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Enhanced annuities and the impact of individual underwriting on an insurer's profit situation

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ABSTRACT

We analyze the effect of enhanced annuities on an insurer engaging in individual underwriting. We use a frailty model for heterogeneity of the insured population and model individual underwriting by a random variable that positively correlates with the corresponding frailty factor. For a given annuity portfolio, we analyze the effect of the quality of the underwriting on the insurer's profit/loss situation and the impact of adverse selection effects.

1. Introduction

In many countries, the United Kingdom and Germany among them, there are tax incentives that encourage owners of old age provision contracts to receive their benefits in the form of a lifelong annuity as opposed to a lump sum. In some places, there are state-subsidized or tax-sheltered product lines for which annuitization is compulsory. However, in a market where only so-called standard annuities are offered, such regulations result in significant disadvantages for insured persons whose life expectancy is below average at the time of annuitization.

With standard annuities, the annuity paid depends only on the amount of money that is annuitized, the insured's age at the time of annuitization, and the insured's gender. Thus, the value for money of a standard annuity is higher the longer the life expectancy of the insured. If certain tax incentives favor annuitization, a person with a reduced life expectancy has the choice only between an annuitization at "unfair" rates or a lump-sum benefit that triggers some sort of tax disadvantage. In product lines with compulsory annuitization, impaired people are, practically speaking, forced to annuitize at unfavorable rates, that is, the present value of the annuity benefits may be significantly lower than the amount to be annuitized.

This "unfair" situation could be avoided if so-called enhanced annuities were offered—products where the annuity paid is larger the lower the insured's life expectancy.[1] In other words, with enhanced annuities, annuity rates are adjusted to reflect the individual health status of an insured.

In this paper, we develop a model to specify individual underwriting of enhanced annuities and, based on that model, quantitatively analyze the effect of individual underwriting, in particular of the underwriting quality, on an insurer's profit/loss situation.

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[1] See, e.g., Ainslie (2000, p. 6), Hamdan and Rinke (1998, p. 5) and Jones and Richards (2004, p. 20).

It is common practice in many term-life and disability insurance markets to offer so-called preferred life products, where the premium is lower for "good risks", i.e., insureds with low mortality or morbidity probabilities. In the annuity business, impaired persons are obviously good risks from the insurer's perspective. Therefore, enhanced annuities are sometimes also referred to as impaired annuities.

For immediate enhanced annuities, the annuity amount for a given single premium depends on the insured's health at the time the contract is signed. For deferred annuities, however, the insurer needs to perform some kind of underwriting at the end of the deferment period. If the insured person does not submit to the underwriting proceeding, he or she would receive the annuity corresponding to the healthiest class of insureds.

The fact that enhanced annuities are still rare in many insurance markets[2] could explain the so-called annuity puzzle. For example, Dushi and Webb (2004) found that only 10.2% of seniors in the United States have annuitized (a portion of) their wealth. Academics are surprised by this low figure because Brown et al. (2005), for example, showed that under usual assumptions, (partial) annuitization increases expected utility. However, this analysis assumes that future mortality probabilities are known and depend only on the insured's age and gender. In other words, it is assumed that the value for money of annuities is essentially the same for all potential insureds. Yet, in reality, strong selection effects can be observed. Persons who elected to annuitize part of their wealth have significantly lower than average mortality probabilities, i.e., higher than average life expectancies. We can conclude that out of those individuals who receive a good value for money when purchasing an annuity, significantly more than 10.2% annuitize, whereas only a very small portion of people with low life expectancy do so. If enhanced annuities based on the insured's individual health information were offered, everybody could get a "fair deal" when purchasing an annuity. In this situation, the purchase of annuities should increase and, at the same time, the degree of adverse selection in the annuity market should decrease.[3]

The existing literature on enhanced annuities concentrates primarily on practical issues of the enhanced annuity market, mainly in the United Kingdom,[4] and covers topics including this market's development, size, or potential, different types of enhanced annuities, underwriting methods and challenges, tax considerations, distribution channels, and reinsurance.[5] Ainslie (2000) provides a quantitative analysis of potential adverse selection effects on the standard annuity market by determining some critical size of the enhanced annuity market. He considers a hypothetical portfolio of males aged 65. The heterogeneity of their health is modeled using a normal distribution for the mortality. For different parameter combinations for this normal distribution he determines the portion of pensioners buying enhanced annuities (instead of standard annuities). Levantesi and Menzietti (2007) focus on the evaluation of biometric risk in enhanced annuity products including long-term care coverage. Jones and Richards (2004) discuss the risk of underwriting enhanced annuities,[6] but do not perform quantitative analyses.

To date, there have been no attempts to develop a model that describes the individual underwriting of enhanced annuities, the quality of such underwriting, or that quantifies the effects of such underwriting on the insurer's profit/loss situation. The impact of adverse selection resulting from competition induced by an enhanced annuities market is another topic that has received no investigation as of yet.

The aim of the present paper is to fill these gaps. We present quantitative analyses of the effect enhanced annuities have on an insurer engaging in individual underwriting. First, the heterogeneity of insured persons is specified in Section 2.1 by modeling the distribution of the degree of impairment within a population using a frailty model for individual mortality probabilities. In Section 2.2, we present our model for individual underwriting. The result of the underwriting is a stochastic frailty factor that correlates with the actual frailty factor of the insured person. The correlation coefficient is our measure of the quality of the underwriting. In Section 2.3, we detail the insurance product considered and the community of insureds, and in Section 2.4, we explain how adverse selection effects can be analyzed within our model framework. Numerical results derived using Monte Carlo methods are presented in Section 3. After specifying the parameters for our analyses in Section 3.1, results for three model companies are given in Section 3.2. By calculating the empirical profit distribution of each of the three companies, we analyze the effect of enhanced annuities and of the quality of the underwriting on the insurer's profit/loss situation. We also assess the impact of adverse selection effects on companies who do not offer enhanced annuities when other insurers in the market do. We summarize our results in Section 4.

2. Model framework

2.1. Individual mortality probabilities

We define (x) as a male person age $x \in \mathbb{N}_0$. Age at death is modeled by the random variable $X \geq 0$. The random variable $K(x) = X - x, X > x$ describes the remaining curtate lifetime of (x). Its distribution function ${}_kq_x$ at a point $k \in \mathbb{N}_0$ is denoted by

$$ {}_kq_x = F_{K(x)}(k) = P(K(x) \leq k | X > x) = 1 - {}_kp_x, \qquad (1) $$

where ${}_kp_x$ is the k-year survival probability of (x).

To specify heterogeneity in the insurance portfolio we use a frailty model, i.e., an individual factor[7] (also referred to as a mortality multiplier) by which the actual mortality of each person differs from a given standard mortality table.[8] Probabilities given in the standard mortality table will be denoted with a prime (') mark.[9] Thus, the one-year individual mortality probability for a given insured with mortality multiplier d is given by

$$ q_x = \begin{cases} d \cdot q'_x, & d \cdot q'_x \leq 1 \\ 1, & \text{otherwise} \end{cases} \quad \text{with } x \in \{0, \ldots, \omega\}. $$

The individual mortality probabilities q_x determine the distribution of annuity payments, i.e., the insurer's liabilities.

The parameter d describes the individual's state of health as follows:

[2] To the authors' knowledge, in the German insurance market, e.g., there are only two enhanced annuity products (LV1871 "Extra-Rente" and "DSP-Vorzugsrente").

[3] See Rothschild and Stiglitz (1976, p. 629).

[4] According to Weinert (2006), in the third quarter of 2005 the market share by premium of enhanced annuities amounted to nearly 20% of the entire annuity market in the United Kingdom.

[5] See, e.g., Ainslie (2000), Hamdan and Rinke (1998), Jones and Richards (2004, p. 20ff), Richards and Robinson (2005), Rinke (2002), and Weinert (2006).

[6] See Jones and Richards (2004, p. 20).

[7] Such a factor (often analogously applied to the continuous force of mortality) is usually called a "frailty factor". See Vaupel et al. (1979, p. 440) and Jones (1998, p. 81).

[8] See, e.g., Pitacco (2004, p. 14). This is a reasonable modeling assumption, since many impairments generally increase mortality over a longer period of time, as, e.g., cardiovascular disease, which, according to WHO Europe (2004, p. 12) and PAN American Health Organization (2006, p. 7), is the most common cause of death. However, in practical implementations, one might prefer to use a different "shape" of extra mortality for different impairments, e.g., so-called flat extras, that is, an additive extra mortality over several years only.

[9] See, e.g., Haberman (1982, p. 211).