Long-Term Care Insurance and Basis Risk

CHRISTOPHE COURBAGE
The Geneva Association, 53 Route de Malagnou, 1208 Geneva, Switzerland
christophe_courbage@genevaassociation.org
Tel. +41-22-7076600

Abstract

Private long-term care insurance market is characterized by the presence of basis risk, i.e. the insurance indemnity received in case of dependency does not directly depend on the cost of health services but is based on a flat benefit. In this paper we address the relationship existing between health-care demands and basis risk in the long-term care insurance market. We wonder how the presence of basis risk modifies health investment and long-term health care. Using the Rank Dependant Expected Utility, we show, depending on the probability of becoming dependent, that the presence of basis risk does not necessarily lead to an increase in health investment relative to situation where no basis risk is present.

Key words: long-term care, market insurance, basis risk, Dual Theory
JEL: D81, G22, I11

1. Introduction

With an ever-greater proportion of people living to an older age, the needs for long-term care are expanding (Jacobzone, 2000). Coupled with low public long-term care coverage, the actual demographic trend opens up a huge market for private insurers. Insurance companies in most industrialized countries have made already private long-term care insurance contracts available.

Theoretical studies dealing with the demand of long-term care insurance are therefore recent. They mainly focus on explaining the low demand level for this type of insurance (e.g. Pauly, 1990; Meier, 1999; Miyazawa et al., 2000; etc…).

The private long-term care insurance market presents an interesting characteristic. Contrary to health insurance for acute care where indemnities depend on the cost of services, the amount reimbursed in case of dependency is based on a flat benefit, either in a form of life annuity or a pre-determined capital sum. As stressed by Assous [2001], this is the case because anticipating dependency occurrence, technological evolution, and length of life is very complicated. In mostly all private long-term care contracts, basis risk is present, i.e. the real expense induced by the chronic disease is not perfectly correlated with the amount paid back. Basis risk is the mismatch between the insurance provision and the effective cost of long-term care.

The literature on basis risk is extensive and mainly concentrates on index-linked catastrophic risk coverage (see Doherty, 1997; Croson and Kunreuther, 2000; Doherty and Richter, 2002). The payoff of many of these new hedging instruments used for insurance securitizations is not a function of the primary insurer's loss, but another random variable that has some correlation with the loss. Those studies stress the trade-off existing between basis risk and moral hazard (either ex-ante or ex-post), and when modelised use a mean-variance setting. Without considering asymmetric information and applied to the health sector, it would say that the presence of basis risk should make increase health investment, i.e. preventive care as the insured supports a larger part of the potential financial burden in case of dependency. It would also mean that basis risk should make decrease long-term care care.

In this paper, we wonder whether basis risk modifies demands for health investment and long-term care. We convey our analysis under Rank Dependent Expected Utility (Quiggin, 1982; Yaari, 1987). We use this decision model not only for tractability reasons but also because it helps to solve economics puzzles (see Doherty and Eeckhoudt, 1995; Hadar and Seo, 1995; Young and Brown, 2000; Courbage, 2001). And finally, because this model allows to consider the underestimation of the risk of dependency by individuals.

Based upon our model, it turns out that basis risk leads to a decrease in long-term care. Yet, the story is different for health investment. It appears that the relation existing between basis risk and health investment depends on the probability of becoming dependent. We show that if this probability is low, the presence of basis risk makes decrease health investment. This result is explainable by the properties of the transformation function of probabilities. Such conclusion puts into question the trade-off between basis risk and preventive actions (see Doherty, 2000). And, it may not legitimate the actual system in terms of public health.

2. The Model

We consider an individual who lives for a time span of two periods, representing a working period and a retirement period. In the first period, this individual chooses his demand for long-term care (LTC) insurance, α such as $0 \le \alpha \le 1$, and his level of health investment, *x*, that reduces the probability of becoming dependent in the second period[1]. His wealth during this period is equal to his income w_0, minus his savings, *s*, his level of health investment, *x*, and a long-term care insurance premium π. In order to keep the model simple, there is no discounting and the cost of *x* is normalized to unity. In the second period, with probability $p(x)$, such that $p'(x) < 0$ and $p''(x) > 0$, the individual becomes disabled, while he remains healthy up to his death at the end of the second period with probability $(1 - p(x))$.

If disability occurs, his health level before care will be H_0 while if he is healthy, it will be H_2. In case of disability, the individual will use LTC, *M*. The price of LTC is normalized to unity. Let's $T(M)$, the impact of LTC on the individual's health level, with $T(.)$ an increasing and concave function. Naturally, $H_0 + T(M) < H_2$.

The valuation function is given by:

$$H = [w_0 - s - x - \pi + L(H_2)] + f(p(x))[s - \pi - (1-\alpha)M + L(H_0 + T(M))] \\ + (1 - f(p(x)))[s - \pi + L(H_2)]$$

with $\pi = \frac{1}{2}\alpha(1+\lambda)p(x)M$.

Let λ represent the loading factor to allow for transaction cost and profit[2]. We assume that the insurance company correctly anticipates the level of *x* chosen by the insured party.

The value function can correspond to two different models. Either preferences are defined *à la* Yaari (1987). In that case *L* is a function that transforms the health stock *H* in monetary value. Or preferences are defined *à la* Quiggin (1982). In that case, the utility function is additively separable in the form $u(w, H) = w + L(H)$, which implies aversion to health risk and neutrality to wealth risk.

f is a transformation function of probabilities that describes the underestimation of the dependency risk from individuals. Researches have shown that individuals tend to underestimate the risk of becoming dependent (e.g. Caussat and Genier, 1995; Lusardi, 2000). Thus we consider that *f* is an increasing and convex function. The individual reduces subjectively the objective probability of the occurrence of dependency and increases that of staying in good health. This property describes an optimistic behavior[3].

3. Health Care Demand and Long-term Care Insurance

Before introducing basis risk, we present the optimal behavior in terms of insurance, health investment and LTC demand. It is well known in the insurance literature (e.g. Manning et al, 1987) that the presence of health insurance can lead to changes in behaviors both in terms of ex-ante and ex-post care consumption.

In line with intuition based on moral hazard, health insurance can conduct the insured party to have less incentive to prevent the occurrence of the risk as he is insured. Ex-post, it can lead to an increase in health care consumption beyond the level the claimant would purchase if not insured. In this section, we examine these points. To that end, we look at the consumer behavior with respect to health investment and LTC when his insurance coverage is modified.

By deriving the valuation function with respect to α we obtain the optimal insurance purchase. As this function is linear in α, it is well known that only corner solutions arise (see Doherty and Eeckhoudt, 1995) which depend on the following equation:

$$\frac{\partial H}{\partial \alpha} = M\left[f(p(x)) - (1+\lambda)p(x)\right] \quad (1)$$

Hence, for small values of λ, i.e. if $1+\lambda < f(p(x))/p(x)$, the individual purchases full insurance ($\alpha = 1$). But over a critical value of the loading factor, i.e. when $1+\lambda > f(p(x))/p(x)$, he switches to zero coverage ($\alpha = 0$).

Turning to health investment and LTC, the optimal levels are given by:

$$\frac{\partial H}{\partial x} = -1 - \alpha(1+\lambda)p_x^{'}M + p_x^{'} f'(p(x))\left[-(1-\alpha)M + L(H_0 + T(M)) - L(H_2)\right] = 0 \quad (2)$$

$$\frac{\partial H}{\partial M} = -\alpha(1+\lambda)p(x) + f(p(x))\left[-(1-\alpha) + T_M^{'} L'((H_0 + T(M)))\right] = 0 \quad (3)$$

Following Courbage [2001], let x_0^* and x_1^* be respectively the solutions of equation (2) when $\alpha = 0$ and $\alpha = 1$. In order to compare x_0^* and x_1^*, we evaluate $\partial H / \partial x$ when $\alpha = 1$ at x_0^*.

$$\left.\frac{\partial H}{\partial x}\right|_{\substack{\alpha=1\\ x=x_o^*}} = p_x^{'} M\left[f'(p(x))-(1+\lambda)\right]$$

Hence, when $f'(p(x))-(1+\lambda)>0$, then $x_0^* > x_1^*$. The presence of insurance makes decrease health investment. Note that this situation arises for a high level of dependency probability[4].

Yet, when $f'(p(x))-(1+\lambda)<0$, then $x_0^* < x_1^*$. In that situation, insurance and health investment are complements. It is mostly the case for a low level of dependency probability.

Now we look at the impact of purchasing insurance on the demand for LTC. We get from (3):

$$-p(x)(1+\lambda)+f(p(x))T_M^{'}L'(H_0+T(M))=0 \qquad \text{if } 1+\lambda < f(p(x))/p(x) \qquad (4)$$

$$f(p(x))\left[T_M^{'}L'(H_0+T(M))-1\right]=0 \qquad \text{if } 1+\lambda > f(p(x))/p(x) \qquad (5)$$

Let M_1^* and M_0^* be respectively solutions of Eqs. (4) and (5). M_0^* corresponds to the optimal LTC demand when the individual chooses no insurance coverage, while M_1^* to the one when he is full insured.

By evaluating $\partial H/\partial M$ when $\alpha=1$ at M_0^*, we get:

$\left.\frac{\partial L}{\partial M}\right|_{\substack{\alpha=1\\ M=M_o^*}} = -p(x)(1+\lambda)+f(p(x))>0$ since $1+\lambda < f(p(x))/p(x)$, leading to $M_1^* > M_0^*$.

As the individual chooses full insurance, his LTC demand is superior to the one when he is not insured.

4. Health Care Demand and Basis Risk

As indicated earlier, the LTC insurance market is characterized by the presence of basis risk. This is the case because the dependency risk is particularly difficult to assess. As theoretically (Doherty and Richter, 2002) and somehow empirically studied, it seems that there exists a trade-off between basis risk and prevention activities.

Turning to the LTC insurance sector, it would mean that the presence of basis risk should increase health investment and then lead to a reduction in the probability of dependency.

In this section, we show that such a conclusion is not necessarily valid. Besides, we wonder how the presence of basis risk impacts the demand for LTC.

In order to introduce basis risk in the model, we distinguish the amount on which the insurance company bases its reimbursement, *A*, from the amount paid effectively by the individual in case of dependency, *M*. The valuation function writes as:

$$L = [w_0 - s - x - \pi + L(H_2)] + f(p(x))[s - \pi - M + \alpha A + L(H_0 + T(M))]$$
$$+ (1 - f(p(x)))[s - \pi + L(H_2)]$$

with $\pi = \frac{1}{2}\alpha(1+\lambda)p(x)A$.

The presence of basis risk lies in the difference existing between *A* and *M*. Note that as *M* is chosen after *A*, *M* can be either larger or smaller that *A*. It means that the insured might be able to make profit on the LTC contract.

4.1. Health Investment and Basis Risk

We first consider the situation for which $A \leq M$. So as to analyze the effect of basis risk on health investment, we study the effect of an increase in *A* on *x*[5]. The lower *A* in comparison to *M*, the more there is basis risk.

The first order condition with respect to *x* is:

$$\frac{\partial L}{\partial x} = -1 - \alpha(1+\lambda)p_x^{'}A + p_x^{'} f'(p(x))[-M + \alpha A + L(H_0 + T(M)) - L(H_2)] = 0 \qquad (6)$$

By differentiating (6) with respect to *x* and *A*, we obtain:

$$\text{sgn}(\frac{dx}{dA}) = \text{sgn}(\frac{\partial^2 L}{\partial x \partial A}) = \text{sgn}(\alpha p_x^{'}(f'(p(x)) - (1+\lambda))) \qquad (7)$$

As stressed before, when $f'(p(x))-(1+\lambda)>0$,i.e. for a high probability level of dependency, insurance makes decrease health investment. In that case, from (7), the more there is basis risk, the more health investment is pursued.

Yet, when $f'(p(x))-(1+\lambda)<0$, i.e. mainly for a low probability level, basis risk leads to a decrease in preventive health care, contrarily to intuition. There exist a trade-off between basis risk and health investment on the LTC market.

Those results can be interpreted as follow: as the individual transforms probability, the perception of the occurrence of the illness is different depending on the level of the probability. As *f* is convex, for a high level of probability, the individual overestimates the variation of *p*, and health investment is perceived as strongly reducing the occurrence of the dependency. Conversely, for low value of *p*, health investment is not perceived to strongly reduce the occurrence of dependency.

Since insurance companies have great difficulties in anticipating future LTC costs, it might happen that $A \geq M$. In that case, the results are the opposite. Indeed, as *A* increases, basis risk does so as well as the profit the individual can make on the contract in case of dependency. At the extreme, the individual may whish to become dependent. From (7), for a high level of probability, the more there is basis risk, the less the individual will practice health investment. This is the case because health investment is perceived to strongly reduce the occurrence of dependency, and as the individual may favor dependency because he can make money on the contract, he will not necessarily avoid dependency. The opposite effect occurs for a low probability level.

4.2. Long Term Care and Basis Risk

The first order condition with respect to *M* is:

$$\frac{\partial L}{\partial M} = f(p(x))\left[-1+T_M^{'}L'(H_0+T(M))\right]=0 \qquad (8)$$

As equation (8) is independent of α , the optimal level of LTC is not a function of the degree of insurance coverage. Thus, in presence of basis risk, the individual has no more incentive to increase his consumption of LTC as he supports a larger part of the risk. In addition, as LTC are chosen ex-post, the perception of the occurrence of the risk has no impact on the LTC decision.

5. Conclusion

Based upon our model, it turns out that, contrary to intuition, the presence of basis risk does not necessarily lead to an increase in health investment relative to a situation where no basis risk is present. For a low probability of dependency, such contracts lead to decreased health investment. This result can be explained by the properties of the transformation function of probabilities.

Thus the presence of basis risk on the LTC insurance market may not be beneficial in terms of public health in the sense that it does not necessarily provide good incentives to increase health investment.

These results are to be linked with the literature stemming from Ehrlich and Becker's article [1972] on the relationship between self-protection and insurance. Indeed, basis risk, as defined in our model, is close to under- or over-insurance, and changing its level leads to a variation in the coverage level.

The main limit of our model is not considering the interdependence between wealth and health, i.e. we admit that satisfaction to consume wealth does not depend on the individual health stock. It could be the topic of future research.

Notes

1. We are here referring to what is commonly called primary prevention (or self-protection activity following Ehrlich and Becker [1972]'s terminology).

2. The premium is paid in both periods while the indemnity is only received in second period. In order to satisfy the budgetary constraint, the premium is divided by two.

3. We will not enter into details regarding the concepts of weak and strong risk aversion. For more details, please refer to Chateauneuf and Cohen [1994]

4. As stressed by Konrad and Skaperdas [1993], from the convexity of the transformation function, for a dependency that occurs with a high probability $f'(.) > 1$. If the dependency occurs with a low probability, then $f'(.) < 1$.

5. Another method is to compare the level of *x* when no basis risk to the one when basis risk. It leads to the same results.

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