

The conversion option in life insurance

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ABSTRACT

This paper introduces an option that has been provided by life insurance companies extensively but has not been discussed in much in the literature; the conversion option. By constructing a valuation model, we first confirm that the conversion option may have positive values. We further find that the value of this option highly depends on the difference of the expected and actual mortality pattern after the insured individual converts his/her policy. Meanwhile, considering the general trend of mortality improvement, we incorporate this trend by applying the Lee–Carter model, hoping to provide a reasonable and fair valuation of the conversion option.

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1. Introduction

Various prestigious papers have discussed valuation of embedded option in life insurance policies. However, most literature on embedded options in life and pension insurance has so far concentrated on the bonus payment option with a number of different models that have been developed, in order to cover different elements of the life and pension insurance contract (Nordahl, 2008).

Meanwhile, there have also been papers discussing valuation of surrender options embedded either in traditional life insurance or equity-linked policies (e.g. Bacinello, 2003, 2005; Bauer et al., 2006; Costabile et al., 2008; Grosen and Jørgensen, 1997, 2000). Steffensen (2002), defined intervention options as the policyholder's surrender and paid-up policy options. The paper deals with the simplest form of intervention, which is optimal stopping, so that the valuation of intervention options is based on optimal intervention strategies, giving rise to arbitrage free values.

Nordahl (2008) introduced an exchange option that is available in Norway. The paper compares the value of the exchange option with the value of the corresponding American surrender option and with combinations of the two options.

This paper focuses on the conversion option, an option that has been provided by life insurance companies extensively but has not been discussed much in the literature. The conversion option is a feature that allows the insured individual to convert his/her

original policy into another type of policy before the original policy expires. This type of feature is most commonly seen in term insurance policies. It allows the policyholders to convert his/her original term insurance policy to whole life insurance before the initial policy is due. Policyholders are often encouraged to convert their policies even when their health situation declines. This is reasonable for the insurance company since it may be much less expensive to convert the policy instead of issuing a new one. However, it should be noted that the future cash flow after the conversion might change since the insured individual may not remain in the standard class as he/she did when applying for the initial policy. Thus, we intend to show that the conversion option may be valuable for the insured individual when he/she has the option to convert his/her term insurance policy into a whole life insurance policy.

Term insurance provides insurance coverage for a term of one or more years. It generally does not build up cash value so that when the term is due and the insured individual is still alive, the contract terminates and no payments would be made. Whole life insurance instead provides coverage as long as the insured individual is alive and the premium is paid. However, the premium could be several times higher than the amount that the insured individual has to pay for the coverage of term insurance. Generally, for each premium dollar paid by the insured, term insurance offers the largest insurance protection.¹

Most term insurance policies are renewable. In practice, insurance companies usually provide a guarantee renewal clause

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¹ The National Association of Insurance Commissioners, 2001, *Life Insurance Buyer's Guide*.

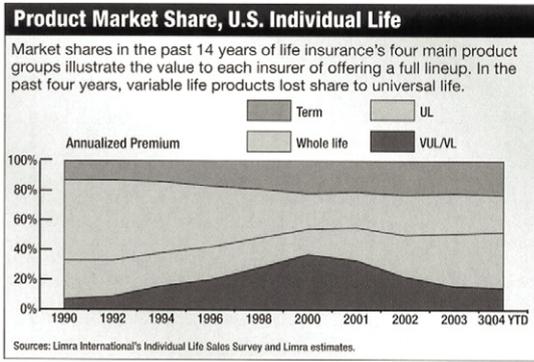


Fig. 1. The product market share of US individual life insurance.

so that the individual is sure to obtain insurance after the initial policy is due. However, evidence of insurability is required and the premium rate is adjusted based on the insured person's age and physical situation. If the individual's health declines, it may become difficult for him/her to qualify for the new term insurance policy at standard rates.

Even though there is a disadvantage in buying term life insurance, these types of products still remain popular in the market because of the significantly smaller amount of premium compared with those of whole life insurance products. Fig. 1 shows the product market share of US individual life insurance from 1990 to 2004. The figure shows that in the past four to six years, not only variable life product lost a share to universal life, but traditional whole life insurance also lost a share to term insurance. A more recent survey showed that, of new individual life insurance policies purchased in 2006, 41%, or 4 million, were term insurance, totaling \$1.3 trillion, or 71%, of the individual life face amount issued.²

Suppose that an individual buys a term insurance policy. When the policy is due and he/she is still alive, he/she may wish to continue the coverage. However, if his/her health situation declines, he/she may be charged a higher premium rate or even be rejected by the insurance company. In this case, another option for the individual would be to convert into a whole life insurance policy any time before the original term insurance is due. The main advantage for the individual to convert his/her policy is that the insurance companies generally will not require any evidence of insurability for the conversion and will calculate the new premium according to the age at the issue of the original contract.

The payments for converting a policy are different from applying for a renewal. When the policyholder applies for policy conversion, the insurance company converts the policy retrospectively. Based on this concept, at the time of conversion, the individual has to pay the difference of cash value between the original term insurance and converted whole life insurance policy; after conversion, the premium that the insurance company charges will then be set according to the converted policy.³ Besides the pay up of the cash value and the additional premium that will be charged thereafter, there is usually no additional cost for the policyholder to activate this option.

To evaluate the conversion option, we first use a static model to show that the conversion option may be valuable when the decline in health situation increases the mortality rate and thus should not be ignored by the insurance company. Under the static mortality model, our simulation results show that, for a 10-year

term insurance policy with insured amount US \$10,000, the value of the conversion option ranges from \$0.34 to \$10.30, depending on the initial age insured, the probability that the individual's health will decline, the impact on mortality when health declines and our assumptions.

Next, we take mortality improvement into consideration by applying the Lee–Carter method when deriving mortality. The approach is similar to that of Denuit et al., 2007. As expected, when there is a general trend of mortality improvement, the value of the conversion option will be lower, ranging from \$0.13 to \$9.95.

The remainder of this paper is organized as follows: In Section 2, we set up the valuation model using traditional actuarial notation to illustrate that the conversion option may be valuable. When deriving the stochastic mortality, the Lee–Carter model was applied. Section 3 presents our simulation results and Section 4 concludes the paper.

2. Valuation

In this section, we try to provide a reasonable and fair valuation of the conversion option in the real world. To simplify the mathematical presentations, we use typical actuarial notations listed below:

$A^1_{x:\overline{n}|}$: the actuarial present value for an n -year term life insurance with \$1 payable at the end of the year of death of an insured age x , calculated from the base mortality table

$P^1_{x:\overline{n}|}$: the annual level premium for an n -year term life insurance with \$1 payable at the end of the year of death of an insured age x , calculated from the base mortality table

A_x : the actuarial present value for a whole life insurance with \$1 payable at the end of the year of death of an insured age x , calculated from the base mortality table

P_x : the annual level premium for a whole life insurance with \$1 payable at the end of the year of death of an insured age x , calculated from the base mortality table

\bar{A}_{x+n} : the actuarial present value for a whole life insurance with \$1 payable at the end of year of death of an insured age $x + n$, calculated from the mortality table adjusted for health declining

\bar{P}_{x+n} : the annual level premium for a whole life insurance with \$1 payable at the end of the year of death of an insured age $x + n$, calculated from the mortality table adjusted for health declining

\ddot{a}_{x+n} : the actuarial present value for an \$1 annuity due of an insured age $x + n$, calculated from the base mortality table

$\tilde{\ddot{a}}_{x+n}$: the actuarial present value for an \$1 annuity due of an insured age $x + n$, calculated from the mortality table adjusted for health declining

δ : the discount rate

${}_n p_x$: the probability that an insured age x will be alive n years later

We assume that, in the beginning, a male insured at age x buys an n -year term insurance policy. When the policy is almost due and the insured individual is still alive, he will consider obtaining further life insurance coverage. If the individual is still healthy, he will then buy a new whole life insurance policy. The issued age of the new whole life insurance policy will be $x + n$. However, if his health declined, he will then choose to convert the original policy into a whole life insurance policy at the end of the n -th policy year. We assume that the probability that the health of the insured individual may decline at the end of the n -th policy year is $\theta_{x,n}$, which is a function of the insured age, x , and the duration of the term insurance, n .

Using the static actuarial notations defined above, the expected present value of death benefit at $t = 0$ is:

$$E(PVDB) = A^1_{x:\overline{n}|} + {}_n p_x \delta^n [(1 - \theta_{x,n}) \cdot A^+_{x+n} \theta_{x,n} \tilde{\bar{A}}_{x+n}], \tag{1}$$

² American Council of Life Insurers, 2007, *Life insurance Fact Book*.
³ Therefore, after conversion, the accumulated cash value amount of the policy and the premium charged thereafter would be the same as if the policyholder had bought the whole life insurance at the beginning.

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