decision by comparing the expected utility values that might be obtained if applying for the insurance in this particular period ( $s = t$ ) against the expected utility values that could be obtained by applying for an LTC insurance plan in all other feasible periods,  $s > t$ . Therefore, I will solve this individual's maximum problem in order to find all of the optimal utility levels for the following eight cases: (1) never apply, (2) apply for LTC insurance in period 1 (20s), (3) apply for LTC insurance in period 2 (30s), (4) apply for LTC insurance in period 3 (40s), (5)

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<sup>8</sup> The national average for daily nursing home costs per person over past ten years has been around \$142.88, so I set the DBA to \$150.

apply for LTC insurance in period 4 (50s), (6) apply for LTC insurance in period 5 (60s), (7) apply for LTC insurance in period 6 (70s) and (8) apply for LTC insurance in period 7 (80s).

Remember that a premium payment relies upon the period in which the individual applied for the LTC insurance. The later in his life that an individual purchases the insurance, the higher the premium is for that individual. However, once an individual purchases the policy, the premium will remain constant in nominal terms throughout each period of his lifetime. In order to make my assumption clearer, I define  $m_{t,j}$  to be the premium that an individual actually needs to pay in period  $t$  when he applies for the LTC insurance in period  $j$ . Thus,

$m_{1,1} < m_{2,2} < \dots < m_{7,7}$ . For example, the premium in each period for an individual who applies for an LTC insurance policy during period 3 would be  $m_{3,3} = m_{4,3} = m_{5,3} = m_{6,3} = m_{7,3}$ .

The first step in solving the maximum problem is to write out the individual's lifetime budget constraint. I substitute  $a_6, a_5, a_4, a_3, a_2$  and  $a_1$  into the final constraint of Equation (2) in order, and divide both the left- and right-hand sides by  $(1+r)^6$ . Then, I let  $Y$  include the terms that are not related to the LTC insurance,  $Y = \sum_{t=1}^7 (1+r)^{7-t} (w_t - o_t)$ , and denote  $e_t = \min(n_t, q_t)$  in order to save notations. Thus, Equation (2) is transformed into Equation (3):

$$c_1 + \frac{c_2}{(1+r)} + \frac{c_3}{(1+r)^2} + \frac{c_4}{(1+r)^3} + \frac{c_5}{(1+r)^4} + \frac{c_6}{(1+r)^5} + \frac{c_7}{(1+r)^6} = \frac{Y - \left\{ \sum_{t=1}^7 (1+r)^{7-t} d_t m_t \right\} - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t (n_t - d_t e_t)] \right\}}{(1+r)^6} \quad (3)$$

The second step is to use Equations (1) and (3) to find the Lagrangian function (Equation (4)) and, from that, derive the first order conditions with respect to  $c_1, c_2, c_3, c_4, c_5, c_6$  and  $c_7$ , respectively.

By deriving these conditions, I am able to attain the individual's optimal consumption levels  $c_t^*$  for the seven periods.



$$L = \sum_{t=1}^7 \beta^{t-1} \pi_{t+1|t} \log c_t + \lambda \left\{ \frac{Y - \left\{ \sum_{t=1}^7 (1+r)^{7-t} d_t m_t \right\} - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t (n_t - d_t e_t)] \right\}}{(1+r)^6} - c_1 - \frac{c_2}{(1+r)} - \frac{c_3}{(1+r)^2} - \frac{c_4}{(1+r)^3} - \frac{c_5}{(1+r)^4} - \frac{c_6}{(1+r)^5} - \frac{c_7}{(1+r)^6} \right\} \quad (4)$$

The third step is to plug these optimal consumption levels into the utility function in order to find the optimal utility levels for all of the cases. Therefore, I am able to determine which utility level will give an individual the largest expected lifetime utility value. For example, if applying for LTC insurance during period 2 gives an individual the biggest value of the expected lifetime utility, then this case implies that period 2 is the best time for this individual to apply for LTC insurance. In other words, applying for LTC insurance in this individual's 30s will maximize his individual's expected lifetime utility. More details on these steps can be found in the Appendix.

#### 4. Data

The main data used for this study are collected from the (1) the Rand HRS data files, waves 2 – 7 (years 1994, 1996, 1998, 2000, 2002 and 2004); (2) the 2006 Federal LTC Insurance Program's details and rates, (3) 1996 - 2003 National Vital Statistics Reports (NVSR) from the National Center for Health Statistics, (4) MetLife Market Survey on Nursing Home and Home Care Costs, years 2002 - 2004, (5) the Health, United States, years 2002 - 2007 and (6) 1994 - 2004 CPI for all items, medical care services and nursing home and adult day care from the Bureau of Labor Statistics in the U.S. Department of Labor.

The Rand HRS is a longitudinal survey, derived from the initial Health Retirement Survey (HRS), designed to be used by researchers to analyze retirement and health issues among the elderly in the United States. This survey has been collected every two years since 1992, and it includes comprehensive information on individuals' characteristics, health status, health

expenses and retirement information. However, because the information of an individual's length of a nursing home stay is one of the important variables in this study and is available after year 1994, I then collect data from year 1994 to 2004.

I only gather data for individuals whose ages are between twenty-one and ninety regardless of their gender and the presence of their spouse. In total, I gather 114,999 complete observations (see Table VII). The youngest individual in my sample is 22. Moreover, as mentioned before, individuals live for seven periods and each period indicates ten years. For that reason, I have divided my sample into seven age groups that are equal to my seven periods (e.g. age group 1 = 21 - 30; age group 2 = 31 - 40, etc.). All the measures of individuals' demographic information are calculated by age groups.

After collecting the individual's personal information, the second step is to compute the premium of the LTC insurance policy for this study. There are many different LTC insurance plan choices available from different insurance companies. Different companies also offer different prices for different benefit levels. In order to avoid difficulty with the above variables, I follow the information provided by the 2006 Federal LTC Insurance Program shopping guide in order to calculate the premium and coverage of LTC insurance.<sup>9</sup>

Using the information from the Federal LTC Insurance Program has two advantages: (1) Unlike most LTC insurance policies, the Federal LTC Insurance Program sets its premium levels based on the National Association of Insurance Commissioners' (NAIC) rate stability guidelines in order to assure the stability of the premium fee, (2) The Federal LTC Insurance Program offers less complicated policies than other insurance plans (see Table VIII). I then abstract from choices of different choices of the Federal LTC Insurance Program and suppose instead that there is only one type of LTC insurance plan. Its concepts are: (1) Facility-only, (2) Daily benefit

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<sup>9</sup> See the homepage of the Federal LTC Insurance Program ([www.ltcfeds.com/index.html](http://www.ltcfeds.com/index.html)).

amount: \$150, (3) Benefit period: 3 years, (4) Waiting period: 90 days and (5) Inflation protection: Automatic compound inflation.

Next, the National Center for Health Statistics is a rich source of information about the health status of America. For this study, I utilized the life tables<sup>10</sup> in order to construct an individual's survival probability. I also collect information on nursing home expenses from the 2002 – 2004 MetLife Market Survey on Nursing Home and Home Care Costs and the 2006 Health, United States. The MetLife Market Survey on Nursing Home and Home Care Costs gives me the costs of nursing home services for the years 2002 – 2004, and I obtain the expenses of nursing home services for years 1994 – 2001 from the Health, United States.

From the Bureau of Labor Statistics, I find the CPI for all items, medical care services and nursing home and adult day care costs. I use this information to measure the growth of income, out-of-pocket medical expense and nursing home costs. The average annual CPI percentage change for all items was around 2.48% from 1994 to 2004. In addition, the average annual CPI increase for medical care services and nursing home and adult day care costs was approximately 4.01% and 4.21%, respectively.

After combining the above information, my completed data set includes a panel of aggregated individuals' information from periods 1 to 7. I obtain good measures of the individuals' demographic information (income, out-of-pocket medical expenses, nursing home costs, insurance coverage, length of a nursing home stay and probability of entering a nursing home) by age group. I collect general data for each age group, rather than specified information on individual cases. More details for each variable can be found in the following sections.

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<sup>10</sup> Life table is a table which shows, what the probability is for an individual at each age that he dies before his next birthday.

#### 4.1. Premium ( $m_t$ )

Assume that a premium depends only upon an individual's age. Based on this assumption, the individual makes a decision about whether to apply for an LTC insurance policy only at the beginning of each period. That is, each individual is able to purchase LTC insurance at age 21, 31, 41, 51, 61, 71 or 81.

The premiums computed for this study is based on 2006 price information of the Federal LTC Insurance Program. After deciding to purchase the LTC insurance based on the above premium, the individual's premium will be constant in nominal dollars throughout his lifetime. While an individual's premium rate will stay the same, if the individual had attempted to purchase the same insurance the next year at the same price, he would have been unable to do so due to inflation. Therefore, the real price of a policy decreases over time. Thus, I calculate the real price of an insurance policy by dividing it by the growth of the CPI.

Then, I translate the premium costs into current dollars by dividing the premiums by the growth of the real interest rate and sum up these present values of the premium for each age group. All the steps described above are shown in Equation (5).

$$PV(\text{premium}_{t,k}) = \text{premium}_k \times \sum_{s \in \{1,2,3,\dots,70\}} \frac{1}{[(1 + CPI)(1 + r)]^{s-1}} \quad (5)$$

Where  $t$  indicates the period ( $t = 1, 2, \dots, 7$ ),  $k$  is the time at which the individual applies for the LTC insurance ( $k = 21, 31, 41, 51, 61, 71$  and  $81$ ) and  $s$  denotes the years that an individual must pay the premium.  $s$  ranges from 1 to 70 depending on when the individual purchased the LTC insurance. For instance, if an individual purchases the LTC insurance in his 20s, then he will have to pay a premium from age 21 to the end of his lifetime (age 90). Therefore, he would pay his premium for 70 years (7 periods).

Table 1 shows all of the possible lifetime premiums if an individual were to purchase LTC insurance at age 21, 31, 41, 51, 61, 71 or 81. For example, an individual who purchases LTC insurance at age 21 will pay \$3,057 in his 20s. He will then pay \$1,780 in his 30s and finally, pay \$119 when he reaches his 80s in real terms.

#### **4.2. Income ( $w_i$ )**

The variable HwITOT in the Rand HRS presents the total income of individuals at the household level and has the sum of three income resources: (1) individual earnings, (2) individual income from an employer pension or annuity, social security disability (SDI), Supplemental Security income (SSI), or social security retirement income, and (3) other resources such as individual income from government transfers and individual unemployment or workers compensation. The income from an employer pension or annuity, SDI or SSI or other social security retirement income is zero for a working individual, while individual earnings are zero for the retired elderly.

Interviewees in the 1994 – 2004 Rand HRS were asked about their total household income for the year prior to the interview year. In addition, since a household could be treated as either a couple household or a single household, I use the variable named HwCPL to identify how a household should be identified. When the respondent's marital status was married or partnered, the HwCPL was set to one, which meant that the household was treated as a couple household. If the respondent was single, then the HwCPL was set to zero and the household was treated as a single household.

Also, the total household income for a couple's household was calculated as the sum of the respondent and his spouse's three income resources. Therefore, for all couple households, I divide the total household income by two in order to estimate the individual income level.

Finally, in order to create the income variable for the study, I translate the income values into real 2006 dollars by using the inflection rate because the variable HwITOT is reported in nominal dollars. For example, in order to find the income values in year 1996 in real terms, I multiply the values by 1.36 because \$1 in 1996 had the same purchasing power as \$1.36 in 2006. Also, in place of the mean values, I apply the Rand HRS dataset to obtain the medians of income values for all periods. The outcomes of this application can be seen in Table 2. These median values indicate general information about an individual's income level during each period (age group).

#### **4.3. Survival Probability ( $\pi_{t+1|t}$ )**

Instead of limiting the life table information used within this study to only one year, I opt to utilize the information from the NVSR of National Center for Health Statistics from 1996 to 2003 in order to construct survival probabilities. The wider range of years allows me to obtain more reliable average information for this study.

The NVSR's life tables contain information about the probability of dying between ages  $x$  and  $x+1$ . However, this study needs the probability of surviving for a person at each age. I then first calculate the probability of being alive between ages  $x$  and  $x+1$ ,  $\phi_{x+1|x}$ : one minus the probability of dying between ages  $x$  and  $x+1$ .

Next, as each period in my model symbolizes a decade, I compute the survival probabilities via the Markov process:  $\pi_{2|1} = 1 \cdot \phi_{31|30} \cdots \phi_{40|39}$ ;

$$\pi_{3|2} = \pi_{2|1} \cdot \phi_{41|40} \cdot \phi_{42|41} \cdots \phi_{50|49}; \dots; \text{ and } \pi_{7|6} = \pi_{6|5} \cdot \phi_{81|80} \cdots \phi_{90|89}.$$

After that, I find the average probability of surviving for all seven periods, from the eight years for which I have data (1996~2003). All of the individuals in the same period will face the same survival probability (see Table 3). For example, all of the individuals whose ages are between the age of 51 and 60 have a 89% chance to survive to the next period.

#### 4.4. Costs of Nursing Home Care ( $n_t$ : Average National Costs \* Length of Stay)

$n_t$  is calculated from the product of the average national nursing home cost per day and the length of a nursing home stay. Based on information from (1) the 2002 to 2004 MetLife Market Survey on Nursing Home and Home Care Costs, (2) nursing home average monthly charge tables found within the Health, United States, 2002 to 2007 and (3) increases in the CPI for medical care services from 1994 to 2004 as published by the Bureau of Labor Statistics at the U.S. Department of Labor, I obtain 1994, 1996, 1998, 2000, 2002 and 2004's average national nursing home cost per day. Then, I translate these amounts into present values (in 2006 dollars). The daily nursing home costs are the same for every individual in the study, regardless of the individual's age.

Next, I use two variables, the RwnHMDAY and RwnRSNIT, from the Rand HRS data file in order to define the average length of a nursing home stay for each period. Both variables represent the same information, and most of the values of these two variables are the same. The variable RwnHMDAY is available from wave 3 (year 1996) forward and represents the number of days spent in a nursing home between the previous interview period and the current interview

period. `RwNRSNIT` represents the number of nights spent in a nursing home and is available from wave 2 (year 1994). It is defined by the Rand HRS that, if a respondent was living in a nursing home during the interview process, then both variables were set to the same number. If an individual reported that he had spent more than one stay in a nursing home and the total number of days spent in the nursing home was less than the duration of time between interviews (i.e. between waves 2 and 3), then only the number of days in a nursing home (`RwNHMDAY`) was counted. For that reason, in order to utilize as much as information as possible about nursing home stays, I combine these two variables. I set the `RwNHMDAY` to be equal to `RwNRSNIT` if the number of days spent in a nursing home was missing and the number of nights in a nursing home was greater than zero. In addition, because `RwNHMDAY` was not available in wave 2, I generate the number of days spent in a nursing home for this wave based on the recorded number of nights spent in a nursing home. The nursing home stay was recorded between the previous interview period and the current interview period. For new interviewees, the period encompassed the last two years. That is, if an individual was interviewed in 1994, 1998, 2000, 2002 and 2004, but not in 1996, then his nursing home stay in 1998 may have exceeded 720 days (two years) or reach  $365 \times 4$  years (i.e. stay in a nursing home from 1994 to 1998). This is because this individual might enter a nursing home at some time between 1994 and 1996 and remained in the nursing home during the interview period, year 1998. In this case, the value of the individual's nursing home stay would be an outlier for year 1998, and the average length of stay obtained from the original values in the survey will be overestimated.

In order to make all of the variables consistent, it is necessary for me to check the attendance of the interviewees for all these survey years. I then divide each interviewee's nursing home stay length by 2, 4, 6, 8, 10 and 12 depending on the number of periods that the individual



had missed between survey interviews. This multiplication will allow me to obtain an individual's yearly nursing home stay length. For example, since the survey period is every two years, if an individual attended the interview every survey year (or for a new interviewee), I divide his nursing home durations by two in order to obtain his average yearly information on nursing home stay. Moreover, if an individual missed one interview, that means his reference period of the length of stay would be four years instead of two years, then I divide his stay length by four.

Next, I produce the nursing home costs variable  $n_t$  by multiplying the distribution of the length of an individual's stay by the present value of the average national nursing home costs. Table 4 shows the average nursing home costs and the average length of a nursing home stay by period. According to my results, an individual in his 50s may spend \$16,606 on average for nursing home services.

#### **4.5. Out-of-Pocket Medical Expenses ( $o_t$ )**

The variable  $RwOOPMD$  indicates an individual's total out-of-pocket medical expenses in the Rand HRS. This variable is the sum of four expenses: (1) hospital and nursing home costs, (2) doctor, dentist and outpatient surgery costs, (3) average monthly prescription drug costs and (4) home health care and special facilities or services costs. However, in my model, I do not count nursing home costs as a part of out-of-pocket medical expenses; therefore, I subtract the nursing home costs from this variable.

In addition, by definition, if an individual's insurance plan paid for all health expenses, then the value of his out-of-pocket medical expenses will be zero. After checking each individual's insurance situation, I discover that some individuals had LTC expenses that were

covered by Medicaid, another governmental health insurance or their employers or spouses' insurance plans. In these cases, I do not separate the cost of nursing home care from the individual's total out-of-pocket medical expenses because the value of his nursing home cost is zero.

The Rand HRS includes five cohorts, the (1) Initial HRS, (2) Asset and Health Dynamics Among the Oldest Old Study (AHEAD), (3) Children of Depression (CODA), (4) War Baby (WB) and (5) Early Baby Boomer (EBB). In wave 2, the AHEAD and Rand HRS utilized different definitions for the reference period. In wave 2A, AHEAD respondents were asked about the previous year's out-of-pocket medical expenses. However, in wave 2H and from wave 3 onward, HRS respondents were asked about the past two years or the period since the last interview. Therefore, for the observations from wave 2A, I keep the initial values because the out-of-pocket medical expense in this case was yearly expense. On the other hand, for wave 2H and wave 3 onward of the Rand HRS survey, I must check the number of waves respondents had missed, and use the previously described calculation method (divide the values by 2, 4, 6, 8, 10 or 12) in order to compute an individual's yearly average of out-of-pocket medical expenses, because in such a case, the reference period of the variable became two-year base or over two years if interviewees did not appear at every survey time.

Finally, I compute the present values of the means of the out-of-pocket medical expenses for each individual as based on the CPI for medical care and the real interest rate (see Table 5). The results of Table 5 show that as an individual's age increases, his out-of-pocket medical expenses increase. Therefore, individuals should anticipate paying an average of \$2,460 for their out-of-pocket medical expenses during period 7 (80s).

#### 4.6. Coverage of Nursing Home Services ( $q_t$ )

The variable  $q_t$  is the product of the nursing home stay length at time  $t$  and an individual's daily benefit amount. According to the 2006 Federal LTC Insurance Program, the daily coverage of LTC services will cover up to 100% of an individual's daily benefit amount for a nursing home facility. However, the LTC insurance plan has a waiting period of 90 days, which means that an individual must wait 90 days to be eligible for benefits and receive coverage. If an individual stays in a nursing home for less than 90 days, then he must pay the nursing home service expenses out-of-pocket. Additionally, individuals need only satisfy the waiting period once in their lifetime and the number of days that they receive service is counted cumulatively. For instance, if an individual stayed in a nursing home for two days each time that he utilized the service, then, not only would he have to pay for the nursing home service expenses out-of-pocket, but it would also take him a longer time to reach the 90 days necessary to receive benefits, compared to long nursing home stay patients.

The object of this paper is to explain how individuals make decisions about when and if to purchase LTC insurance. Therefore, I calculate each insured individual's coverage for each period via the following calculations: (1) an insured individual whose nursing home stay length is less than 90 days:  $q_t = 0$ , (2) an insured individual whose stay length is over 90 days:  $q_t = (\text{the average days of stay at time } t - 90) \times \text{Daily Benefit Account}$  and (3) an insured individual who has satisfied the waiting period at least once in his lifetime:  $q_t = (\text{the average days of stay at time } t) \times \text{Daily Benefit Account}$ . After following the method described above and computing the present values (2006 dollars) of the daily benefit account for each period, I construct a table (Table 6) containing the average coverage values of LTC in real terms. For example, if an individual applies for LTC insurance at the age of 61 and expects to

stay in a nursing home for 106 days on average in his 60s, then he should expect that the insurance company would pay an average of \$2,350 for his nursing home services.

#### **4.7. Probability of Staying in a Nursing Home ( $p_t$ )**

Nursing home facilities are institutions that take care of individuals with chronic diseases or individuals unable to complete the basic activities of daily life. Table 7 shows the percentage of individuals in the Rand HRS who have ever stayed in a nursing home, by age group, from 1994 to 2004. This table shows that 12.68% of the elderly between 81 and 90 have stayed in a nursing home. Other studies have had similar results. For example, Alexih (2006) and the report from the 2006 and 2007 Health, United States show that only 13.9% of the elderly over 85 stayed in a nursing home in 2004 (Table IX and X).

In fact, the percentage of nursing home utilization decreased from 1985 to 2004 (Tables IX and X). This reduction may result from several possibilities. One possibility is that an increasing number of substitutes for nursing home care, such as home care, exist and that an increasing number of elderly individuals choose to receive home care or community services<sup>11</sup>. The elderly would feel more comfortable to have cares at home instead of entering to a nursing home.

Another possibility is that the individuals interviewed are wealthier and, therefore, better able to maintain their health with regular doctor visits, healthy living and prescriptions. In addition, a wealthier individual will more likely than poor person to have home health care because he is able to afford the expensive costs. This situation will then reduce the nursing home use rate.

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<sup>11</sup> Community service is a service that a resident can receive the benefits from his local community. For example, the community services can provide special needs to elderly individuals and families. Also, it can enhance self-help and mutual-help ability to improve the quality of life of the elderly.

A third possibility is that people are living longer and healthier than they were in previous generations due to improvements in medical technology. This circumstance may reduce the nursing home admission and postpone individuals' timing of entering a nursing home. A study conducted by Lichtenberg (2006) examines the effect of new drug usage on admission of elderly Americans to hospitals and nursing homes, and shows that new drug reduce the growth of the number of hospital discharges to nursing homes. Moreover, the expenditures of hospital and nursing home cares decrease as the increased drug expenditures.

#### **4.8. Discounted factor $\beta$ and the real interest rate $r$**

As the final point for Section 4, I assume that the discounted factor  $\beta$  is equal to  $0.995^{10} = 0.9511$  because the individuals in my study live for seven periods and each period indicates a decade. Finally, I follow the studies conducted by Diamond (2005) and Olsho (2006) and assume that the annual real interest rate is 3% across each of the years in my model.

### **5. Results**

After solving the seven period life cycle model and obtaining the optimal consumption levels and utilities for eight cases, I am now able to show that, given all of the general individual information and the 3% real interest rate, an individual would be better off if they do not apply for an LTC insurance policy (see Figures 1-3). This result is consistent with the current situation in the small LTC insurance market as only 10% of elderly persons purchased an LTC insurance policy in 2004 (Brown & Finkelstein, 2004). One explanation for this low percentage is that individuals now live longer and are healthier due medical advancements. As the result, a rational individual would prefer to not apply for LTC insurance.

In addition, with the current probability of a nursing home entry that I compute from the Rand HRS, even though an individual may expect a low real interest rate in the future (ex: 1% or 2% -- Figures 1-1 and 1-2) or to become a long-stay resident at a nursing home in his later years (see Figures 1-10 - 1-12), he would still prefer to not purchase an LTC insurance policy. This is because individuals believe they are unlikely to need the nursing home care in their retirement years. An individual only have a 12.68% chance of being admitted to the nursing home after the age of 85. Purchasing an LTC insurance policy is then not a smart decision for an individual to make in improving his quality of life.

### **5.1. Results under the increased probability of nursing home use case**

In this subsection, I increase the probability of entering a nursing home for each age group to state the importance of the probability of entering a nursing home. I instead assume the probability of being place in a nursing home is distributed as 0%, 5%, 10%, 15%, 25%, 45% and 70% in period 1, 2, 3, 4, 5, 6 and period 7, respectively. In this case, with a 3% real interest rate, the individuals would be better off if they purchase LTC insurance and apply for the policy in 40s (see Figure 2-3).

Additionally, changing the real interest rate also has an effect on an individual's decision of when to apply for LTC insurance. The results show that (1) when the real interest rate is either 1% or 2%, individuals would prefer to purchase the LTC insurance and apply for the policy early. For example, in this case purchasing LTC insurance in period 2 (30s) gives the individual the highest value for his lifetime discounted utility (Figures 2-1 and 2-2); (2) when the real interest rate is 3%, the optimal timing for applying for the LTC insurance is period 3 (40s) (Figure 2-3) and (3) if the real interest rate is greater than or equal to 4%, then the best choice for the

individual is to not apply for the LTC insurance (Figures 2-4 to 2-9). These results occur because a higher real interest rate implies that the present value is more expensive than the future value, which means that individuals may be able to afford the cost of nursing home services by themselves in the future because it will be cheaper.

In addition, if an individual expects to have a long stay in a nursing home during his later years, then purchasing LTC insurance and applying for the policy in his 60s will give him the highest utility (see Figures 2-10 ~ 2-12). That is, an individual would prefer to purchase LTC insurance right at the time he needs the assistance.

## **5.2. Results of premium and/or nursing home costs changes**

I examine how the decision of when to apply for LTC insurance will be affected if the LTC insurance premium decreases and/or the nursing home cost increases in this subsection. Figure 3-1 shows that with the original probability of entering a nursing home that used by the model, neither a decreasing premium nor increasing nursing home costs would change the results of this study and a rational consumer would not apply for an LTC insurance policy.

However, if an individual believe that the probability of entering a nursing home is 0%, 5%, 10%, 15%, 25%, 45% and 70% throughout the periods in the model, then the individual will make the best financial decision if he applies for an LTC insurance policy in his 40s (Figure 3-2) regardless of whether the premium decreases or the nursing home costs increase.

Figure 3-3 illustrates, when the nursing home costs increase and the insurance premiums decrease at the same time, individuals will purchase LTC insurance if they believe that they will face a high probability of entering a nursing home during their later life. Again, such results

show that an individual's belief in whether he will utilize a nursing home is an important factor in that individual's decision of whether and when to apply for LTC insurance.

From the exercises in section 5.1 and 5.2, we can see that the probability of entering a nursing home entry is a major factor in affecting an individual's decision of when to apply for LTC insurance. However, individuals often cannot accurately estimate their medical risk of entering a nursing home. In order to avoid the income loss on the expense of insurance premium, an individual will prefer to not purchase any LTC insurance, unless he is certain about his risk of being admitted to a nursing home in the near future.

## **6. Conclusion**

In place of applying a complex dynamic programming model to the discrete choice problem, this paper applies the option value model to show whether a rational consumer should purchase LTC insurance and, if the consumer should purchase the insurance, when would be the optimal moment for the LTC insurance application using a calibration exercise. In order to create an estimation of the most financially sound timing for an LTC insurance application, I collect data based on six sources: the Rand HRS, MetLife Market Survey on Nursing Home and Home Care Costs, Federal LTC Insurance Program guidelines, NVSR from the Bureau of Labor Statistics and the Health, United States. I obtain each individual's income level, out-of-pocket medical expenses, nursing home costs and insurance coverage information, and, also, gather the following information by age group: average length of a nursing home stay, insurance premium, survival probability and probability of a nursing home stay.

The results of the study show that when individuals expect to have a constant 3% real interest rate throughout their lives and face a less than 15% probability of a nursing home stay



after retired, then they are not inclined to apply for LTC insurance as such a decision gives them the highest expected lifetime utility. That is, the findings suggest that a rational individual should not apply for an LTC insurance policy due to a low probability of nursing home use.

In addition, this exercise allows me to identify how correlations, such as the probability of a nursing home stay, real interest rate, length of a nursing home stay, nursing home costs and insurance premium influence an individual's decision about whether and when to apply for LTC insurance as well. A change in an individual's probability of entering a nursing home influences an individual's decision on when to apply for an LTC insurance policy. The higher the expectation of entering a nursing home later in life, the more likely an individual is to purchase an LTC insurance policy.

As the real interest rate decreases, coupled with a high probability of entering a nursing home, individuals are more likely to apply for LTC insurance as with a lower interest rate, individuals expect the LTC service will be more expensive in the future. Therefore, they would apply for an LTC insurance policy now and have their expenses of LTC covered later. However, in the case that an individual has a small chance to enter a nursing home, lowering the real interest rate does not encourage him to purchase any LTC insurance policy.

In addition, if an individual has a higher risk of entering a nursing home after period 5 and expects to stay in a nursing home for a long time, then the best time to purchase the insurance is during period 5; therefore, the individual can reduce his financial burden on LTC services at the time he needs the care.

From all the exercises in this study, results suggest that the belief of the risk of being admitted to a nursing home is the most important factor that affects an individual's decision of the LTC insurance application. However, it is difficult for individuals to estimate accurately

about their medical risk. Therefore, a lack of information regarding the estimation of an individual's health condition may explain the limited size of the LTC insurance market.

This paper suggest that encouraging people to understand the benefits of applying for LTC insurance can help to relieve them of medical expense burdens in their later lives. Therefore, the United States government should offer programs or conferences to middle-aged individuals so that they can learn the details about the variety of LTC insurance policies that exist and become able to define their health statuses accurately.

At the same time, the government needs to protect the consumer's rights by making standard regulations about insurance claims in order to control private insurance companies. As a result, LTC insurance companies should not be able to deny an insured claim just simply because he waited too long to use the nursing home care. An LTC insurance policy is supposed to help the elderly become released from financial problems at the time at which they need the LTC services and, therefore, improve the individual's quality of life, not make it worse.

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## Appendix

Here shows the example of case one (never applying LTC insurance). If an individual never applies for LTC insurance, the equations (4) and (5) in the content will turn out to be equations (8) and (9) here:

$$c_1 + \frac{c_2}{(1+r)} + \frac{c_3}{(1+r)^2} + \frac{c_4}{(1+r)^3} + \frac{c_5}{(1+r)^4} + \frac{c_6}{(1+r)^5} + \frac{c_7}{(1+r)^6} =$$

$$\frac{Y - \left\{ (1+r)^5 [p_2 n_2] + (1+r)^4 [p_3 n_3] + (1+r)^3 [p_4 n_4] + (1+r)^2 [p_5 n_5] + (1+r) [p_6 n_6] + [p_7 n_7] \right\}}{(1+r)^6} \quad (8)$$

$$L = \log c_1 + \beta \pi_{2|1} \log c_2 + \beta^2 \pi_{3|2} \log c_3 + \beta^3 \pi_{4|3} \log c_4 + \beta^4 \pi_{5|4} \log c_5 + \beta^5 \pi_{6|5} \log c_6 + \beta^6 \pi_{7|6} \log c_7$$

$$+ \lambda \left\{ \frac{Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\}}{(1+r)^6} - c_1 - \frac{c_2}{(1+r)} - \frac{c_3}{(1+r)^2} - \frac{c_4}{(1+r)^3} - \frac{c_5}{(1+r)^4} - \frac{c_6}{(1+r)^5} - \frac{c_7}{(1+r)^6} \right\} \quad (9)$$

So, the first order conditions with respect to  $c_1, c_2, c_3, c_4, c_5, c_6$ , and  $c_7$  are

$$c_1 : \frac{1}{c_1} = \lambda \Rightarrow c_1 = \frac{1}{\lambda} ; \quad c_2 : \frac{\beta \pi_{2|1}}{c_2} = \frac{\lambda}{(1+r)} \Rightarrow c_2 = \frac{(1+r) \beta \pi_{2|1}}{\lambda} ;$$

$$c_3 : \frac{\beta^2 \pi_{3|2}}{c_3} = \frac{\lambda}{(1+r)^2} \Rightarrow c_3 = \frac{(1+r)^2 \beta^2 \pi_{3|2}}{\lambda} ; \quad c_4 : \frac{\beta^3 \pi_{4|3}}{c_4} = \frac{\lambda}{(1+r)^3} \Rightarrow c_4 = \frac{(1+r)^3 \beta^3 \pi_{4|3}}{\lambda} ;$$

$$c_5 : \frac{\beta^4 \pi_{5|4}}{c_5} = \frac{\lambda}{(1+r)^4} \Rightarrow c_5 = \frac{(1+r)^4 \beta^4 \pi_{5|4}}{\lambda} ; \quad c_6 : \frac{\beta^5 \pi_{6|5}}{c_6} = \frac{\lambda}{(1+r)^5} \Rightarrow c_6 = \frac{(1+r)^5 \beta^5 \pi_{6|5}}{\lambda} ;$$

$$c_7 : \frac{\beta^6 \pi_{7|6}}{c_7} = \frac{\lambda}{(1+r)^6} \Rightarrow c_7 = \frac{(1+r)^6 \beta^6 \pi_{7|6}}{\lambda}$$

Thereupon I replace  $c_1, c_2, c_3, c_4, c_5, c_6$ , and  $c_7$  in terms of  $\lambda$  into equation (6) to find the value

of  $\frac{1}{\lambda}$ .

$$\frac{1}{\lambda} \left[ 1 + \beta \pi_{2|1} + \beta^2 \pi_{3|2} + \beta^3 \pi_{4|3} + \beta^4 \pi_{5|4} + \beta^5 \pi_{6|5} + \beta^6 \pi_{7|6} \right] = \frac{Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\}}{(1+r)^6}$$

$$\Rightarrow \frac{1}{\lambda} = \frac{Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\}}{(1+r)^6 \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right]}$$

Putting  $\frac{1}{\lambda}$  back to equation (10), I am capable of getting the optimal consumption levels for seven periods of case one.

$$c_1^* = \frac{Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\}}{(1+r)^6 \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right]}$$

$$c_2^* = \frac{\beta \pi_{2|1} \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\}}{(1+r)^5 \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right]}$$

$$c_3^* = \frac{\beta^2 \pi_{3|2} \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\}}{(1+r)^4 \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right]}$$

$$c_4^* = \frac{\beta^3 \pi_{4|3} \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\}}{(1+r)^3 \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right]}$$

$$c_5^* = \frac{\beta^4 \pi_{5|4} \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\}}{(1+r)^2 \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right]}$$

$$c_6^* = \frac{\beta^5 \pi_{6|5} \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\}}{(1+r) \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right]}$$

$$c_7^* = \frac{\beta^6 \pi_{7|6} \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\}}{\left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right]}$$

Therefore, the optimal utility in this case is

$$\begin{aligned}
u_0^* = & \log \left( \frac{Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\}}{(1+r)^6 \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right]} \right) + \beta \pi_{2|1} \log \left( \frac{\beta \pi_{2|1} \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\}}{(1+r)^5 \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right]} \right) + \\
& \beta^2 \pi_{3|2} \log \left( \frac{\beta^2 \pi_{3|2} \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\}}{(1+r)^4 \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right]} \right) + \beta^3 \pi_{4|3} \log \left( \frac{\beta^3 \pi_{4|3} \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\}}{(1+r)^3 \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right]} \right) + \\
& \beta^4 \pi_{5|4} \log \left( \frac{\beta^4 \pi_{5|4} \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\}}{(1+r)^2 \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right]} \right) + \beta^5 \pi_{6|5} \log \left( \frac{\beta^5 \pi_{6|5} \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\}}{(1+r) \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right]} \right) + \\
& \beta^6 \pi_{7|6} \log \left( \frac{\beta^6 \pi_{7|6} \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\}}{\left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right]} \right)
\end{aligned}$$

After rewriting the optimal utility level, I have

$$\begin{aligned}
u_0^* = & \log \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\} - \log(1+r)^6 \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right] \\
& + \beta \pi_{2|1} \log \beta \pi_{2|1} + \beta \pi_{2|1} \log \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\} \\
& - \beta \pi_{2|1} \log \left\{ (1+r)^5 \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right] \right\} + \beta^2 \pi_{3|2} \log \beta^2 \pi_{3|2} + \beta^2 \pi_{3|2} \log \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\}
\end{aligned}$$



$$\begin{aligned}
& -\beta^2 \pi_{3|2} \log \left\{ (1+r)^4 \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right] \right\} + \beta^3 \pi_{4|3} \log \beta^3 \pi_{4|3} + \beta^3 \pi_{4|3} \log \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\} \\
& -\beta^3 \pi_{4|3} \log \left\{ (1+r)^3 \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right] \right\} + \beta^4 \pi_{5|4} \log \beta^4 \pi_{5|4} + \beta^4 \pi_{5|4} \log \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\} \\
& -\beta^4 \pi_{5|4} \log \left\{ (1+r)^2 \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right] \right\} + \beta^5 \pi_{6|5} \log \beta^5 \pi_{6|5} + \beta^5 \pi_{6|5} \log \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\} \\
& -\beta^5 \pi_{6|5} \log \left\{ (1+r) \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right] \right\} + \beta^6 \pi_{7|6} \log \beta^6 \pi_{7|6} + \beta^6 \pi_{7|6} \log \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\} \\
& -\beta^6 \pi_{7|6} \log \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right] \\
\Rightarrow u_0^* & = B \log k + D \cdot \log \left\{ Y - \left\{ \sum_{t=2}^7 (1+r)^{7-t} [p_t n_t] \right\} \right\}
\end{aligned}$$

where  $B \log k$  is a constant term, and  $D = \left[ 1 + \sum_{t=1}^6 \beta^t \pi_{t+1|t} \right]$ .

$$\begin{aligned}
B \log k & = \beta \pi_{2|1} \log \beta \pi_{2|1} + \beta^2 \pi_{3|2} \log \beta^2 \pi_{3|2} + \beta^3 \pi_{4|3} \log \beta^3 \pi_{4|3} + \beta^4 \pi_{5|4} \log \beta^4 \pi_{5|4} \\
& + \beta^5 \pi_{6|5} \log \beta^5 \pi_{6|5} + \beta^6 \pi_{7|6} \log \beta^6 \pi_{7|6} - \log \{(1+r)^6 D\} - \beta \pi_{2|1} \log \{(1+r)^5 D\} - \\
& \beta^2 \pi_{3|2} \log \{(1+r)^4 D\} - \beta^3 \pi_{4|3} \log \{(1+r)^3 D\} - \beta^4 \pi_{5|4} \log \{(1+r)^2 D\} \\
& - \beta^5 \pi_{6|5} \log \{(1+r) D\} - \beta^6 \pi_{7|6} \log D
\end{aligned}$$

I use similar method to solve case (2) ~ case (8), and I get the following results:

$$u_1^* = B \log k + D \cdot \log \left\{ Y - \left[ \left( \sum_{t=0}^6 (1+r)^t \right) m_{1,1} \right] - \left[ \sum_{t=2}^7 (1+r)^{7-t} [p_t(n_t - e_t)] \right] \right\}$$

$$u_2^* = B \log k + D \cdot \log \left\{ \left\{ Y - \left[ \left( \sum_{t=0}^5 (1+r)^t \right) m_{2,1} \right] - \left[ \sum_{t=2}^7 (1+r)^{7-t} [p_t(n_t - e_t)] \right] \right\} \right\}$$

$$u_3^* = B \log k + D \cdot \log \left\{ Y - \left[ \left( \sum_{t=0}^4 (1+r)^t \right) m_{3,1} \right] - \left[ (1+r)^5 (p_2 n_2) + \sum_{t=3}^7 (1+r)^{7-t} [p_t(n_t - e_t)] \right] \right\}$$

$$u_4^* = B \log k + D \cdot \log \left\{ Y - \left[ \left( \sum_{t=0}^3 (1+r)^t \right) m_{4,1} \right] - \left[ (1+r)^5 (p_2 n_2) + (1+r)^4 (p_3 n_3) + \sum_{t=4}^7 (1+r)^{7-t} [p_t(n_t - e_t)] \right] \right\}$$

$$u_5^* = B \log k + D \cdot \log \left\{ Y - \left[ \left( \sum_{t=0}^2 (1+r)^t \right) m_{5,1} \right] - \left[ (1+r)^5 (p_2 n_2) + (1+r)^4 (p_3 n_3) + (1+r)^3 (p_4 n_4) + \sum_{t=5}^7 (1+r)^{7-t} [p_t(n_t - e_t)] \right] \right\}$$

$$u_6^* = B \log k + D \cdot \log \left\{ Y - \left[ (1 + (1+r)) m_{6,1} \right] - \left[ (1+r)^5 (p_2 n_2) + (1+r)^4 (p_3 n_3) + (1+r)^3 (p_4 n_4) + (1+r)^2 (p_5 n_5) + (1+r)(p_6(n_6 - e_6)) + (p_7(n_7 - e_7)) \right] \right\}$$

$$u_7^* = B \log k + D \cdot \log \left\{ Y - [m_{7,1}] - \left[ (1+r)^5 (p_2 n_2) + (1+r)^4 (p_3 n_3) + (1+r)^3 (p_4 n_4) + (1+r)^2 (p_5 n_5) + (1+r)(p_6 n_6) + (p_7(n_7 - e_7)) \right] \right\}$$

## Tables

**Table I. Resident population (Number in thousands)**

Year\Age	65-74	75-84	85+
1950	8,430	3,278	577
1960	10,997	4,633	929
1970	12,435	6,119	1,511
1980	15,581	7,729	2,240
1990	18,045	10,012	3,021
2000	18,391	12,361	4,240
2002	18,274	12,735	4,593
2003	18,337	12,869	4,713
2004	18,463	12,971	4,860

Note. Data collected from Health, United States, 2006.

**Table II. Total nursing home and home care expenditures (Amount in billion)**

	Nursing Home	Home care
1960	0.8	0.1
1970	4.0	0.2
1980	19.0	2.4
1990	52.6	12.6
1995	74.1	30.5
2000	95.3	30.6
2002	105.7	34.3
2003	110.4	38.1
2004	115.2	43.2

Note. Data collected from Health, United States, 2006.

**Table III. The national average costs of a nursing home and home care**

	Nursing home care (daily rate)		Home care (hourly rate)
	Semiprivate room	Private room	
2002	142.56	167.82	17.60
2003	158.26	181.24	18.12
2004	169	192	18
2005	176	203	19
2006	183	206	19
By 2030*	522.19 190,600 (annual)		52.30 68,000 (annual)

Note. 2002~2006 MetLife Market Survey on Nursing Home and Home Care Costs.

\* American Council of Life Insurers, “*Can Aging Baby Boomers Avoid the Nursing Home?*,”

Stucki, B., and Mulvey, J., March 2000.

**Table IV. Health, United States, 2006: Nursing home expenditures by source of funds (%)**

	Out-of- pocket payments	Private health Insurance	Other private funds (LTCI)	Government	Medicaid	Medicare
1960	77.3	0	6.3	16.4	-	-
1970	52.0	0.2	4.8	16.2	23.3	3.5
1980	37.2	1.2	4.2	2.0	53.8	1.6
1990	36.1	5.6	7.2	2.1	45.8	3.2
1995	28.1	7.9	6.7	2.2	46.0	9.1
2000	30.0	8.2	4.7	2.2	44.1	10.8
2002	27.9	8.2	3.8	2.2	44.6	13.3
2003	27.6	7.9	3.6	2.5	44.9	13.5
2004	27.7	7.8	3.6	2.7	44.3	13.9

**Table V. Primary reasons for purchasing LTC insurances in order:**

1. Persons who do not want to rely on his/her children co pay for LTC when needed.  
(Persons who would like to avoid depending on others for care and to preserve their independence).
2. Persons who worry about how to pay for LTC when needed.
3. Persons who believe they may need LTC services in the future.  
(From a family history, people have higher risk to be ill, so they believe they will need LTC, or people are caution persons, they think they may need LTC in the future.)
4. Persons who think insurance industry offers adequate coverage for LTC, which government would not cover for them.
5. Persons who would like to minimize their financial exposure to protect their assets and would like to guarantee that they will be able to afford needed LTC services.
6. Persons who have friends lose savings by paying for nursing home or home health care, so that they would like to avoid this situation.
7. Persons who would like to avoid depending on Medicaid.
8. Persons who are below age 75, female, married persons, total liquid assets are greater than and equal to \$100,000, or college-educated are more likely to buy a long-term care insurance.

**Table VI. Income and Asset limits:**

	1999		2004		2007	
	Income	Asset	Income	Asset	Income	Asset
<b>Individual</b>	\$500	\$2,000	\$564	\$2,000	\$623	\$2,000
<b>Couple</b>	\$751	\$3,000	\$846	\$3,000	\$934	\$3,000

Source: Centers for Medicare & Medicaid Services (CMS)

**Table VII. Observations in each age group over six waves**

Age groups	Observations
1: 21-30	52
2: 31-40	565
3: 41-50	4,643
4: 51-60	34,124
5: 61-70	35,351
6: 71-80	27,371
7: 81-90	12,893

**Table VIII. The Federal LTCI program V.S. other Private LTCI products**

<b>Benefit options</b>	<b>The Federal LTCI program</b>	<b>Private LTCI products</b>
Coverage	Comprehensive or Facilities-only	Comprehensive, Facilities-only, or Home-care-only
Daily benefit amount (DBA)	\$50 to \$300	\$18 to \$500
Waiting periods	30 days or 90 days	0 days to 730 days
Benefit periods	3 years, 5 years, or lifetime	1 year to lifetime
Inflation protection	Automatic compound or Future purchase option	Automatic compound, Simple, Future purchase option, Other, or None

Note. United States Government Accountability Office (GAO): “Report to Congressional Committees: Long-Term Care Insurance- Federal Program Compared Favorably with Other Products, and Analysis of Claims Trend Could Inform Future Decisions, Table 1: Benefit Options in the Federal LTCI program and in Individual and Group Products Sold from July 1, 2002 through March 31, 2005” March, 2006.

**Table IX. Nursing Home Use Rate**

	<b>Health, United States 1996-1997<sup>(a)</sup></b>		<b>National Nursing Home Survey (NNHS)<sup>(b)</sup></b>	
	<b>1985</b>	<b>1995</b>	<b>1985</b>	<b>2004</b>
65-74	1.23 %	0.93 %	1.0 %	0.9 %
75-84	5.91 %	4.49 %	5.2 %	3.6 %
85+	22.87 %	20.07 %	21.1 %	13.9 %

Note. (a) Bishop (1999), “Data watch: Where are the missing elders? The decline in nursing home use, 1985 and 1995, Exhibit 1: nursing home residents age 65 and over, per thousand elderly, by age, 1985 and 1995.” Health Affairs, Vol (18), No. 4.; and (b) Alexih (2006), “Nursing home use by ‘oldest old’ Sharply declines, Exhibit 4: nursing home use rates by age for selected years.” The Lewin Group, national press club.

**Table X. The distribution of the elderly population in 1999 by sex**

	% of entering nursing home					
	1999			2004		
	All	Male	Female	All	Male	Female
<b>65~74</b>	1.07%	1.03%	1.10%	0.94%	0.90%	0.98%
<b>75~84</b>	4.26%	3.07%	5.06%	3.62%	2.70%	4.23%
<b>85+</b>	18.14%	11.63%	20.88%	13.87%	8.00%	16.52%

Data resource: Health, United States, 2006 and 2007--Table 1: Population by age, sex, and race; and Table 99 and 104: Nursing home residents 65 years of age and over by age, sex, and race.

### Data Statistics tables

**Table 1 Premiums by age groups (present values: 2006 dollar)**

Timing of Applying LTCI	Age groups						
	1: 21~30	2: 31~40	3: 41~50	4: 51~60	5: 61~70	6: 71~80	7: 81~90
21	3,057	1,780	1,037	604	352	205	119
31	-	3,158	1,839	1,071	624	363	212
41	-	-	4,353	2,535	1,477	860	501
51	-	-	-	6,318	3,680	2,143	1,248
61	-	-	-	-	9,725	5,664	3,299
71	-	-	-	-	-	17,439	10,157
81	-	-	-	-	-	-	40,234

**Table 2. Median income by age groups (present values: 2006 dollar)**

Age groups	Median
1: 21-30	24,570
2: 31-40	32,294
3: 41-50	35,520
4: 51-60	32,300
5: 61-70	23,027
6: 71-80	17,654
7: 81-90	14,963

**Table 3. Survival probabilities by age groups**

<b>Age groups</b>	<b>Average survival probabilities through year 1996 to year 2003</b>
1: 21-30	1.0000
2: 31-40	0.9848
3: 41-50	0.9535
4: 51-60	0.8866
5: 61-70	0.7446
6: 71-80	0.4923
7: 81-90	0.1967

**Table 4. Means of Nursing home costs (2006 dollar) and the length of stay by age groups**

<b>Age groups</b>	<b>Mean of NHC</b>	<b>Mean of length of stay</b>
1: 21-30	0	0
2: 31-40	670	5
3: 41-50	4,047	26
4: 51-60	16,606	104
5: 61-70	17,398	106
6: 71-80	17,403	108
7: 81-90	23,044	142

**Table 5. Mean of Out-of-pocket medical expenses by age groups (2006 dollar)**

<b>Age groups</b>	<b>Mean of OOPMD</b>
1: 21-30	285
2: 31-40	882
3: 41-50	1,298
4: 51-60	1,265
5: 61-70	1,519
6: 71-80	1,629
7: 81-90	2,460



**Table 6. Means of coverage by periods (based on the mean length of stay in Data 4)**

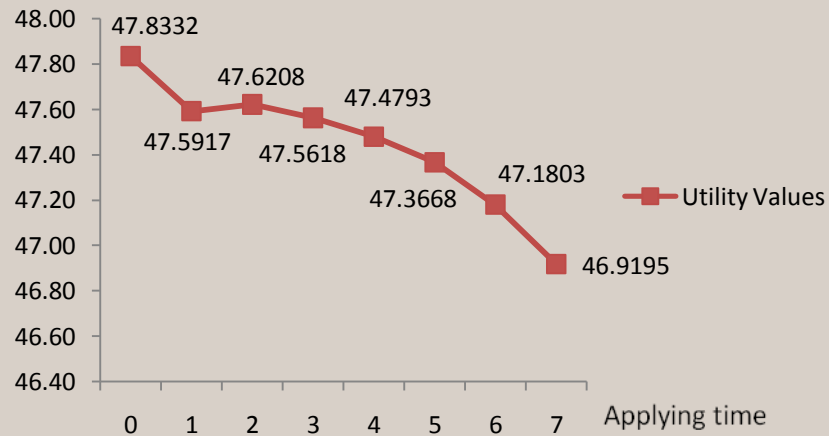
Timing of Applying LTCI	Age groups						
	1: 21~30	2: 31~40	3: 41~50	4: 51~60	5: 61~70	6: 71~80	7: 81~90
21	0	0	0	5,746	12,917	12,560	15,761
31	0	0	0	6,021	13,535	13,161	16,514
41	0	0	0	5,608	14,182	13,790	17,304
51	0	0	0	2,056	14,860	14,450	18,131
61	0	0	0	0	2,350	15,140	18,998
71	0	0	0	0	0	2,644	19,907
81	0	0	0	0	0	0	7,638

**Table 7. The probability of a nursing home stay**

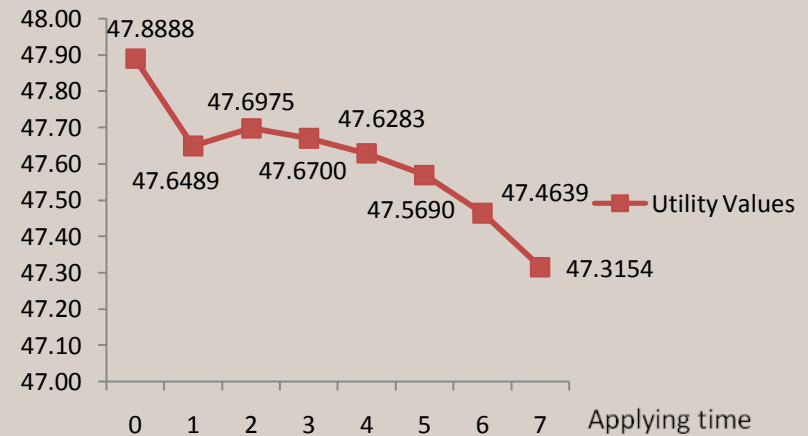
Age Group	% of people ever stayed in nursing home
1: 21-30	0
2: 31-40	0.18%
3: 41-50	0.47%
4: 51-60	0.46%
5: 61-70	1.39%
6: 71-80	3.57%
7: 81-90	12.68%

## Figures

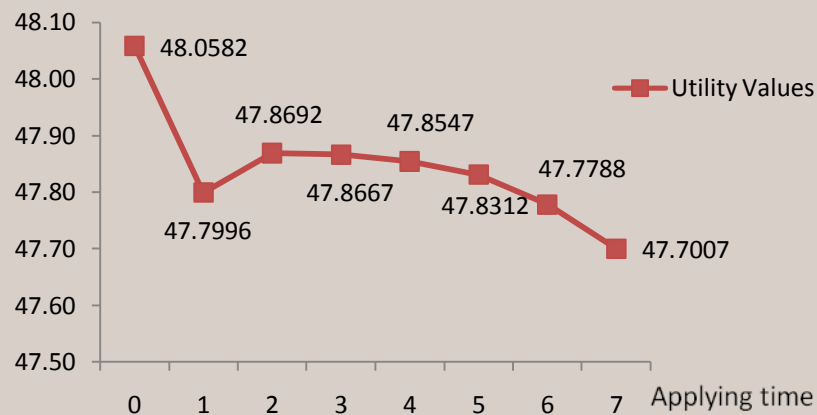
**Figure 1-1. LTC insurance application with  $r=0.01$**



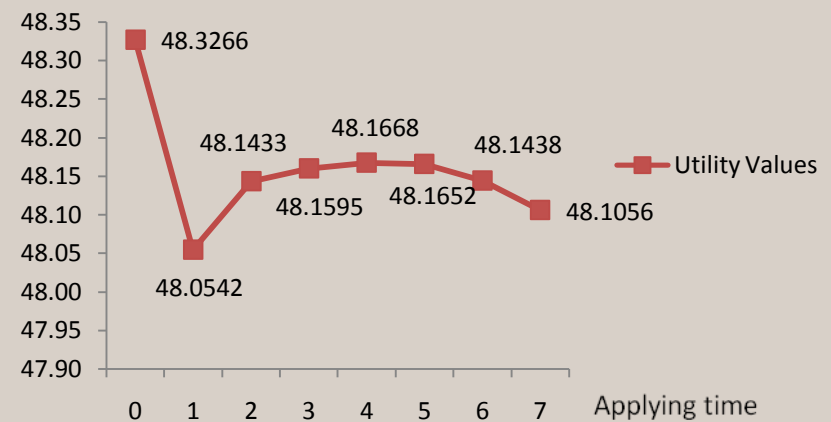
**Figure 1-2. LTC insurance application with  $r=0.02$**



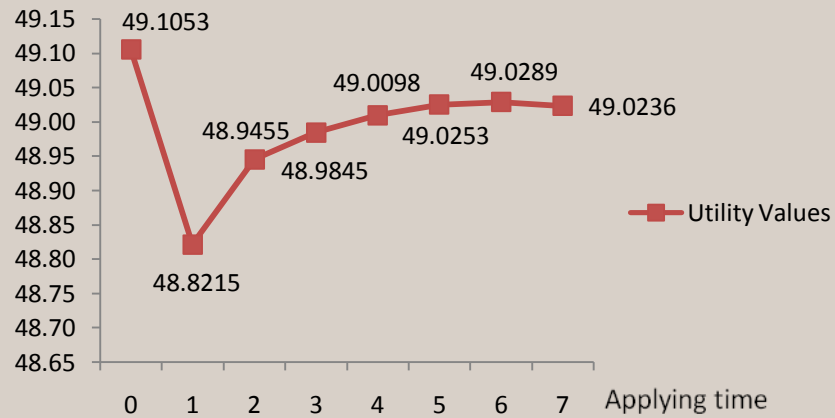
**Figure 1-3. LTC insurance application with  $r=0.03$**



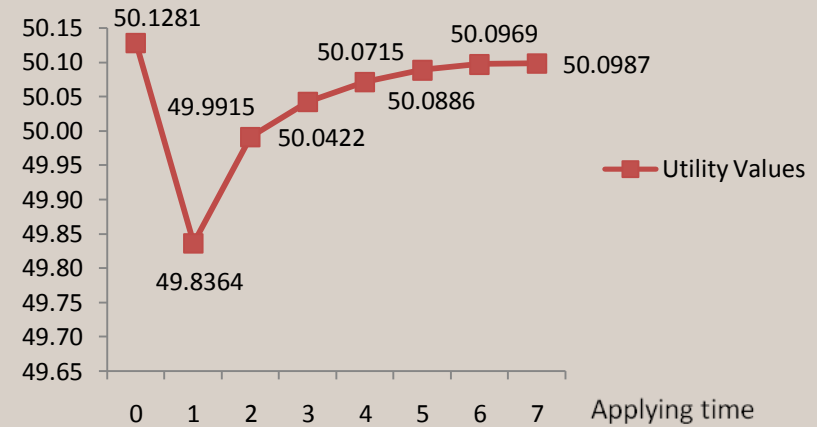
**Figure 1-4. LTC insurance application with  $r=0.04$**



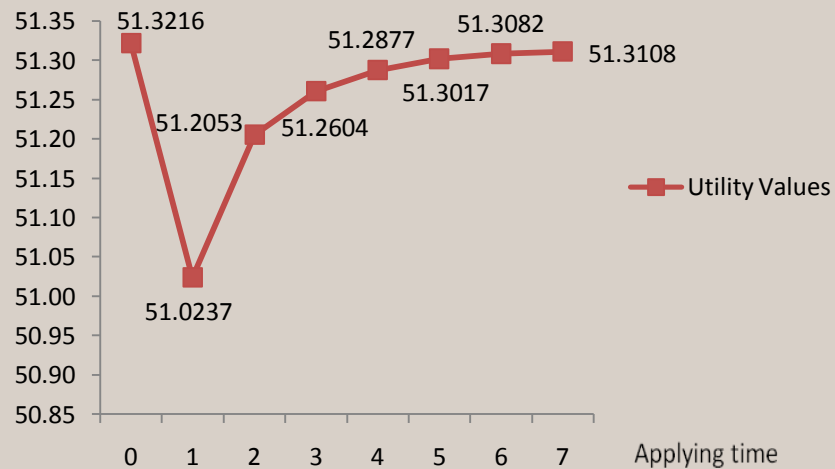
**Figure 1-5. LTC insurance application  
with  $r=0.06$**



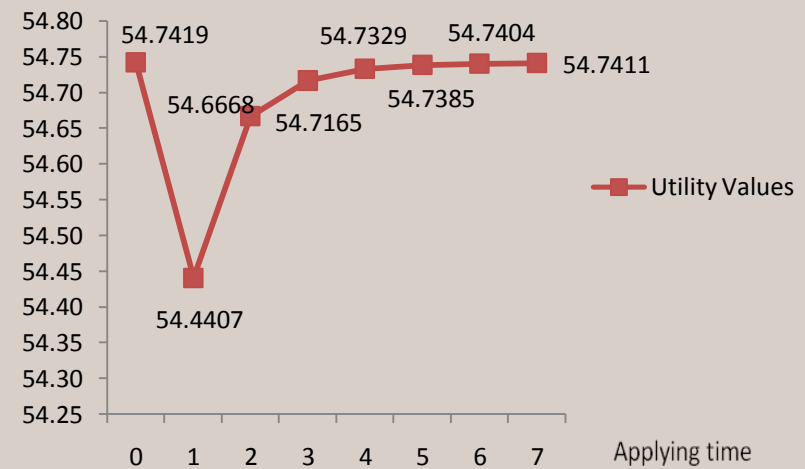
**Figure 1-6. LTC insurance application  
with  $r=0.08$**



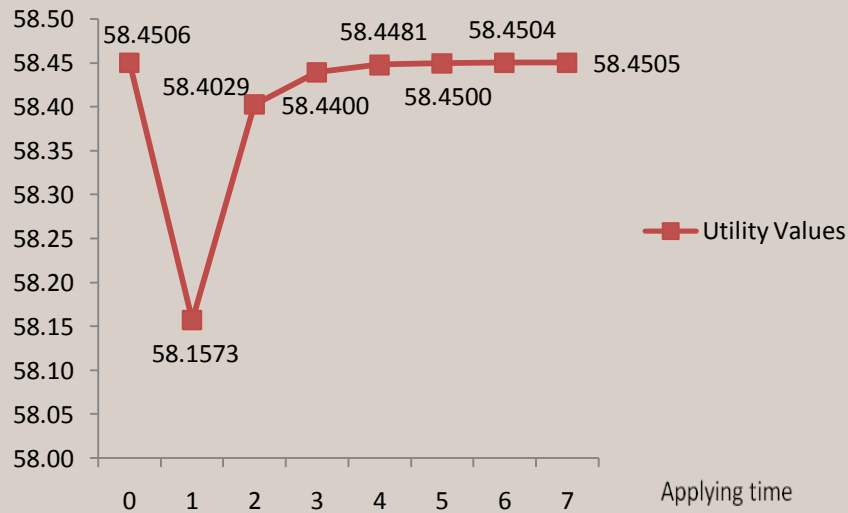
**Figure 1-7. LTC insurance application  
with  $r=0.10$**



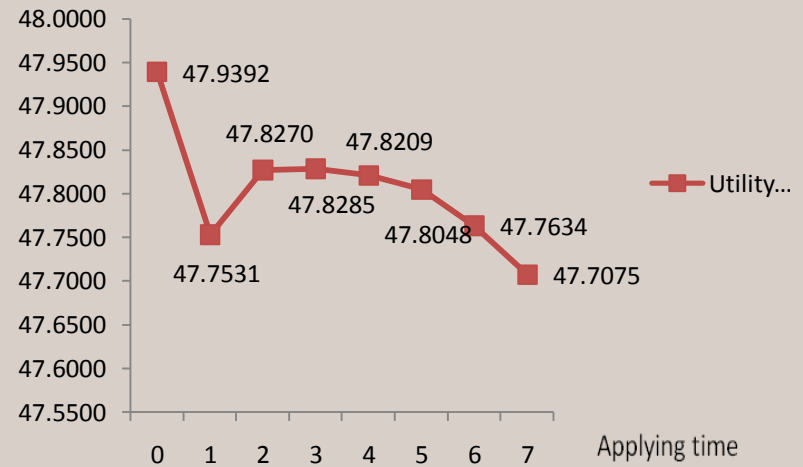
**Figure 1-8. LTC insurance application  
with  $r=0.15$**



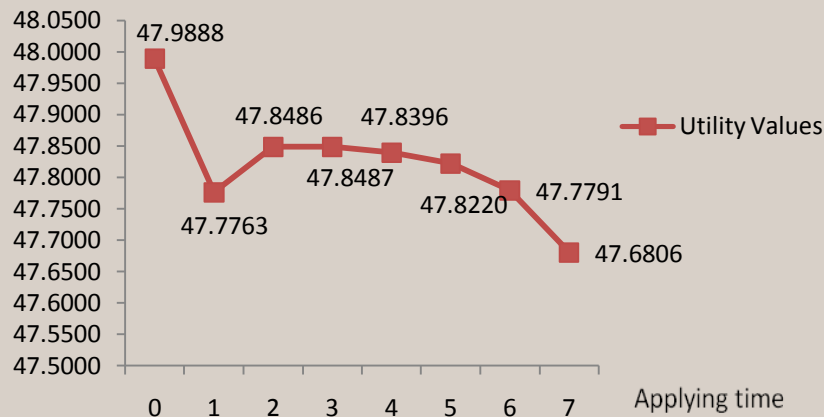
**Figure 1-9. LTC insurance application  $r=0.20$**



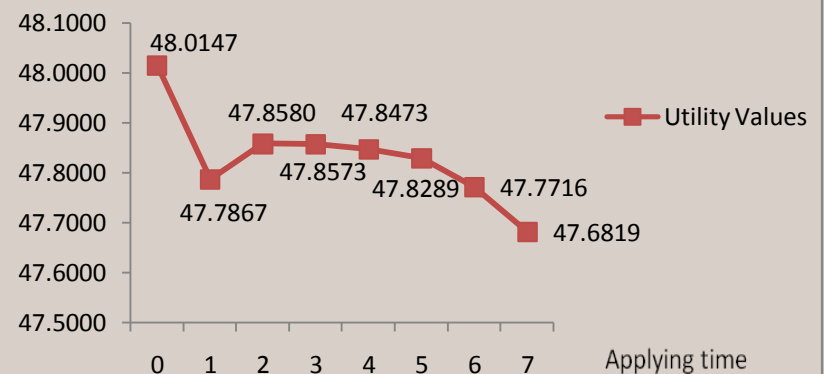
**Figure 1-10. LTC insurance application with length of stay 900 in 80s**



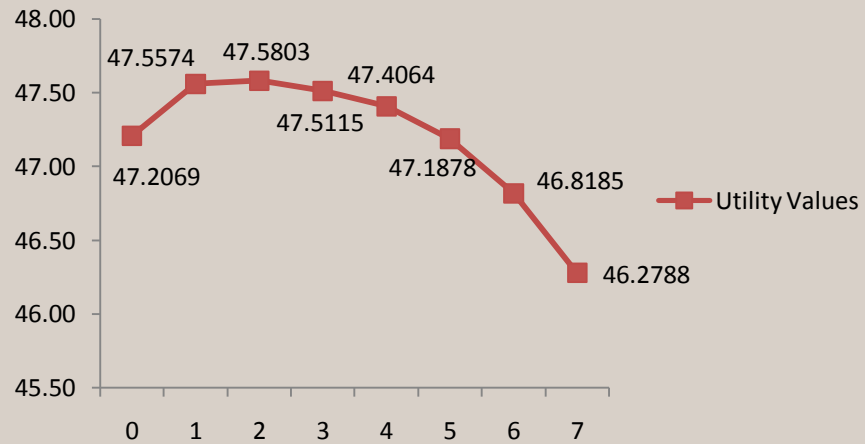
**Figure 1-11. LTC insurance Application with length of stay 450 in 70s and 80s**



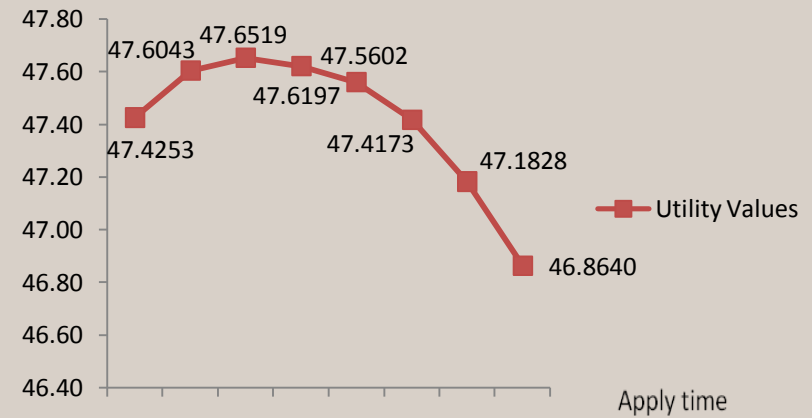
**Figure 1-12. LTC insurance Application with length of stay 300 in 60s, 70s, and 80s**



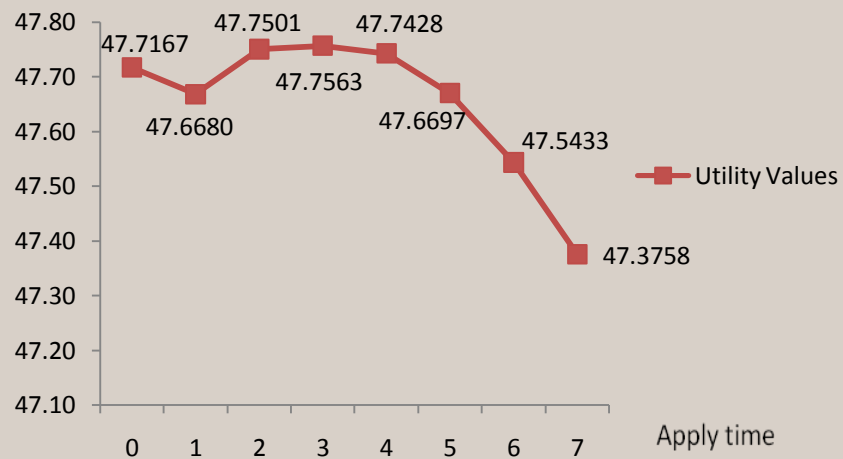
**Figure 2-1. LTCI Application  
under high probability --  $r=0.01$**



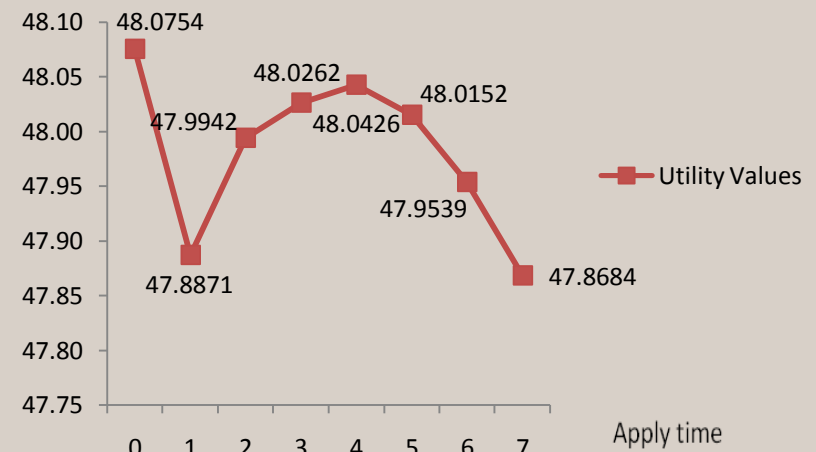
**Figure 2-2. LTCI Application  
under high probability --  $r=0.02$**



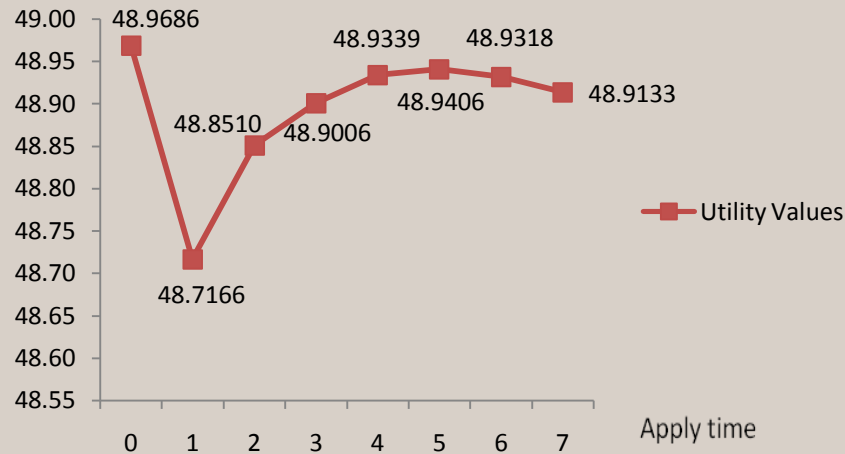
**Figure 2-3. LTCI Application  
under high probability --  $r=0.03$**



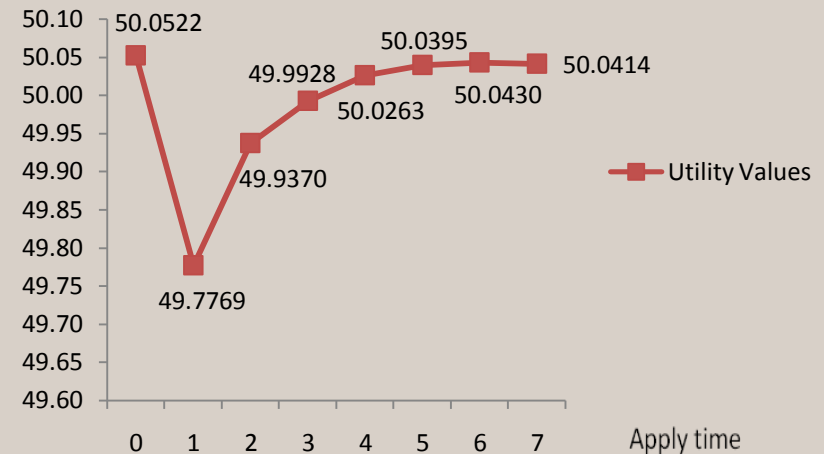
**Figure 2-4. LTCI Application  
under high probability --  $r=0.04$**



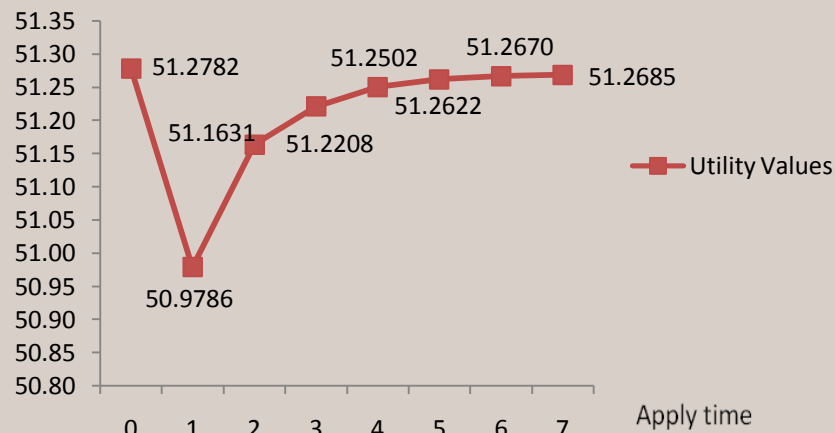
**Figure 2-5. LTCI Application  
under high probability --  $r=0.06$**



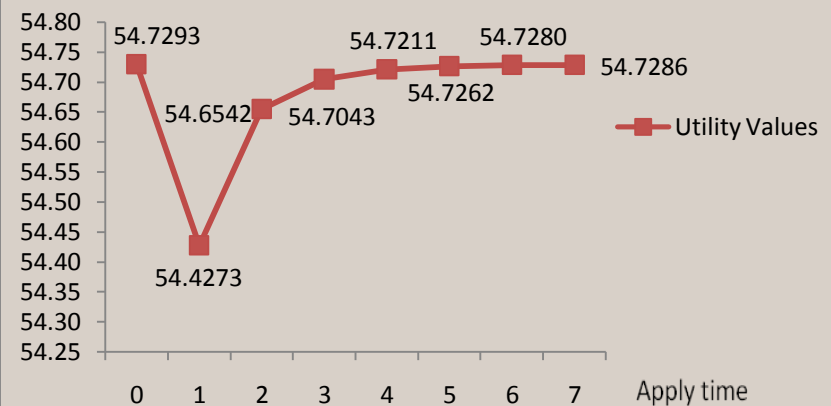
**Figure 2-6. LTCI Application  
under high probability --  $r=0.08$**



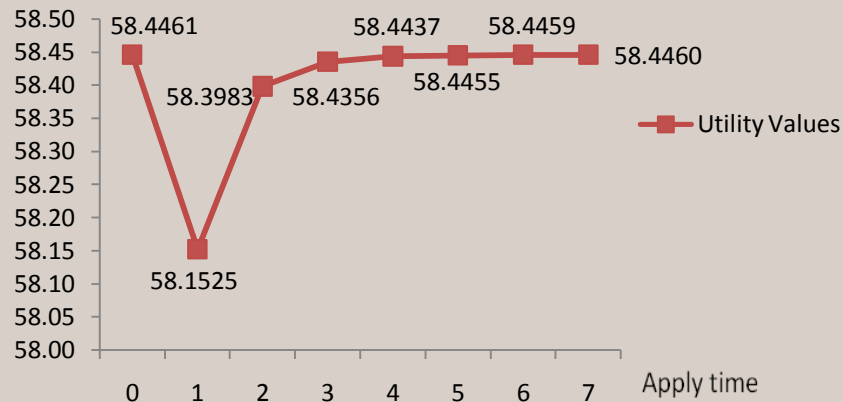
**Figure 2-7. LTCI Application  
under high probability --  $r=0.10$**



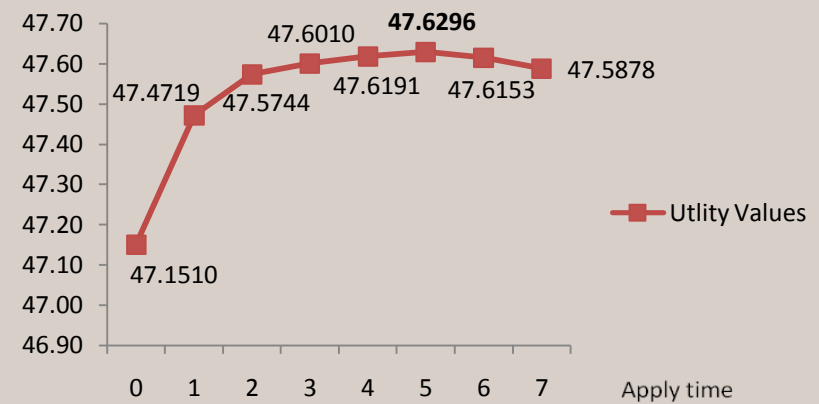
**Figure 2-8. LTCI Application  
under high probability --  $r=0.15$**



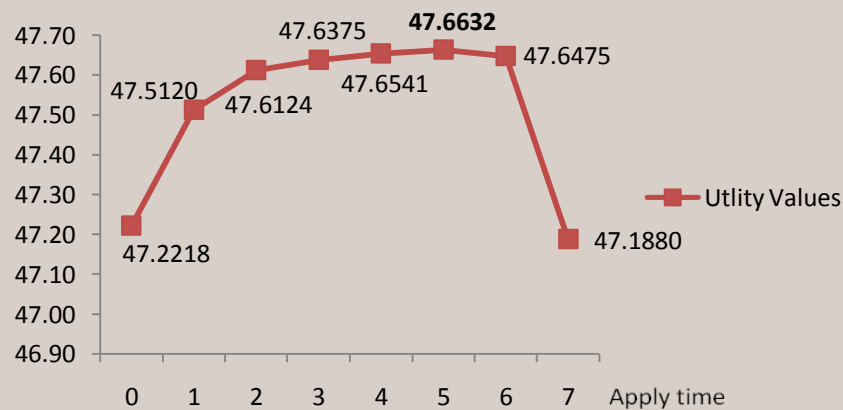
**Figure 2-9. LTCI Application under high probability --  $r=0.20$**



**Figure 2-10. LTCI Application under high probability--with length of stay 900 in 80s**



**Figure 2-11. LTCI Application under high probability--with length of stay 450 in 70s and 80s**



**Figure 2-12. LTCI Application under high probability--with length of stay 300 in 60s, 70s, and 80s**

