

Modelling Joint Life Functional Disability and Mortality and Joint Insurance Pricing

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Abstract

This research investigates the dependence between the health states of married couples, along with the variables of age, gender, and time. Based on a three-state Markov chain, we study four health transition models, incorporating terms to capture the dependence of health states between couples. Using this joint health transition model, we delve into the pricing of Long-Term Care Insurance (LTCI) products, focusing on the differences in premiums across distinct LTCI contracts. We assess the influence of spouses' health states on the pricing of LTCI products, and consequently, the demand for these insurance contracts. Another significant feature of our study is the comparison between single contracts and joint contracts for couples. This research is motivated by the following facts:

First, as life expectancy increases, the length of time people spend in disability states also increases. Yet, decreasing family sizes make informal care at home difficult, and some families cannot provide adequate care for disabled family members. This has resulted in high care costs, which are not covered by most health insurance policies.

Second, although LTCI has been developed for decades, it is still unpopular in most insurance markets, which may be due to a number of reasons, such as its high price, people's lack of knowledge about the product, distrust of insurance companies, among others. A progressive health transition model can more accurately predict the evolution of a couple's health states, which can drive the development of LTCI and related products such as life annuities and life insurance.

Third, we note that even though many health transition models have been discussed in the

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literature, most of them are for single individuals, that is, the transition rates depend only on their own information. However, joint models are rarely discussed. Indeed, the bulk of research examining health dependence between couples in various databases provide solid evidence of the existence of health dependence due to similar lifestyle. Thus, we consider a joint health transition model assuming that the state of the spouse is also an influencing factor of transition rates.

Our findings indicate that unmarried individuals have a higher mortality rate than married individuals. Furthermore, through the likelihood ratio tests, we find that the dependence in health states between married couples is significant. Married individuals are more likely to transition to the state in which their spouses are currently in. Analysis of disability rates shows that, regardless of gender and age, individuals with a disabled spouse have significantly higher disability rates. Moreover, if the spouse is dead, the individual has a higher mortality rate regardless of whether they are in the healthy state or LTC state. Our analysis of total life expectancy yields similar conclusions, that is, those whose spouses are dead have the shortest life expectancy, while those with disabled spouses tend to have the highest life expectancy. Our models do not exhibit significant trend in transition rates over time. The inclusion of dependence terms lead to a reduction in the variance of the frailty term but an increase in the value of coefficients of the frailty term. The frailty model has better model fitting compared to the dependence model.

Through the comparison of the premiums among various LTCI products, we observe that premiums for insurance with limited policy terms tend to monotonically increase with age for individuals who are in the healthy state. The premium of other products, excluding the combined product of LTCI and life insurance, is significantly influenced by the health state of spouses. The death of a spouse has a relatively less impact on premiums, while the disability of a spouse elevates the premium markedly. Most single LTCI contracts in the real insurance market only assess the health states of the insured individuals and not those of their spouses. The calculation of the premium is usually based on the health condition of the entire population. As a result, the premiums for individuals with healthy spouses actually includes excessive disability risks and thus being overpriced.

Comparing the premiums of single contracts with the corresponding joint contracts, we find that the price of a joint contract is not always more attractive than that of two individual contracts, which also depends on the characteristics of products, such as variations in the benefit limits and policy terms. When comparing the premiums of individuals in the healthy state with those in the LTC state, we discern that there is incentive for individuals to purchase LTCI products while in the healthy state, as entering the LTC state results in a considerable increase in premiums.

Keywords: Health transition model, Joint model, Markov chain, LTCI, Insurance pricing