



Received: 21 November 2013
Accepted: 21 April 2014
Published: 08 July 2014

*Corresponding author: Tetsuji Yamada,
Department of Economics, and Center
for Children and Childhood Studies,
Rutgers University, The State University
of New Jersey, Camden, NJ 08102, USA
E-mail: tyamada@crab.rutgers.edu

Reviewing Editor:
Steve Cook, Swansea University

Further author, article and funding
information is available at the end of
the article

RESEARCH ARTICLE

Determinants of health insurance and hospitalization

Tadashi Yamada¹, Tetsuji Yamada^{2*}, Chia-Ching Chen³ and Weihong Zeng⁴

Abstract: Our paper empirically examines how the decision to purchase private insurance and hospitalization are made based on household income, socio-demographic factors, and private health insurance factors in both Japan and the USA. Using these two data-sets, we found some similarities and dissimilarities between Japan and the United States. As income of households rises, households have a positive effect on purchasing health insurance as a normal good. Another similarity between the two countries is seen in the income effect on risk of hospitalization, which is negative for both Japanese and US cases. For dissimilarity, the insurance premium effect on risk of hospitalization is positive for the Japanese case, while negative for the US case. Since the Japanese insurance data had variables such as payments per day of hospitalization if household gets hospitalized, insurance payments upon death of an insured person, and annuity payments at maturity, we tested to see if these characteristics affect the risk of hospitalization for households; we do not eliminate a possibility of adverse selection. For the US pure health insurance characteristics, an increase in premium of health insurance policies cause individuals to substitute more health capital investment which causes lower risk of hospitalization.

Keywords: I—health, education, and welfare, H—public economics, I1—health, I0—general, A—general economics and teaching

RESEARCH GROUP OVERVIEW

The four scholarly authors specialize in research subjects relevant to health behaviors and health economics. In this study, the authors examined how health behaviors, i.e. utilization of hospital services, are related to an increase in health insurance premiums and associated with the purchasing “hole” of health insurance. The incentive behaviors of purchasing health insurance are based on the status of an individual’s health and illness. Furthermore, the adverse selection connected to health insurance arises when information gap of health status exists between consumers and insurers. Thus, a disproportional number of high-risk consumers use more healthcare services, leading to higher premiums. This effect creates an incentive to low-risk consumers to drop out or to look for another health insurance policy. The focus of this study does not reject the possibility of adverse selection in the US and Japan. However, the study relates to the recent Obama Healthcare Act of health insurance registration and individual behaviors influence on purchasing health insurance and health insurance companies’ management decision.

PUBLIC INTEREST STATEMENT

The rapid increase in health insurance premiums and healthcare costs will raise the financial burden on consumers, namely health of population and government budgets. For example, the financial burden on consumers is associated with the steady hike in income taxes. Purchasing health insurance affects individuals’ behavior in three ways: [1] an increase in access to healthcare services and an improvement of health; [2] an insurance coverage of giving incentives to maintain healthy behavior and healthy lifestyle; and [3] an encouragement of preventive care. These factors will raise individuals’ health status and overall health capital; thus, expanding life expectancy, and increasing economic activity. Increasing private health insurance premiums result in a risk of hospitalization in Japan’s national health insurance, since private health insurance policies have unique features such as payment of per day hospitalization, annuity payment of maturity, etc. However in the US, an increase in healthcare premiums cause individuals to substitute more health capital investment to improve health and lower the risk of hospitalization.

1. Introduction

Uncertainty in earnings results from the uncertainty in the health of the individual since the length of the working period in an individual's lifetime is determined primarily by his/her health stock (Grossman, 2007). As such, the healthier an individual is, the higher his/her labor earnings are. If this is true, individuals may invest more of their health stock because they expect a longer working period (i.e. prolonged economic activity). It follows that individuals with poor health may have more incentives to buy health insurance in order to improve productivity relative to those in good health with a given income. Thus, the former may be more willing than the latter to purchase insurance policies for their family members to avoid a sudden loss in labor earnings, *ceteris paribus*. Therefore, uncertainty in the state of health does affect the individual's purchase decision on insurance policies as well as the decision on the rate of saving.

Previous research shows individuals purchase more health insurance and preventive medicine when they are uncertain of their state of health (Doiron, Jones, & Savage, 2008; Nordquist & Wu, 1976). Sometimes, insurance works oppositely. Liljas (1998) shows that social insurance against income loss makes individuals tend to have a smaller optimal health stock under uncertainty. Furthermore, preventive medical care lowers the probability of health loss (Heiss, McFadden, & Winter, 2009). Similarly, high uncertainty surrounding the incidence of illness increases the demand for medical care (Dardanoni & Wagstaff, 1987; Picone, Uribe, & Wilson, 1998; Rice, Lavarreda, Ponce, & Brown, 2005). If health investments are made at an early stage of an individual's life, medical expenditures may even be lower as he/she gets older (Cropper, 1997; Yamada, Chen, Yamada, Fahs, & Fukawa, 2006).

Wealth, or accumulated savings, also plays an important role in reducing uncertainty in the state of health of individuals. Individuals with higher endowments of financial capital invest more in their health than those with lower endowments (Dardanoni & Wagstaff, 1987; Poletti et al., 2007). In contrast to the multiplicative shocks in Dardanoni and Wagstaff (1987), if the utility function exhibits decreasing absolute risk aversion, additive shocks surrounding the health capital function give a negative income elasticity of health investment (Selden, 1993). Longevity, reflecting an improvement in the state of health, is influenced more by wealth rather than by current income with respect to decisions on saving, on insurance purchase, and on health investment (Ehrlich, 2000; Ehrlich & Chuma, 1990). In addition to savings and life insurance, an individual may choose to purchase an annuity in anticipation of the retirement period and self-employed status (Ehrlich, 2000; Heim & Lurie, 2009). In a choice between health investment and saving, individuals invest more of their income on health rather than saving if marginal returns to health are higher than the returns to saving (Chang, 1996). Furthermore, this health investment behavior is neither independent of the decision to purchase health and life insurance policies and medical services nor the individual's attitude toward risk (Doiron et al., 2008; Heiss et al., 2009; Kessler, 2008).

Health uncertainty has been treated more theoretically than empirically in the literature. For instance, the number of theoretical papers on the uncertainty in the stock of health capital dominates empirical studies. In particular, we find few empirical studies that explicitly deal with the decisions on health investment and life insurance policies under an uncertain state of health related to the wealth of the household. In this experimental study, we aim to provide empirical results on the issue of how the decision on health investment relates to purchasing health insurance policies in the household while incorporating the wealth of the household. The next section briefly reviews the data-set from the *National Survey on Life Insurance* used for this empirical study. In Section 3, we present our analytical framework of household/consumption behavior in the context of a Von Neumann–Morgenstern utility function and selected issues in comparative static analysis. Section 4 gives the empirical results of the bivariate model of health and life insurance equations. The summary and conclusion of this study are reported in Section 5.

2. Discussion of the Data-Set and Background

The data-set used in this study comes from the survey in the *National Survey on Life Insurance: Fiscal Year 2000* (Seimei Hoken ni kan sum Zenkoku Jittai Chosa: Heisei 12 Nen-do, in Japanese; hereafter *NSLI*). The survey was based on 6,500 households throughout Japan and conducted by the non-profit

organization Life Insurance Culture Center from May to June 2000. About 4,657 households responded and provided answers to the survey. Life insurance policies in Japan have a variety of attractive features for consumers other than the benefits claimed if an insured person dies. One of the attractive features is the monetary supplement paid out on a per-day basis if the insured becomes hospitalized. As mentioned earlier, since individuals with insurance for health or against loss of income tend to have individual stock of health lower at optimum than those without them, households with more life insurance policies may alter their incentives in health investment. Since Japan has a comprehensive health insurance system directly administrated by the Japanese government, various health insurance policies in Japan are run by different private organizations (Yamada & Yamada, 2003).

In this survey data-set, 73.1% of the 4,657 household heads have private insurance (hereafter insurance) policies; 51.1% of spouses also have insurance policies. There are basically three types of organization selling insurance policies in Japan: private firms, public postal offices, and Japanese Agriculture Cooperation (JA). Of the 4,657 households, 87.9% of household heads have insurance policies from at least one of these three institutions. The mean number of insurance policies held by the households with insurance policies is 3.1 policies, while the means for the household head and spouse are 1.6 policies and 1.3 policies, respectively. The mean payment at the time of maturity for household heads who have insurance policies is 67,900 dollars (6.79 million yen: 1 dollar=100 yen) and the mean insurance claim upon the household head's death is 256,100 dollars (25.61 million yen). The exchange rate was about 100 Japanese yen per US dollar in early 2009. Here, we use 100 yen per dollar for brevity since the exchange rate changes daily; the numerical simplicity of \$1=100 yen makes it easier to translate from dollar to yen and vice versa. On the other hand, the payments for household spouses are 42,200 dollars for maturity and 107,900 dollars for death claims. These statistics show households hedge more heavily against the sudden loss of earnings of household heads rather than spouses. An interesting statistic from this survey is that 29.6% of the households that have private life insurance policy claims for hospitalization and/or medical operations benefitted after they had bought private life insurance policies.

The average number of private life insurance policies per household in different household wealth categories are: wealth category 1: less than \$10 thousand (683 households); wealth category 2, \$10–50 thousand (1301 households); wealth category 3, \$50–100 thousand (862 households); wealth category 4, \$1–2 million (641 households); wealth category 5, \$.20–.3 million (335 households); and wealth category 6, \$.3 million and over (400 households). We grouped households in each household wealth category into two groups: the “hospitalized” and the “not hospitalized” households. Hospitalized households represent the households which have received payments from private insurance companies because family members of the households were hospitalized and/or had medical operations. Not-hospitalized households represent all the other households other than the hospitalized households. The average number of insurance policies per household is 1.81 policies in wealth category (less than \$10 thousand). As the wealth category increases, the average number of private life insurance policies increases. Households in the highest wealth category \$.3 million and over have 3.13 policies, showing that wealthier households hold more private insurance policies. In contrast, the average number of insurance policies held by hospitalized households is larger than those of not-hospitalized households across different wealth categories, although not-hospitalized households follow the tendency of increasing number of policies as wealth increases. For example, the averages for hospitalized and not-hospitalized households in the wealth category less than \$10 thousand are 2.07 and 1.73 policies, for wealth category \$.1–.2 million are 3.13 and 2.41 policies, and 3.51 and 2.91 policies for wealth category \$.3 million and over, respectively.

Average insurance premiums per year paid out by households are slightly larger among the hospitalized households than the not-hospitalized households across all wealth categories. The difference in the average premiums between the two groups is about .3 (=1.27–.97, or \$300 per year) for wealth category 1. The differences narrow to .01 for wealth category 5 (\$200,000 ~ under \$300,000) and .14 for wealth category 6.

We illustrate how these two groups differ in the payments received from the private insurance companies for each day of the hospital stay should the household head become sick, injured, and/or

hospitalized. The per-day average payment ranges from \$52.6 for hospitalized households in wealth category 1 to \$75.6 for wealth category 6. In contrast, the per-day average payment range for not-hospitalized households is \$44.9 for wealth category 1 to \$60.5 for wealth category 6. The largest difference between the two groups is \$17.1, in wealth category 2 (\$10,000 ~ under \$50,000). The average difference in the average payment is \$23.0 from wealth categories 1–6 for the hospitalized household group, and \$15.6 from wealth categories 1–6 for the not-hospitalized household group. These statistics illustrate that hospitalized households bought insurance policies with higher payments for hospital stays when they purchased insurance policies than the not-hospitalized households. For both household groups however, wealthier households expect higher payments if their family members get hospitalized than less wealthy households.

From this, we observe three patterns. First, wealthier households have more insurance policies than less wealthy ones. Second, wealthier households pay higher insurance premiums than less wealthy ones, probably indicating that the former choose better insurance policies than less wealthy ones. Third, households in which the head-of-household was hospitalized bought insurance policies that paid more than policies held by households with no family member hospitalizations.

Based on the preceding patterns, we might say that households whose family members face higher risks in becoming sick in the future buy more and better insurance policies than those households who expect lesser risks of sickness. This is partially a typical phenomenon of adverse selection due to asymmetric information between insurance holders and providers. Alternatively, households who had bought more and better insurance policies faced higher risk of sickness among their family members due to a lack of incentive to maintain good health than those who had bought fewer insurance policies with fewer benefits. This second explanation reflects the moral hazard problem to some extent (Cutler & Zeckhauser, 2000). In this study, due to limitations in the available data, we were unable to identify which proportion of hospitalized insurance holders received monetary payments from insurance companies due to moral hazard or adverse selection. Thus, in order to avoid omitted variable biases, we included a variable on the probability of becoming sick as an explanatory variable in our empirical regressions. However, it is highly possible to theorize and estimate these aspects of individual behavior if provided with adequate data-sets to test the hypothesis.

3. Analytical Framework

3.1. Theoretical Model

This section presents the analytical framework used to analyze the household decision on health investment and the decision to purchase private insurance policies. We assume that a representative household i faces a higher risk of sickness if the household has a smaller health stock; the household maximizes its expected utility by allocating labor earnings among health investment, life insurance policies, and other consumption. We show how the households differ in their behavior against uncertainty in life in terms of their decision on life insurance policies differentiated by levels of wealth. Gärdenfors and Sahlin (1988) differentiate “risk” from “uncertainty” since these words reflect different degrees of partial information on the probability distribution of an event in question. We use the word “risk” pertaining to sickness, while the word “uncertainty” is generally used throughout the study so that the words are used less strictly than the ways defined by Gärdenfors and Sahlin (1988).

The representative household i accumulates labor earnings in period 1 and appropriates a fixed proportion of these earnings to period 2. As previously mentioned, it is more insightful if the rate of saving is endogenous in the household decisions. The lack of data on saving precludes this in the current empirical study: the model assumes saving to be exogenously given. Notwithstanding the lack of data, an endogenous decision on saving makes the formulation highly intractable, at least at the theoretical level.

In the first period, the household faces a probability of loss in labor earnings when it faces health uncertainty because illness or hospitalization causes a loss in earnings. However, since illness and/or

hospitalization interfere with earnings, the household receives payment for medical expenditures from the insurance policies its holds. Therefore, the net loss for the household due to sickness and/or hospitalization is not the entire amount of forgone labor earnings minus the insurance payment received for hospitalization.

In period 2, income comes only from the savings made in period 1 plus the applicable interest. The household faces two uncertain outcomes at the end of the first period: either the household head may have died at the end of period 1 or not. The probability of the household head's dying is subject to the amount of health investment made in period 1. Should he die at the end of period 1, death claim benefits from insurance policies accrue to the remaining family members in the household. These family members are, however, not explicitly specified in our model. Should the household head continue to live in period 2, the entire household would receive annuities as the insurance policies mature. Now, let us provide a formal presentation of our model. We extend the model of Sheshinski and Weiss (1981), which examines the annuity aspect of social security to an issue in health economics of life insurance and moral hazard.

3.1.1. First-period Consumption

In our theoretical model, a household is a single economic entity, although a household consists of more than one family member. Furthermore, a household is assumed to be synonymous with the household head. This assumption is made for at least three reasons. First, households normally buy insurance policies for the working household head to avoid an interruption in labor earnings. Second, we can easily extend our basic model to other members in the household. Third, this assumption makes our model much simpler than a case of all household members facing different risks in the state of sickness; the latter provides very little marginal insight in the model in exchange for its complexity. A representative household i has the following consumption equation:

$$c_1^i = F_H(H^i)(1-s)y + (1 - F_H(H^i)) \alpha P_I - P_I I_i - P_h h^i \quad (1)$$

where $F_H(H)$ is a probability distribution function of the random variable H^i , i.e. health stock of the household, and $1 - F_H(H)$ is the probability of the household to become sick and hospitalized. Health stock of the household is specified as $H^i = (1 - \delta)H_0^i + h^i + \varepsilon^i$, where H is initial stock of health of household i , $H \sim N(\mu_H, \sigma_H^2)$; δ is the depreciation rate of stock of health, and ε^i is a stochastic error term with $\varepsilon^i \sim N(0, \sigma_H^2)$.

The probability distribution function of the random variable stock of health H is then defined as $F_H(H^i) = \int_{-\infty}^{H^i} f_H(t) dt$, which represents a proportion of healthy time of the household when the household works in the labor market in period 1, and $f_H(H^i)$ is a normal probability density function of the health stock of the household. The household has a standardized random variable of $Z_H = \frac{H^i - \mu_H}{\sigma_H}$.

Other factors in Equation 1 are defined to be as: y is labor earnings of household i in period 1; s is a proportion of labor earnings to be saved in period 1 and $0 < s < 1$. We assume no saving is made if the household is hospitalized. Horioka (2002) makes an excellent discussion on various aspects of the individual's behavior toward saving, annuity, and welfare of other family members. α is a proportion of life insurance coverage for hospitalization costs of the household i , $0 < \alpha < 1$; P_I is the insurance premium per unit of insurance policy; I^i is the number if insurance policies bought by household i in period 1; P_h is the unit price of health investment; and h^i is the quantity of health investment made by household i in period 1.

3.1.2. Second-period consumption

If household i survives to period 2, the household enjoys consumption c_2 . The household's budget would consist of savings from period 1 plus interest and annuity payments A^i accruing at the maturity of insurance policies. The annuity payment is a proportion of total insurance expenditures $A^i = \lambda P_I I^i$, $0 \leq \lambda < 1$. Insurance policies recently have an annuity characteristic at maturity. If $\lambda = 0$, the insurance policy does not have an annuity payment. Also, λ should not exceed 1 since the insurance policy provides service as security to the household and the insurance companies pay benefit claims if the household dies.

The consumption in period 2 may be specified as follows:

$$c_2^i = F_H(H^i)Rsy + A^i = F_H(H^i)Rsy + \lambda P_I I^i \quad (2)$$

where $R=(1+r)$, in which r is an interest rate, $0 < r < 1$. For simplicity, we assume that the head of household i retires from the labor market in period 1.

On the other hand, if household i dies at the end of period 1, the other family members $j, j \neq i$, have consumption c_2^j in period 2. The budget consists of savings with interest after inheritance tax and insurance payments due to death of household i .

$$c_2^j = F_H(H^i)Rsy + B^i = (1-t)\{F_H(H^i)Rsy + \Psi P_I I^i\} \quad (3)$$

where B^i is insurance payments from insurance companies when the household dies at the end of period 1 and is a proportion of total insurance expenditures $\Psi P_I I^i$ in period 1, $\Psi > 1$. Of Ψ , if it is equal to $\frac{1}{1-F_\Theta(H^i)} > 1$, where $1-F_\Theta(H^i)$ is the probability of the household's death at the end of period 1, the life insurance policy is actually fair: $P_I I^i = [1-F_\Theta(H^i)] B^i$. If there are running costs for insurance policies, we can extend the equation by setting $B^i = \Psi P_I I^i - \eta$, where η is running costs. So, it will be reasonable to assume: $1 < \Psi \leq \frac{1}{1-F_\Theta(H^i)}$. And, t in Equation 3 is an inheritance tax rate, which is levied on the wealth, i.e. $F_H Rsy$. Inheritance tax is levied not only on inherited wealth but also on insurance payments accruing from death claim benefits of an insured person in a household. Tax exemption in the case of inherited wealth is for the first \$500,000 plus \$100,000 multiplied by the number of legal heirs, beyond which the inheritance tax scheme is applied. Tax exemption insurance death claims is for \$50,000 multiplied by the number of legal heirs, beyond which the rest of insurance claims will be included into the inherited wealth, on which inheritance tax is levied.

The additively separable expected utility function of household i over two periods such as $t=1$ and $t=2$, is given as:

$$EV^i = u(c_1^i) + F_\Theta(H^i)\rho u(c_2^i) + [1-F_\Theta(H^i)]\tau v(c_2^j) \quad (4)$$

where τ is the discount factor of other family members j 's utility, $v(c_2^j)$, $v(c_2^i)$ is expressed as state-dependent, and $F_\Theta(H^i)$ is the probability of household i not dying at the end of period 1. In Equation 4, we assume $\rho u(c_2^i) > \tau v(c_2^j)$ for $(c_2^i) = (c_2^j) > 0$, and also $u_1^i \equiv \frac{\partial u}{\partial c_1^i} > 0$, $u_1^{ii} \equiv \frac{\partial^2 u}{\partial c_1^{i2}} < 0$, $u_2^i \equiv \frac{\partial u}{\partial c_2^i} > 0$, $u_2^{ii} \equiv \frac{\partial^2 u}{\partial c_2^{i2}} < 0$, $v_2^j \equiv \frac{\partial v}{\partial c_2^j} > 0$, $v_2^{jj} \equiv \frac{\partial^2 v}{\partial c_2^{j2}} < 0$, and $\rho u_2^i > \tau v_2^j$ for $(c_2^i) = (c_2^j) > 0$.

Concerning the survival probability of household i , $F_\Theta(H^i)$, at the end of period 1, we define a random variable of life uncertainty Θ , whose probability distribution function is $F_\Theta(\Theta^1) = \int_{-\infty}^{\Theta^1} f_\Theta(t) dt$ and where $f_\Theta(\Theta^1)$ is a normal density function of health stock H^i such as $\Theta^i = \beta_0 + \beta_1 H^i$, the density function of life uncertainty can be specified as $F_\Theta(\Theta^1) = f_\Theta(\beta_0 + \beta_1 H^i)$. In order to avoid computational clumsiness, however, we assume $\beta_0 = 0$ and $\beta_1 = 1$. Thus, we have $F_\Theta(\Theta^1) = f_\Theta(H^i) \equiv f_\Theta$ and $\Theta \sim N(\mu_\Theta, \sigma_\Theta^2) = N(\mu_H, \sigma_H^2)$. These strong assumptions on the survival probability of household i result in $f_\Theta(\Theta^1) = f_\Theta(H^i) = f_H(H^i)$, i.e. $f_\Theta = f_H$, and also $F_\Theta(\Theta^1) = F_\Theta(H^i) = F_H(H^i)$, i.e. $F_\Theta = F_H$. Equation 5 may be expressed in terms of $F_H(H^i)$ rather than $F_\Theta(H^i)$ as:

$$EV^i = u(c_1^i) + F_H(H^i)\rho u(c_2^i) + [1-F_\Theta(H^i)]\tau v(c_2^j) \quad (5)$$

After substituting Equations 1, 2, and 3 into Equation 5, household i maximizes the lifetime expected utility function, EV^i , with respect to insurance policies I^i and health investment h^i in period 1. We assume there is an optimum of EV^* with I^{i*} and h^{i*} and that the optimum values of I^{i*} and h^{i*} must satisfy the following Kuhn and Tucker conditions (Zweifel & Breyer, 1997, pp. 156–200):

$$\begin{cases} \frac{\partial EV^i}{\partial I^i} \leq 0, & \text{if } B^{i*} = 0 \\ \frac{\partial EV^i}{\partial I^i} = -P_{1I^i} u_1^i + F_H(H^i) \lambda P_1 \rho u_2^i + [1 - F_H(H^i)] \Psi P_1 \tau v_2^i = 0 \\ \text{Or} = -P_{1I^i} u_1^i + F_H(H^i) A^i \rho u_2^i + [1 - F_H(H^i)] B^i \tau v_2^i = 0 & \text{if } 0 < B^{i*} < L^i \\ \frac{\partial EV^i}{\partial I^i} \geq 0, & \text{if } B^{i*} = L^i \end{cases} \quad (6)$$

where L^i represents the loss in household i when the household dies.

$$\begin{cases} \frac{\partial EV^i}{\partial h^i} \leq 0, & \text{if } h^{i*} = 0, \\ \frac{\partial EV^i}{\partial h^i} = \left\{ f_H^i [(1-s)y - \alpha P_1] - P_h \right\} u_1^i + f_H^i \left(\rho u \left(c_2^i \right) - \tau v \left(c_2^i \right) \right) \\ + f_H^i Rsy \left[F_H(H^i) \rho u_2^i + (1 - F_H(H^i)) \tau v_2^i \right] = 0, \\ \text{if } h^{i*} > 0 \end{cases} \quad (7)$$

where $f_H^i \equiv \frac{\partial F_H(H^i)}{\partial H^i} > 0$, $f_\Theta^i \equiv \frac{\partial F_\Theta(H^i)}{\partial H^i} = \frac{\partial F_H(H^i)}{\partial H^i} \equiv f_H^i > 0$, $\frac{\partial H^i}{\partial h^i} = 1$, $F_H(H^i) = F_\Theta(H^i)$ and $\left\{ f_H^i [(1-s)y - \alpha P_1] - P_h \right\} < 0$.

In the equilibrium condition of Equation 6, a one-unit increase in insurance policy reduces household consumption in period 1, resulting in lower total utility in period 1 by an amount $P_1 u_1^i$. However, the loss in total utility in period 1 is compensated by gains in utility through increases in consumption c_2^i (due to an increase in A^i) and c_2^j (due to an increase in B^i) in period 2. In short, marginal utility in period 1 is a weighted average of discounted marginal utilities of the two states in period 2, in which the weights are the probabilities of being healthy and of being hospitalized. That is, u_1^i is a convex set of $\lambda \rho u_2^i$ and $\Psi \tau v_2^i$.

As for the equilibrium condition of Equation 7, an increase in health investment results in an increase in the length of working time, i.e. f_H^i , while the net gain (actually, negative gains by including the costs of health investment) in monetary term is $\left\{ f_H^i [(1-s)y - \alpha P_1] - P_h \right\} < 0$ in period 1. However, the negative gains are compensated by an increase in the survival probability f_Θ^i , which is equal to f_H^i and increases in c_2^i and c_2^j due to an improvement in healthy time by an amount f_H^i .

Now, let us derive the second-order conditions:

$$\begin{aligned} \frac{\partial^2 EV^i}{\partial I^2} &= P_1^2 u_1^{ii} + F_H(\lambda P_1)^2 \rho u_2^{ii} + (1 - F_H)(\Psi P_1)^2 \tau v_2^{ii} < 0, \\ \frac{\partial^2 EV^i}{\partial h^2} &= \left\{ f_H^i [(1-s)y - \alpha P_1] - P_h \right\}^2 u_1^{ii} + f_H^i \left(-\frac{Z_H}{\sigma_H} \right) [(1-s)y - \alpha P_1] u_1^i \end{aligned} \quad (8)$$

$$\begin{aligned} &f_H^i \left(-\frac{Z_H}{\sigma_H} \right) \left(\rho u \left(c_2^i \right) - \tau v \left(c_2^i \right) \right) + 2 \left(f_H^i \right)^2 Rsy \left(\rho u_2^i - \tau v_2^i \right) \\ &+ f_H^i \left(-\frac{Z_H}{\sigma_H} \right) Rsy \left[F_H \rho u_2^i + (1 - F_H) \tau v_2^i \right] + \left(f_H^i Rsy \right)^2 \left[F_H \rho u_2^{ii} + (1 - F_H) \tau v_2^{ii} \right] \end{aligned} \quad (9)$$

$$\begin{aligned} \frac{\partial^2 EV^i}{\partial h^i \partial I^i} &= -[f_H^i (1-s)y - \alpha P_1 - P_h] P_1 u_1^{ii} + f_H^i \left(\lambda P_1 \rho u_2^i - \Psi P_1 \tau v_2^i \right) \\ &+ f_H^i Rsy \left(F_H \lambda P_1 \rho u_2^{ii} + (1 - F_H) \Psi P_1 \tau v_2^{ii} \right) \end{aligned} \quad (10)$$

In Equation 9, only $2 \left(f_H^i \right)^2 Rsy \rho u_2^i$ is positive whereas all other terms are negative. Since $\frac{\partial^2 EV^i}{\partial h^2} < 0$ is necessary to satisfy the second-order condition, the positive term is assumed to be out-weighted by other negative terms. The sign of Equation 10 is again not obvious, since $\lambda \rho u_2^i > 0$. However, we assume $\Psi \cong \frac{1}{1 - F_\Theta(H^i)} = \frac{1}{1 - F_H(H^i)} > 1$ is large enough to have $\Psi \tau v_2^i < \lambda \rho u_2^i$, and $0 \leq \lambda < 1$. We assume the determinant of Hessian to be a negative definite:

$$|H| \equiv \begin{vmatrix} \frac{\partial^2 EV^i}{\partial I^2} & \frac{\partial^2 EV^i}{\partial I \partial h^i} \\ \frac{\partial^2 EV^i}{\partial I \partial h^i} & \frac{\partial^2 EV^i}{\partial h^2} \end{vmatrix} = D > 0 \quad (11)$$

3.2. Effects of the parameters on health capital investment

In this section, we present the comparative static analyses to show how household i responds to changes in the parameters in the model. However, comparative static analyses are highly intractable unless we make further restrictions on second-order conditions and parameters. First, we assume that household i has its stock of health equal to or greater than the mean of the distribution, i.e. $H^i \geq \mu_H$, which implies $\frac{Z_H}{\sigma_H} \geq 0$. Second, by following the law of demand, we then restrict $|\frac{\partial^2 EV^i}{\partial^2 h^2}| > |\frac{\partial^2 EV^i}{\partial h^i \partial I^i}|$ based on the comparative static analysis of the effect of P_I on I^i , while its effect on h^i is uncertain. The restriction will also allow a positive income elasticity of the demand for insurance policies, whereas a positive income elasticity of the demand for health capital investment is obtained without it. In subsequent presentations, we mainly focus on the effects of parameters of our interest on health capital investment since the effects on insurance policies are mostly symmetric.

3.2.1. Coverage for Hospitalization Costs: α

First, let us see how an increase in coverage α of hospitalization costs affects the household behavior of health investment. Our comparative analysis shows the effect of the coverage on health capital investment is negative:

$$\frac{\partial h^i}{\partial \alpha} = \left(\frac{1}{D} \right) \left| \frac{\partial^2 EV^i}{\partial I^2} - \frac{\partial^2 EV^i}{\partial I \partial h^i} \frac{\partial I^i}{\partial \alpha} \right| < 0, \quad \left| \frac{\partial^2 EV^i}{\partial I \partial h^i} - \frac{\partial^2 EV^i}{\partial h^2} \frac{\partial I^i}{\partial \alpha} \right| \quad (12)$$

where $\frac{\partial^2 EV^i}{\partial I \partial h^i} = -(1 - F_H)P_I \{ f_H^i [(1-s)y - \alpha P_I] - P_h \} u_1^{ii} < 0$ if $-\frac{f_{Hy}^i}{(1-F_H)\{f_H^i[(1-s)y - \alpha P_I] - P_h\}} > -\frac{y u_1^{ii}}{u_1^i} \equiv R_A$, which is called absolute risk aversion (Sydsaeter, Strøm, & Berck, 2005).

A higher coverage (or compensation) of hospital costs from insurance companies will make life insurance policies more attractive and give less incentives for health investment, so that the demand for insurance policies rises but the demand for health capital investment decreases. In other words, if household i buys insurance policies that provide more generous compensation against a loss of income due to hospitalization, the insured household will have less incentive to keep oneself healthy. Then, the negative effect of coverage of hospital costs on health capital investment may look like a moral hazard phenomenon, but the effect in our model is typical of rational behavior exhibited by the insured household.

On the other hand, if we explicitly treat moral hazard in our model by re-formulating $F_H(H^i)$ as $F_H(H^i, \alpha)$, of which we assume $\frac{\partial F_H(H^i, \alpha)}{\partial \alpha} = -f_H^\alpha$, and $\frac{\partial f_H^\alpha}{\partial \alpha} = f_H^{i\alpha} \left(\frac{Z_H}{\sigma_H} \right) = 0$ at $H^i = \mu_H$, this comparative static analysis also shows the same negative effect of α on h^i , i.e. $\frac{\partial^2 EV^i}{\partial I \partial h^i} > 0$ and $\frac{\partial^2 EV^i}{\partial h^2} < 0$, given $F_H(H^i, \alpha)$.

Therefore, strictly speaking, we consider it unidentifiable to observe a moral-hazard-free effect of coverage of hospital costs α on health capital investment based on an estimated coefficient of the variable on coverage of hospitalization costs α in our empirical specification.

3.2.2. Annuity and Insurance Payments

Now, we examine the effect of an increase in annuity payment, i.e. $A^i = \lambda P_I I^i$, on health capital investment. The effect is positive in h^i , whereas negative on I^i , if $\frac{y}{A^i} < R_A < \frac{1}{F_H R_S}$, where $R_A = -\frac{y u_1^i}{u_1^i}$. A higher annuity payment for the household's retirement will induce the insured household to increase health capital investment and enjoy the annuity. This is reasonable, since the individual invests more in health capital so that the individual faces a lower risk of illness, i.e. a longer working period and less uncertainty of dying at the end of the first period, and is consequently able to receive the annuity. If insurance

policies have better annuity characteristics than death claim benefits, the household would consider health capital investment substitutable for insurance policies and might save more in expectation of a longer retirement period. As far as effects of saving are concerned, we have $\frac{\partial \frac{\partial EV^i}{\partial s}}{\partial s} > 0$ and $\frac{\partial \frac{\partial EV^i}{\partial h^i}}{\partial s} < 0$. Saving (or wealth accumulation) seems to lower health capital investment. However, the comparative static analysis of the negative effect of s on h^i is not definitive so we must wait for the empirical result.

While the annuity characteristic of an insurance policy is preferable as a means of saving for households, the incentives for households to buy more insurance policies will not be too large. There are a couple of reasons why this may be so. First, as mentioned earlier, since the tax exemption for insurance payment upon death of an insured person is only up to \$50,000 multiplied by the number of legal heirs, this amount is significantly much smaller than the tax exemptions for inherited wealth for the first \$500,000 plus \$100,000 multiplied by the number of legal heirs. Therefore, sooner or later, households may seek other means of saving other than having a large number of insurance policies. Second, if households buy insurance for the purpose of receiving an annuity, the interest rate used for the calculation of annuity payments at maturity will be much smaller than those on other types of saving since insurance policy provides psychic services (i.e. relief) to insured households and other household members against sudden death of the insured individual.

Concerning the effect of insurance payments B^i on health capital investment, the comparative static analyses give $\frac{\partial h^i}{\partial B^i} < 0$ and $\frac{\partial I^i}{\partial B^i} > 0$ with $\frac{Y}{B^i} < -\frac{Yv_2^j}{v_2^j}$. These results imply that better insurance payments will give fewer incentives for the household to make health capital investments, while giving more incentives to purchase insurance policies. The absolute risk aversion of other household members is larger than the ratio of labor earnings of household i to insurance payments, whose value seems to be less than one. Putting it differently, as insurance payments increase with insurance premiums unchanged, more households are willing to buy insurance policies.

3.2.3. Depreciation Rate of Stock of Health and Initial Stock of Health

Let us denote $H^* = (1 - \delta)H_0^i$, where H_0^i and δ are initial stock of health of household i and depreciation as defined earlier. Our results are:

$$\left\{ \begin{array}{l} \frac{\partial \left(\frac{\partial EV^i}{\partial I^i} \right)}{\partial H^{i*}} = -f_H^i [(1-s)y - \alpha P_1] P_1 I^i u_1^{ii} + f_H^i (A^i \rho u_2^i - B^i \tau v_2^j) \\ \quad + f_H^i Rsy \left\{ F_H(H^i) A^i \rho u_2^{ii} + [1 - F_H(H^i)] B^i \tau v_2^{jj} \right\} < 0, \\ \text{and} \\ \frac{\partial \left(\frac{\partial EV^i}{\partial H^{i*}} \right)}{\partial H^{i*}} = -f_H^i \left(-\frac{z_H}{\sigma_H} \right) [(1-s)y - \alpha P_1] u_1^i + f_H^i [(1-s)y - \alpha P_1] - P_h u_1^{ii} \\ \quad + f_H^i \left(-\frac{z_H}{\sigma_H} \right) [\rho u(c_2^j) - \tau v(c_2^j)] + 2 \left(f_H^i \right)^2 Rsy (\rho u_2^i - \tau v_2^j) \\ \quad + f_H^i \left(-\frac{z_H}{\sigma_H} \right) Rsy [F_H(H^i) \rho u_2^{ii} + (1 - F_H(H^i)) \tau v_2^{jj}] \\ \quad + \left(f_H^i Rsy \right)^2 \left[F_H(H^i) \rho u_2^{ii} + (1 - F_H(H^i)) \tau v_2^{jj} \right] > 0. \end{array} \right. \quad (13)$$

In the preceding equation $\frac{\partial \left(\frac{\partial EV^i}{\partial H^{i*}} \right)}{\partial H^{i*}} > 0$, we assume $|f_H^i [(1-s)y - \alpha P_1] - P_h| > |f_H^i Rsy|$ from Equation 7 and $|(1-s)y - \alpha P_1| > |f_H^i Rsy|$. For brevity, the result is evaluated at $H^i \geq \mu_H$. The resulting comparative static analyses give $\frac{\partial h^i}{\partial H^{i*}} > 0$ and $\frac{\partial I^i}{\partial H^{i*}} < 0$. These results indicate that, for example, as household i gets older depreciation rate on health capital stock, δ increases and the household has less health capital stock and the demand for life insurance policies increases, since $\frac{\partial H^i}{\partial \delta} = \frac{\partial H^i}{\partial h^i} \frac{\partial h^i}{\partial H^{i*}} \frac{\partial H^{i*}}{\partial \delta} < 0$ and $\frac{\partial I^i}{\partial \delta} = \frac{\partial I^i}{\partial h^i} \frac{\partial h^i}{\partial H^{i*}} \frac{\partial H^{i*}}{\partial \delta} < 0$ where $H^{i*} = (1 - \delta)H_0^i$.

3.2.4. Summary of the Comparative Static Analyses

By using a comparative static analysis with minimal assumptions, we have shown the following:

- (1) Labor earnings have a positive effect on health capital investment. In other words, individuals with higher income face lower risk of illness than those with less income.

- (2) A recent popular aspect of life insurance, such as monetary compensation from insurance policies, gives incentives for individuals to invest less health capital investment, which is a reflection of moral hazard.
- (3) Health capital investment may be a substitute and also wealth accumulation.
- (4) Insurance policies with more annuity characteristics induce individuals to buy those types of insurance policies and to have higher health capital investment.
- (5) Life insurance policies with more annuity characteristics are a substitute for saving.

In short, we are proposing that health capital investment of individuals is intertwined with savings, wealth accumulation, and purchase of insurance policies with annuity characteristics. In the next section, we present our econometric model to test our proposed hypotheses.

3.3. Empirical Model

The primary interest of the current study is the analysis of individual behavior regarding life insurance policies and the event of hospitalization. The three observed situations may be enumerated as follows: (1) not buying insurance policies and then being hospitalized, (2) buying insurance policies and then not being hospitalized, and (3) buying insurance policies and then being hospitalized. Therefore, we use a truncated bivariate probit model to evaluate the effects of the socioeconomic characteristics of individuals on the probability of being hospitalized, given individuals bought insurance policies. To be more precise in testing the primary hypothesis on the interactions among the decisions on health investment, purchasing insurance policies, and saving, a savings equation included in the model would be more appropriate. However, the lack of data on the rate of saving precludes the possibility of pursuing our primary concern and hence, we use a bivariate model of health and insurance equations in which the wealth variable is included as an explanatory variable.

Consider the following binary sample selection model.

$$y_1^* = \begin{cases} x_1\beta_1 + u_1 \\ \text{not observed} \\ \text{if } y_1^* \leq 0, \end{cases} \quad \text{then } y_1 = \begin{cases} 1 \\ 0 \end{cases} \quad \text{if } y_1^* < 0, \quad (14)$$

$$y_2^* = x_2\beta_2 + u_2 \quad \text{then } y_2 = \begin{cases} 1 \\ 0 \end{cases} \quad \text{if } y_2^* > 0 \\ \text{if } y_2^* \leq \text{not observed} \\ \begin{bmatrix} u_1 \\ u_2 \end{bmatrix} \sim N \left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix} \right) \quad (15)$$

where y_i^* , $i = 1, 2$, are latent variables; y_1 is the primary outcome variable of our interest, e.g. $y_1 = 1$: the case where $y_1 = y_1^*$ is well known as the Heckman sample selection model and the outcome of individuals who bought insurance policies and are hospitalized; $y_2 = 1$: the outcome of individuals who bought insurance policies; and u_i , $i = 1, 2$, are random error terms, defined as Equation 15, in which $\rho = \text{COV}(u_1, u_2)$. The observed data are y_1, y_2, x_1, x_2 , while the parameters to be estimated are β_1, β_2 and ρ .

If $\rho = 0$, two equations y_i^* , $i = 1, 2$, are independent and β_1 can efficiently be estimated by a standard y_1 probit estimation. If $\rho \neq 0$, efficient estimate of the parameters can be obtained by the maximum likelihood method. The log likelihood function to be estimated is:

$$L = \sum_{i \in (y_{2,i} = 0)} \log \Pr(y_{2,i}^* \leq 0) + \sum_{i \in (y_{2,i} = 1, y_{1,i} = 0)} \log \Pr(y_{1,i}^* \leq 0, y_{2,i}^* > 0) + \sum_{i \in (y_{2,i} = 1, y_{1,i} = 1)} \log \Pr(y_{1,i}^* > 0, y_{2,i}^* > 0), \quad (16)$$

where

$$\begin{aligned} \Pr(y_{2,i}^* \leq 0) &= \Phi_1(-x_2\beta_2) = 1 - \Phi_1(x_2\beta_2), \\ \Pr(y_{1,i}^* \leq 0, y_{2,i}^* \leq 0) &= \Phi_2(-x_1\beta_1, x_2\beta_2, -\rho), \text{ and} \\ \Pr(y_{1,i}^* < 0, y_{2,i}^* < 0) &= \Phi_2(x_1\beta_1, x_2\beta_2, \rho) \end{aligned} \tag{17}$$

where $\Phi_1 = \int_{-\infty}^x \phi_1(z) dz$ and $\Phi_2(x_1, x_2, \rho) = \int_{-\infty}^{x_1} \int_{-\infty}^{x_2} \phi_2(z_1, z_2, \rho) dz_1 dz_2$ are the univariate and bivariate standard normal cumulative distribution functions, respectively (Greene, 2012). The density functions are defined as:

$$\phi_1(z) = \frac{1}{\sqrt{2\pi}} e^{-\frac{z^2}{2}} \text{ and } \phi_2(z_1, z_2, \rho) = \frac{1}{2\pi\sqrt{1-\rho^2}} e^{-\frac{z_1^2 + z_2^2 - 2\rho z_1 z_2}{2(1-\rho^2)}} \tag{18}$$

Thus, the maximum likelihood estimation is straightforward, provided that we can numerically evaluate the univariate and bivariate normal cumulative distribution functions.

Note that we cannot use a simple bivariate probit routine to estimate our binary probit model in the text because of sample selection. If we ignore sample selection bias, the estimates will be biased. Furthermore, a two-step estimation procedure to correct the sample selection bias is not recommended either, since the bias factor appears as multiplicative rather than additive in equation.

For the standard Heckman sample selection model with $y_1 = y_1^*$ it is well known (Greene, 2012) that:

$$E[y_1 | y_2^* < 0] = x_1\beta_1 + \rho \frac{\phi_1(x_2\beta_2)}{\Phi_1(x_2\beta_2)} \tag{19}$$

This result leads to a Heckman's two-step estimation procedure with an inverse Mills ratio correction, i.e. $\lambda_1 = \frac{\phi_1(x_2\beta_2)}{\Phi_1(x_2\beta_2)}$.

Regarding the case of a binary probit model ignoring the sample selection, we have the binary sample selection model:

$$E[y_1 | y_2^* > 0] = \Pr(y_1^* > 0 | y_2^* > 0) = \Pr(u_1 > -x_1\beta_1 | u_2 > -x_2\beta_2) = \int_{-x_1\beta_1}^{\infty} f(u_1 | u_2 > -x_2\beta_2) du_1 \tag{20}$$

The conditional density function $f(u_1 | u_2 > -x_2\beta_2)$ in the Equation 20 can be written as

$$\begin{aligned} f(u_1 | u_2 > -x_2\beta_2) &= \frac{f(u_1 | u_2 > -x_2\beta_2)}{f(u_2 > -x_2\beta_2)} = \frac{1}{\Phi_1(x_2\beta_2)} \int_{-x_2\beta_2}^{\infty} \phi_2(u_1, z_2, \rho) dz_2 \\ &= \frac{1}{\Phi_1(x_2\beta_2)} \int_{-\infty}^{x_2\beta_2} \phi_2(u_1, z_2, -\rho) dz_2 \\ &= \frac{1}{\Phi_1(x_2\beta_2)} \int_{-\infty}^{x_2\beta_2} \left(\frac{1}{\sqrt{2\pi}} e^{-\frac{u_1^2}{2}} \right) \\ &\quad \left(\frac{1}{\sqrt{2\pi(1-\rho^2)}} e^{-\frac{(z_2 + \rho u_1)^2}{2(1-\rho^2)}} \right) dz_2 = \frac{1}{\Phi_1(x_2\beta_2)} \phi_1(u_1) \Phi_1 \left(\frac{x_2\beta_2 + \rho u_1}{\sqrt{1-\rho^2}} \right). \end{aligned} \tag{21}$$

By substituting the result of Equation 21 into Equation 20, we have

$$\begin{aligned}
 E[y_1 | y_2^* > 0] &= \int_{-x_1\beta_1}^{\infty} f(u_1 | u_2 > -x_2\beta_2) du_1 = \frac{1}{\Phi_1(x_2\beta_2)} \int_{-x_1\beta_1}^{\infty} \phi_1(u_1) \Phi_1\left(\frac{x_2\beta_2 + \rho u_1}{\sqrt{1-\rho^2}}\right) du_1 \\
 &= \frac{1}{\Phi_1(x_2\beta_2)} \int_{-\infty}^{x_1\beta_1} \phi_1(u_1) \Phi_1\left(\frac{x_2\beta_2 + \rho u_1}{\sqrt{1-\rho^2}}\right) du_1 = \frac{1}{\Phi_1(x_2\beta_2)} \Phi_1\left(\frac{x_2\beta_2 - \rho x_1\beta_1}{\sqrt{1-\rho^2}}\right) \Phi_1(x_1\beta_1).
 \end{aligned} \tag{22}$$

The second to last equality follows from a simple change of variable (sign), while the last equality follows from repeated applications of integration by parts as follows:

$$\begin{aligned}
 \int_{-\infty}^c F(x)F(ax+b)dx &= F(x)F(ax+b) \int_{-\infty}^c -a \int_{-\infty}^c F(x)F'(ax+b)dx \\
 &= F(x)F(ax+b) \int_{-\infty}^c -a(F(x)F(ax+b)) \int_{-\infty}^c - \int_{-\infty}^c F'(x)F(ax+b)dx \\
 &= F(x)F(ax+b) \int_{-\infty}^c, \text{ where we set } c = x_1\beta_1, a \\
 &= -\frac{\rho}{\sqrt{1-\rho^2}}, b = \frac{x_2\beta_2}{\sqrt{1-\rho^2}}, \text{ and } F(x) = \Phi_1(x).
 \end{aligned} \tag{23}$$

Under a standard univariate probit, we have $E[y_1] = \Phi_1(x_1\beta_1)$ so that the first two terms of the last equality in Equation 22 represent the bias factor from ignoring the sample selection. Hence, we know two things about this bias factor. First, if $\rho = 0$, the bias factor reduces to one and the univariate probit estimation yields consistent estimates. Second, unlike the standard Heckman's model, there does not appear to be a simple two step method to correct this bias in Equation 22. This is not surprising, given the non-linear nature of binary models.

4. Empirical Results

In the above comparative static analyses, we have shown how parameters of insurance policies affect health capital investment. In the following section, we examined if reality supports those theoretical predictions. For a comparative purpose, we used data from Japan and the United States. As mentioned in Section 2, the Japanese data was from the survey in the *National Survey on Life Insurance: Fiscal Year 2000 (NSLI)*, whose sample size was 4,657 households. Due to missing values, the final Japanese sample size became 3,720. On the other hand, the US data was from *Community Tracking Study Household Survey, 1996-1997: [United States]*, whose total observation was 60,446. Due to missing values, the final US sample size became 53,270. Since these two data-sets were different in their characteristics. For example, reimbursement for hospitalization through private life insurance policy by Japanese data but not the US data, and the maturity of private health insurance policy by the Japanese data, but not the US. However, our results fundamentally showed how consumers respond to changes in insurance characteristics since the focuses were health insurance purchase, hospitalization and health capital investment. Using each country's data, we estimated two models: a bivariate probit model and a Heckman probit model. The variable descriptions and statistics for the Japanese data and the US data are reported in Tables 1 and 4, respectively.

Table 1. Definition and Basic Statistics for the Variables used in this Study (Japanese Adults < 65) (n = 3729)

Variable	Variable description	Mean	Std. Dev.	Min	Max
Hospitalization with claim	Those who claimed health insurance benefits for hospitalization = 1; =0 otherwise	.30	.46	0	1
Private health insurance	Household head has private integrated health and life insurance = 1; =0 otherwise	.83	.38	0	1
Premium	Amount paid per private insurance policy held in ten thousands yen	12.99	13.09	0	130
Reimbursement for hospitalization	Payment per day per private insurance if household head is hospitalized in ten thousands yen	4.75	4.89	0	100
Death benefit	Private insurance claim upon the death of the household head in millions yen	21.52	22.42	0	280
Maturity	Total claim on household head's private insurance upon maturity in millions yen	3.97	8.50	0	170
Purchased year	Year of latest private insurance policy bought: 1 = 2000; 2 = 1999; 3 = 1998; 4 = 1997; 5 = 1996; 6 = 1995; 7 = 1994 and before; =0 otherwise	3.48	2.81	0	7
Dummy of the purchased year	Purchased year = 1 otherwise 0	.25	.44	0	1
Illness experience	Proportion of people who became ill in 1999 per hundred thousand person by age cohorts	.05	.02	.02	.10
Household income	Total household income last year (1999) in millions yen	6.98	4.46	0	1
Income is not reported	If total household income is not reported = 1, otherwise 0	.05	.21	0	1
Wealth	Total household wealth in millions yen: 1 = .75; 2 = 3; 3 = 7.5; 4 = 15; 5 = 25; 6 = 35	8.32	9.74	0	35
Wealth is not reported	If wealth is not reported = 1, otherwise 0	.09	.28	0	1
Age	Age of household head	47.23	10.60	20	64

(Continued)

Table 1. (Continued)

Variable	Variable description	Mean	Std. Dev.	Min	Max
Age ²	Age of household head squared	2343.29	978.27	400	4096
Male	Household head is male = 1; =0 otherwise	.95	.21	0	1
Married	Household head is married = 1; =0 otherwise	.93	.25	0	1
Children	Total number of children per household, including unemployed and married children	1.46	1.02	0	7
Mortgage holder	Household has mortgage on house = 1; =0 otherwise	.37	.48	0	1
White collar	Household head is employed in managerial, professional and clerical positions = 1; =0 otherwise	.40	.49	0	1
Blue collar	Household head is employed in manual and manufacturing work = 1; =0 otherwise	.28	.45	0	1
Self-employed	Household head is self-employed = 1; =0 otherwise	.17	.38	0	1
Part-time work	Household head is employed in part-time positions = 1; =0 otherwise	.03	.17	0	1
Primary industry	Household head is employed in the primary industry = 1; =0 otherwise	.04	.20	0	1

4.1. The Results from Japanese Data

First, we discuss the results from Japanese data, reported in Tables 2 (bivariate model) and 3 (Heckman probit). In each model, one of the dependent variables is “private health insurance,” which equals 1 if the household head has private life insurance policies. Another dependent variable is “claimed,” which equals 1 if the household receives coverage of hospitalization costs from insurance firms (see Table 1 for description and statistics of the variables used in this analysis). In general, the variable of education should be omitted neither from the private health insurance nor claimed equations. We were, however, unable to find the variable such as years of education of household head in the Japanese survey data and were consequently aware of an omitted variable problem in both equations. To mitigate such a problem, like the omitted-variable one, types of job were included, although those variables had their good reasons to be included in the models.

Of the private health insurance equation in Table 2, the income and wealth variables are statistically significant and their estimates are positive. In our theoretical model, we indicated the sign of income was positive, while that of savings was indeterminate. With the wealth variable, we were rather more inclined to predict a negative effect of wealth in life insurance policies if the purpose of

Table 2. Bivariate Probit Estimation for Owning Private Health Insurance (n = 3729) and Hospitalization with Claimed Health Insurance Benefit (n = 3729) (Japanese adults < 65)

Dependent variable = owning private health insurance	Estimated coefficient	Standard error	P-value	Marginal effect	Standard error	P-value
Household income	.037	.008	.000	-.001	.002	.713
Income is not reported	.215	.144	.135	-.027*	.040	.507
Wealth	.010	.003	.002	.002	.001	.003
Wealth is not reported	-.141	.103	.170	-.025*	.029	.380
Illness experience	5.339	6.051	.378	.028	.318	.378
Age	.081	.030	.008	.027	.007	.000
Age ²	-.001	.000	.018	.000	.000	.000
Male	.221	.164	.177	-.101*	.054	.060
Married	.451	.130	.001	.101*	.032	.002
Children	.061	.028	.027	.022	.007	.002
Mortgage holder	.208	.059	.000	.021*	.015	.165
White collar	.351	.107	.001	-.049*	.029	.097
Blue collar	.161	.105	.123	-.056*	.029	.050
Self-employed	.166	.109	.129	-.063*	.029	.029
Part-time work	-.134	.156	.389	-.013*	.046	.781
Primary industry	-.616	.133	.000	-.077*	.033	.020
_cons	-2.010	.708	.005	-	-	-
Dependent variable = hospitalization with claimed health insurance benefit	Estimated coefficient	Standard error	P-value	Marginal effect	Standard error	P-value
Premium	.002	.002	.192	-.001	.001	.191
Reimbursement for hospitalization	-.004	.005	.493	-.001	.002	.493
Death benefit	.002	.001	.058	.001	.000	.058
Maturity	-.001	.003	.681	.000	.001	.681
Purchased year	-.026	.011	.020	-.008	.003	.020
Dummy of the purchased year	-.388	.097	.000	-.010*	.025	.000
Household income	-.009	.006	.162	-.001	.002	.713

(Continued)

Table 2. (Continued)

Dependent variable = owning private health insurance	Estimated coefficient	Standard error	P-value	Marginal effect	Standard error	P-value
Income is not reported	-.122	.136	.372	-.027*	.040	.507
Wealth	.007	.003	.016	.002	.001	.003
Wealth is not reported	-.060	.097	.539	-.025*	.029	.380
Age	.076	.022	.000	.027	.007	.000
Age ²	-.001	.000	.002	.000	.000	.000
Male	-.377	.157	.016	-.101*	.054	.060
Married	.287	.137	.036	.101*	.032	.002
Children	.064	.024	.007	.022	.007	.002
Mortgage holder	.035	.049	.470	.021*	.015	.165
White collar	-.223	.097	.022	-.049*	.029	.097
Blue collar	-.218	.097	.025	-.056*	.029	.050
Self-employed	-.242	.101	.016	-.063*	.029	.029
Part-time work	-.018	.155	.906	-.013*	.046	.781
Primary industry	-.139	.134	.300	-.077*	.033	.020
_cons	-2.051	.478	.000	-	-	-
Log-likelihood	-3718.941					
rho	.177	.059	.002			
Likelihood-ratio test of rho = 0:	chi ² =8.932					

*Discrete change of dummy variable from 0 to 1.

buying life insurance policies was for a saving purpose. According to our positive estimated coefficient on wealth variable, households purchase life insurance policies for the purpose of avoiding a sudden interruption of income stream. Concerning other variables of illness experience and males have positive estimated coefficients as expected. However, both coefficients are not statistically significant. That is, if the household head has a higher risk of getting sick, he/she would buy life insurance policies than those with less risk. Our illness experience variable is not the history of illness of household heads, but it is an average of its age category since our survey data does not have the history of sickness of household heads.

Of the hospitalization with claimed health insurance benefit equation in Table 2, the effect of premium on variable of the hospitalization with claimed health insurance benefit is positive and not statistically significant. That is, an increase in insurance premiums paid will increase the probability of hospitalization among household members. In theory, an increase in insurance premiums will cause household head to substitute health capital investment for insurance policies. If so, the stock of health capital should rise and consequently lowers the risk of sickness. Since we observe a positive effect of price on Table 2, i.e. insurance premium, we suspect some adverse selection of high-risk households. The variable of reimbursement for hospitalization, which is payment per day if the household head is hospitalized, is not statistically insignificant, which implies little moral hazard for

Table 3. Heckman Probit Estimation for Owning Private Health Insurance and Hospitalization with Claimed Health Insurance Benefit (Japanese Adults < 65) (n = 3729)

Dependent variable = owning private health insurance	Estimated coefficient	Standard error	P-value	Marginal effect	Standard error	P-value
Household income	.038	.008	.000	-.010	.002	.000
Income is not reported	.184	.140	.189	-.060*	.047	.203
Wealth	.010	.003	.003	.001	.001	.405
Wealth is not reported	-.105	.100	.293	.021*	.036	.557
Illness experience	4.790	4.776	.316	.000	.000	.000
Age	.076	.027	.005	.002	.008	.788
Age ²	-.001	.000	.010	.000	.000	.948
Male	.252	.155	.105	-.126*	.058	.031
Married	.438	.126	.000	-.037*	.048	.437
Children	.059	.027	.029	.013	.009	.135
Mortgage holder	.202	.058	.001	-.011*	.018	.526
White collar	.321	.105	.002	-.130*	.036	.000
Blue collar	.145	.103	.159	-.097*	.035	.006
Self-employed	.163	.107	.126	-.115*	.035	.001
Part-time work	-.120	.154	.436	.057*	.061	.346
Primary industry	-.636	.130	.000	.062*	.051	.223
_cons	-1.919	.621	.002	-	-	-
Dependent variable = hospitalization with claimed health insurance benefit	Estimated coefficient	Standard error	P-value	Marginal effect	Standard error	P-value
Premium	.003	.002	.077	.001	.001	.077
Reimbursement for hospitalization	-.003	.004	.424	-.001	.002	.424
Death benefit	.002	.001	.017	.001	.000	.017
Maturity	-.001	.002	.536	-.001	.001	.536
Purchased year	-.020	.009	.022	-.008	.003	.022
Dummy of the purchased year	-.291	.071	.000	-.112*	.026	.000
Household income	-.026	.006	.000	-.010	.002	.000

(Continued)

Table 3. (Continued)

Dependent variable = owing private health insurance	Estimated coefficient	Standard error	P-value	Marginal effect	Standard error	P-value
Income is not reported	-.156	.126	.213	-.060*	.047	.203
Wealth	.002	.003	.405	.001	.001	.405
Wealth is not reported	.053	.090	.555	.021*	.036	.557
Age	.005	.020	.788	.002	.008	.788
Age ²	.000	.000	.948	.000	.000	.948
Male	-.316	.147	.032	-.126*	.058	.031
Married	-.095	.122	.435	-.037*	.048	.437
Children	.034	.023	.135	.013	.009	.135
Mortgage holder	-.029	.046	.526	-.011*	.018	.526
White collar	-.335	.093	.000	-.130*	.036	.000
Blue collar	-.251	.093	.007	-.097*	.035	.006
Self-employed	-.301	.096	.002	-.115*	.035	.001
Part-time work	.145	.153	.342	.057*	.061	.346
Primary industry	.156	.127	.221	.062*	.051	.223
_cons	.362	.433	.403	-	-	-
Log-likelihood	-3458.648					
rho	-5.286	29.166	.856			
Likelihood-ratio test of rho=0:	chi ² = 2.39					

*Discrete change of dummy variable from 0 to 1.

insurance policy holders. The estimated coefficient of death benefit is positive and statistically significant. The results supported our hypotheses since insurance payments for a case of death of an insured household head is associated with health capital investment. However, the estimated coefficient of annuity payments by the maturity is independent of health capital investment. The variable of age is statistically significant and positive, while the squared term has a negative estimated coefficient. Since age is a proxy of health capital depreciation, as an individual gets older, the individual is more likely to get sick. In this case, the estimated coefficient of age needs to be positive and age² to be negative.

Now, of the results of the Heckman probit model in Table 3, since the estimated coefficients of the variables in the private health insurance equation are nearly the same as those we discussed above, we will reflect on the results of the claimed equation of the Heckman probit model. The estimated coefficients show the behavior of those who bought insurance policies. In other words, the hospitalization with claimed health insurance benefit is one of interest in this study.

The premium variable in Table 3 has a statistically significant positive effect on the variable of hospitalization with claimed health insurance benefit. We consequently do not reject an idea of adverse selection of high-risk households. Of other variables, those variables related to insurance

Table 4. Definition and Basic Statistics for the Variables Used in this Study (US Adults < 65) (n = 53270)

Variable	Variable description	Mean	Std. Dev.	Min	Max
Hospitalization	People stay in any hospital overnight or longer during the past 12 months = 1; =0 otherwise	.09	.29	0	1
Private health insurance	Private health insurance is held = 1; =0 otherwise	.76	.43	0	1
Premium	Amount paid per private insurance policy held in thousands dollars	.12	.66	0	6.72
Illness experience	People visit doctors in past 12 months = 1; =0 otherwise	.55	.50	0	1
Household income	Total household income in thousands dollars: 1 = 5; 2 = 15; 3 = 25; 4 = 35; 5 = 45; 6 = 75; 7 = 125	4.19	1.95	1	7
Education	The number of years of education completed for persons who were 18 years of age or older	10.84	5.86	0	19
Medicaid	Medicaid is held = 1; =0 otherwise	.05	.22	0	1
Age	Age of person	33.28	16.62	0	64
Age ²	Age of person squared	1383.70	1095.22	0	4096
Male	The person is male = 1; =0 otherwise	.52	.50	0	1
Married	The person is married = 1; =0 otherwise	.65	.48	0	1
Children	Total number of children per household	1.03	1.16	0	7
White	The person is White = 1; =0 otherwise	.74	.44	0	1
African-American	The person is African-American = 1; =0 otherwise	.12	.32	0	1
Hispanic	The person is Hispanic = 1; =0 otherwise	.10	.29	0	1

(Continued)

Table 4. (Continued)

Variable	Variable description	Mean	Std. Dev.	Min	Max
Private sector	The person is employed by a private company = 1; =0 otherwise	.41	.49	0	1
Government sector	The person is employed by government = 1; =0 otherwise	.10	.30	0	1
Self-employed	The person is self-employed = 1; =0 otherwise	.07	.26	0	1
Small firm	The person is employed by firm of less than 10 employees	.11	.31	0	1
Firm size 1	The person is employed by firm of 10–99 employees	.12	.33	0	1
Firm size 2	The person is employed by firm of 100–499 employees	.08	.26	0	1
Firm size 3	The person is employed by firm of 500–999 employees	.02	.15	0	1
Firm size 4	The person is employed by firm of 1,000 employees or more	.16	.37	0	1

payments for death benefit are statistically significant while annuity payments are not significant. The positive sign of death benefit shows the higher the risk of sickness in the household is, the more death benefit with the hospitalization a household has. The result itself does not indicate either an adverse selection or moral hazard problem (or both together) dominating since both problems will have positive effects on probability of getting sick.

Income and wealth variables in Table 3 are also significant and the signs are the same as those of the “owing private insurance” equation in Table 2. Since wealth is accumulated savings, the positive sign shows savings are a substitute for health capital investment (or health stock of capital). Then, to rationalize this substitution, an individual might accumulate wealth mainly not as annuity but inheritance for left family members or avoidance of interruption of income flow in Table 3. We might say a purpose of inheritance is dominant over that of annuity in the household. This might be at least one of the explanations for the positive effect of wealth on the variable of private health insurance, i.e. purchasing more insurance policies as wealth rises.

The negative income effect on sickness (i.e. equation of “hospitalization with claimed health insurance benefit”) is reasonable since a decrease in income will decrease the demand for health services (i.e. hospitalization) and, hence, individuals have less claimed. On the other hand, the positive effect of the variable of wealth on hospitalization with claimed health insurance benefit is not statistically significant and not intuitive.

4.2. The Results from US Data

In order to contrast, we also examine data from American individuals. However, we were not successful in obtaining similar US data to the Japanese counterparts. That is, the US data is not an integrated private health and life insurance policies, but from pure health insurance policies. The variable descriptions and statistics of US data are reported in Table 4.

The results of the bivariate model are presented in Table 5 and Heckman probit models are reported in Table 6. The results of estimated coefficients are consistent between the bivariate and Heckman probit models. The variable of household income in the result of “hospitalization” has a negative and significant estimated coefficient in the bivariate probit model in Table 5 and in the Heckman probit model in Table 6. We consider the negative effect based on the US results as justified and congruent with the positive effect based on the Japanese results in the hospitalization equation. This is relevant because the reasoning behind the behavior of individuals who bought health insurance policies is the subject of our interest in this study. An increase in income is associated with an increase in health stock, which leads to less hospitalization.

In Tables 5 and 6, we have noticed the estimated coefficients of premium of insurance policies are both negative and statistically significant. The negative result obtained from the US data contrasts the positive result of the Japanese data, although the former again is of health insurance policies rather than the integrated health and life insurance policies like the Japanese case. Japanese private insurance policies have a variety of attractive features for consumers besides the benefits claimed if an insured person dies, and one of these attractive features is the monetary supplement paid out on a per-day basis if the insured becomes hospitalized. The negative coefficient is hypothesized as being higher premiums of health insurance policies cause individuals to substitute more health capital investment and, hence, they have lower risk of hospitalization.

The variables of household income in the results of “owing private health insurance” are both positive and statistically significant in Tables 5 and 6. The results are congruent with Japanese results. For education, a household having higher income is more likely to purchase health insurance. Medicaid is another interesting variable in that Medicaid households are less likely to purchase private health insurance because of coverage by the state government program.

In Tables 5 and 6, the variable of education in the result of “hospitalization” is statically significant and positive; this result is rather puzzling. An individual with better and more education will be more efficient in the production of health capital and, hence, have a higher demand for health capital stock and will be healthier than an individual with less education, *ceteris paribus*. Our result from the US data contradicted the theoretical hypothesis, although the Japanese data did not contain the variable of educational. A reason for this may be due to an omitted variable like a wealth variable, which may be positively correlated with an education variable and the variable of hospitalization. The variable of Medicaid is positive and statistically significant; this implies individuals with Medicaid people are more subject to higher risk of becoming ill.

Of the other variables in the hospitalization equation in Table 6, some are consistent with our theoretical predictions while some are not. At the least, the negative effect of age is not consistent as long as the variable is a proxy for health capital depreciation because aging reduces the health capital stock and raises hospitalization. There is another possible answer to the negative effect on hospitalization: if the distribution of age in the US is young, the health stock will increase up to a certain age while decreasing the use of hospital services and then the health stock declines beyond a certain age with an increase in use of hospital services with aging. Those positive effects on the variables such as male, married, children, and white are as expected.

Now, let us summarize our comparative studies of Japanese data and US data. The data is not the same in characteristics such as the former pertaining to purchasing private health insurance under the national health insurance program and the latter to private health insurance policies under

non-nationalized health insurance program. Since both are health insurance related to purchasing, hospitalization, and health capita related issues, there are similarities and dissimilarities between them. First of all, a similarity of both results shows that households with higher income are more likely to purchase private health insurance and less likely to have hospitalization. The US price (premium) effect is negative in the Heckman probit estimation while the Japanese premium effect is positive. A quick answer for the positive and negative effects lacks a definite answer of existence of adverse selection and/or moral hazard. Some other similarities are of the positive effects of income, married, and children on risk in the hospitalization estimation, and the positive coefficients are always statistically robust.

Besides the effect of income there are some other variables which have different signs between the two countries. First, the age variable has a positive effect on risk of hospitalization in the case of Japanese data, whose sign conforms to our theoretical prediction, while the sign is negative in the US data. Another variable is that of gender such as male, whose variable has a negative effect on the risk of hospitalization in the Japanese case, while it is positive for the US case. In general, we consider it more natural that males are more prone to sickness than females.

Table 5. Bivariate Probit Estimation for Owning Private Health Insurance and Hospitalization (US Adults < 65) (n = 53270)

Dependent variable = owning private health insurance	Estimated coefficient	Standard error	P-value	Marginal effect	Standard error	P-value
Household income	.323	.005	.000	.002	.001	.001
Education	.006	.002	.011	.006	.000	.000
Medicaid	-2.238	.058	.000	-.053*	.002	.000
Illness experience	.235	.015	.000	.005*	.000	.000
Age	-.033	.003	.000	-.005	.000	.000
Age ²	.000	.000	.000	.000	.000	.000
Male	.103	.015	.000	.026*	.002	.000
Married	.131	.018	.000	.015*	.002	.000
Children	.020	.007	.008	.004	.001	.000
White	.112	.035	.001	.007*	.005	.153
African-American	-.038	.039	.332	.012*	.006	.049
Hispanic	-.248	.039	.000	-.003*	.006	.551
Private sector	.742	.055	.000	-.019*	.006	.004
Government sector	.732	.032	.000	-.036*	.003	.000
Self-employed	.541	.064	.000	-.024	.007	.000
Small firm	-.688	.059	.000	-.030*	.006	.000
Firm size 1	-.465	.056	.000	-.027*	.005	.000
Firm size 2	-.142	.060	.017	-.013*	.007	.053
Firm size 4	.015	.057	.796	-.006*	.007	.365
_cons	-.512	.046	.000	-	-	-
Dependent variable = hospitalization	Estimated coefficient	Standard error	P-value	Marginal Effect	Standard Error	P-value
Premium	-.032	.013	.013	-.004	.002	.013

(Continued)

Table 5. (Continued)

Dependent variable = owing private health insurance	Estimated coefficient	Standard error	P-value	Marginal effect	Standard error	P-value
Household income	-.042	.005	.000	.002	.001	.001
Education	.047	.003	.000	.006	.000	.000
Medicaid	.326	.032	.000	.053*	.002	.000
Age	-.034	.003	.000	-.005	.000	.000
Age ²	.000	.000	.000	.000	.000	.000
Male	.192	.016	.000	.026*	.002	.000
Married	.098	.020	.000	.015*	.002	.000
Children	.026	.008	.001	.004	.001	.000
White	.034	.039	.384	.007*	.005	.153
African-American	.097	.043	.024	.012*	.006	.049
Hispanic	.025	.045	.586	-.003*	.006	.551
Private sector	-.282	.054	.000	-.019*	.006	.004
Government sector	-.439	.031	.000	-.036*	.003	.000
Self-employed	-.290	.069	.000	-.024	.007	.000
Small firm	-.115	.062	.063	-.030*	.006	.000
Firm size 1	-.146	.057	.011	-.027*	.005	.000
Firm size 2	-.082	.060	.170	-.013*	.007	.053
Firm size 4	-.052	.055	.344	-.006*	.007	.365
_cons	-1.265	.049	.000	-	-	-
Log-likelihood	-34792.963					
rho	-.034	.013	.010			
Likelihood-ratio test of rho=0:	chi ² =6.600					

*Discrete change of dummy variable from 0 to 1.

Table 6. Heckman Probit Estimation for Owning Private Health Insurance and Hospitalization (US Adults < 65) (n = 53270)

Dependent variable = owing private health insurance	Estimated coefficient	Standard error	P-value	Marginal effect	Standard error	P-value
Household income	.314	.005	.000	.061	.003	.000
Education	.005	.002	.047	.009	.001	.000
Medicaid	-2.249	.058	.000	-.655*	.025	.0
Illness experience	.298	.013	.000	.000	.000	.000
Age	-.029	.003	.000	-.003	.001	.000
Age ²	.000	.000	.000	.000	.000	.000
Male	.088	.015	.000	.029*	.005	.000
Married	.127	.017	.000	.004*	.006	.513
Children	.021	.007	.005	.005	.002	.018

(Continued)

Table 6. (Continued)

Dependent variable = owing private health insurance	Estimated coefficient	Standard error	P-value	Marginal effect	Standard error	P-value
White	.100	.034	.003	-.009*	.011	.423
African-American	-.041	.038	.277	.040*	.014	.003
Hispanic	-.242	.039	.000	.072*	.015	.000
Private sector	.696	.053	.000	-.150*	.014	.000
Government sector	.695	.031	.000	-.156*	.007	.000
Self-employed	.508	.063	.000	-.107	.014	.000
Small firm	-.650	.058	.000	-.088*	.020	.000
Firm size 1	-.428	.055	.000	-.029*	.017	.090
Firm size 2	-.135	.058	.019	-.002*	.016	.888
Firm size 4	.016	.055	.769	-.016*	.015	.289
_cons	-.536	.045	.000	-	-	-
Dependent variable = hospitalization	Estimated coefficient	Standard error	P-value	Marginal effect	Standard error	P-value
Premium	-.019	.009	.031	-.006	.003	.030
Household income	-.197	.007	.000	-.061	.003	.000
Education	.031	.003	.000	.009	.001	.000
Medicaid	1.903	.111	.000	.655*	.025	.000
Age	-.010	.003	.001	-.003	.001	.000
Age ²	.000	.000	.000	.000	.000	.000
Male	.095	.017	.000	.029*	.005	.000
Married	.013	.020	.514	.004*	.006	.513
Children	.018	.008	.019	.005	.002	.018
White	-.030	.039	.420	-.009*	.011	.423
African-American	.127	.042	.003	.040*	.014	.003
Hispanic	.221	.044	.000	.072*	.015	.000
Private sector	-.508	.050	.000	-.150*	.014	.000
Government sector	-.631	.030	.000	-.156*	.007	.000
Self-employed	-.402	.062	.000	-.107*	.014	.000
Small firm	.268	.058	.000	.088*	.020	.000
Firm size 1	.091	.053	.082	.029*	.017	.090
Firm size 2	-.007	.053	.889	-.002*	.016	.888
Firm size 4	-.052	.050	.294	-.016*	.015	.289
_cons	-.010	.064	.874	-	-	-
Log-likelihood	-30323.850					
rho	-1.504	.082	.000			
Likelihood-ratio test of rho=0:	chi ² =174.61					

*Discrete change of dummy variable from 0 to 1.

5. Summary and Conclusions

By simply looking at the relationship between risk of hospitalization of individuals (or households) and insurance premiums paid per household, we noticed a positive and slightly concave relationship. Then, we wondered why households or individuals are more likely to become sick once if they have paid higher insurance premiums. Then, we referred to Grossman (1972) as a starting point; his pioneer paper on the demand for health shows better health will increase healthy days, which

implies that a healthy individual should have a longer life than an individual that is less healthy. If so, then the individual would decide his/her optimal behavior in allocating income among health capital investment, health insurance policies, and savings. While these three types of income expenditures seem intertwined, we treat savings as exogenous while expenditures on health capital investment and health insurance policies are endogenous in our model.

Our theoretical model, using a Von Neumann–Morgenstern utility function of a two-period model, shows how expenditures on health capital investment and health insurance policies change and shows changes in the parameters of insurance policies. To prove our theoretical predictions, we used two different data-sets for a comparative purpose: one is Japanese data from the survey in the *National Survey on Life Insurance: Fiscal Year 2000 (NSLI)*, whose sample size is 4,657 households, and the other is the US data from the *Community Tracking Study Household Survey, 1996–1997: United States*, whose sample size is 60,446 households. Due to missing values, the final Japanese sample size became 3,720 and the US data became 53,270.

Of these two data-sets, we found some similarities and dissimilarities between Japan and the United States. As a similarity, the number of insurance policies bought by a household has a strongly positive effect on the risk of hospitalization of individuals. The income effect on hospitalization is negative for both countries since an increase in income is associated with health capital stock, which leads to less hospitalization. The income effect for owing private health insurance is positive for both countries since the health insurance is a normal good. Another similarity for both countries is the illness experience; this has a positive influence on owing health insurance. The US case reveals statistically significant results which seem to be an idea of adverse selection under the market-oriented private health insurance system, while Japan is under a national health insurance program. The results of the data-set from Japan and the US did not show a robust aspect of the possibility of adverse selection by the health insurance policies.

As a typical difference, the insurance premium effect on risk of hospitalization is positive for the Japanese case, while negative for the US case. Since the integrated private Japanese health and life insurance has unique features (such as payments per day of hospitalization if household gets hospitalized, insurance payments upon death of an insured, and annuity payments at maturity) an increase in premium is related to variety of characteristics of health and life insurance policy coverage, which includes hospitalization. Thus, we do not eliminate a possibility of adverse selection. For the US pure health insurance characteristics, an increase in premium of health insurance policies causes individuals to substitute more health capital investment, which causes lower risk of hospitalization. Another difference between the two countries is seen in the age effect (i.e. health stock depreciation) on risk of hospitalization. This effect is positive for the Japanese case but negative for the United States. The age variable is proxy for the health stock depreciation with aging, which causes more hospitalization by aging. It is the theoretically sounded prediction. There is another possibility for the negative effect on hospitalization—if the distribution of age in the US is young—the hospitalization declines first and then increases with aging. Thus, the health stock will increase up to a certain age while the use of hospital services decreases and then the health stock declines beyond a certain age while use of hospital services increases with aging.

A few limitations were encountered during this study. First, the Japanese data has variables on wealth but not education, while the US data has variables on education but not wealth. A choice of private health insurance is associated with individual educational level, health status, risk preference, etc. in addition to the other variables that we included in this study. Thus, a lack of information of individual characteristics from data may lead results to omit variable bias. Second, the effects of the Japanese wealth variable and the US education variable are also statistically positive. While both positive effects are counter intuitive, the positive effect of the former may be defended if good health and savings are substitutes. On the other hand, a positive effect of education on the risk of hospitalization may not be justifiable since the education is a proxy for health knowledge and health production efficiency. Third, our study did not cover the US Government

program, e.g. Obama Health Care Act in 2014, and the Japanese Government's new policy of lifting the ban on private health insurance products in 2013 because of the year of our survey data.

Our results imply a rapid increase in healthcare costs with increasing financial burden on the population at an individual and national level under the national healthcare system. This is true because the national healthcare system effectuates a trend towards self financing for healthcare services, e.g. Obama Health Care Act in 2014 in the US; and the market has quickly expanded the new insurance products for monetary compensation for hospitalization, supplemental coverage for services under the national health insurance, cancer, heart disease, and stroke, long-term care, etc. in Japan. The insurance industry can extend the variety of policies offered to cover different types of healthcare services. The new policy would attract new consumers with existing private health insurance policies. This market environment with a change in consumer behaviors will encourage future studies using different data information.

Acknowledgments

We would like to thank Michael Grossman, Bernard Okun, John, D. Worrall, seminar participants at Osaka University in Osaka, and those at the Institute of Statistical Research in Tokyo for their helpful comments on our previous version of this study. We also acknowledge the support from the SSJ Data Archive, Information Center for Social Science Research on Japan, Institute of Social Science, and the University of Tokyo for the provision of the health/life insurance data used in this study. The views presented here are those of the authors and do not necessarily represent those of the below-mentioned funding agencies and the affiliated institutions.

Funding

We gratefully acknowledge the research supports provided by the Ministry of Education, Culture, Sports, Science and Technology, Japan: Japan Society for Promotion of Science for Scientific Research (Grant #14530042 (C)), the Nomura Foundation (Japan) and the Research Council of Rutgers University (#202243 and #202089).

Author details

Tadashi Yamada¹

E-mail: ykymd_tsukuba1222@yahoo.co.jp

Tetsuji Yamada²

E-mail: tyamada@crab.rutgers.edu

Chia-Ching Chen³

E-mail: ChiaChing_Chen@nymc.edu

Weihong Zeng⁴

E-mail: zengwh@hotmail.com

¹ Graduate School of Humanities and Social Sciences, Institute of Policy and Planning Sciences, University of Tsukuba, Tsukuba, Ibaraki 305-8573, Japan.

² Department of Economics, and Center for Children and Childhood Studies, Rutgers University, The State University of New Jersey, Camden, NJ 08102, USA.

³ Department of Epidemiology & Community Health, School of Health Sciences and Practice, New York Medical College, Valhalla, New York 10595, USA.

⁴ School of Public Policy and Administration, Xi'an Jiaotong University, Xi'an, Shaanxi Province 710049, China.

Article Information

Cite this article as: Determinants of health insurance and hospitalization, T. Yamada, T. Yamada, C.-C. Chen & W. Zeng, *Cogent Economics & Finance* (2014), 2: 920271.

References

Chang, F. R. (1996). Uncertainty and investment in health. *Journal of Health Economics*, 15, 369–376.
[http://dx.doi.org/10.1016/0167-6296\(96\)00006-9](http://dx.doi.org/10.1016/0167-6296(96)00006-9)

- Cropper, M. L. (1997). Health, investment in health, and occupational choice. *Journal of Political Economy*, 85, 1273–1294.
- Cutler, D. M., & Zeckhauser, R. J. (2000). The anatomy of health insurance. In A. J. Culyer & J. P. Newhouse (Eds.), *Handbook of health economics* (Vol. 1A, pp. 563–643). Amsterdam: Elsevier.
- Dardanoni, V., & Wagstaff, A. (1987). Uncertainty, inequalities in health and the demand for health. *Journal of Health Economics*, 6, 283–290.
[http://dx.doi.org/10.1016/0167-6296\(87\)90016-6](http://dx.doi.org/10.1016/0167-6296(87)90016-6)
- Doiron, D., Jones, G., & Savage, E. (2008). Healthy, wealthy and insured? The role of self-assessed health in the demand for private health insurance. *Health Economics*, 17, 317–334.
- Ehrlich, I. (2000). Uncertain lifetime, life protection, and the value of life saving. *Journal of Health Economics*, 19, 341–367.
- Ehrlich, I., & Chuma, H. (1990). A model of the demand for longevity and the value of life extension. *Journal of Political Economy*, 98, 761–782.
<http://dx.doi.org/10.1086/jpe.1990.98.issue-4>
- Gärdenfors, P., & Sahlin, N. (1988). *Decision, probability, and utility*. Cambridge: Cambridge University Press.
<http://dx.doi.org/10.1017/CBO9780511609220>
- Greene, W. H. (2012). *Econometric analysis*. Upper Saddle River, NJ: Prentice Hall.
- Grossman, M. (1972). On the concept of health capital and the demand for health. *Journal of Political Economy*, 80, 223–255. <http://dx.doi.org/10.1086/jpe.1972.80.issue-2>
- Grossman, M. (2007). The human capital model. In A. J. Culyer & J. P. Newhouse (Eds.), *Handbook of health economics* (Vol. 1A, pp. 347–408). Amsterdam: Elsevier.
- Heim, B. T., & Lurie, I. Z. (2009). Do increased premium subsidies affect how much health insurance is purchased? Evidence from the self-employed. *Journal of Health Economics*, 28, 1197–1210.
<http://dx.doi.org/10.1016/j.jhealeco.2009.07.002>
- Heiss, F., McFadden, D., & Winter, J. (2009). *Regulation of private health insurance markets: Lessons from enrollment, plan type choice, and adverse selection in Medicare Rate D*. NBER working paper No.15392, Cambridge, MA, USA.
- Horioka, C. Y. (2002). Are the Japanese selfish, altruistic or dynastic? *The Japanese Economic Review*, 53, 26–54.
<http://dx.doi.org/10.1111/jere.2002.53.issue-1>
- Kessler, D. (2008). The long-term care insurance market. *The Geneva Papers*, 33, 33–40.
- Liljas, B. (1998). The demand for health with uncertainty and insurance. *Journal of Health Economics*, 17, 153–170.
[http://dx.doi.org/10.1016/S0167-6296\(97\)00021-0](http://dx.doi.org/10.1016/S0167-6296(97)00021-0)
- Nordquist, G., & Wu, S. Y. (1976). The joint demand for health insurance and preventive medicine. In R. N. Rosett (Ed.), *The role of health insurance in the health*

- services sector (pp. 35–65). New York, NY: National Bureau of Economic Research.
- Picone, G., Uribe, M., & Wilson, M. R. (1998). The effect of uncertainty on the demand for medical care, health capital and wealth. *Journal of Health Economics*, 17, 171–185.
- Poletti, T., Balabanova, D., Ghazaryan, O., Kocharyan, H., Hakobyan, M., Arakelyan, K., & Normand, C. (2007). The desirability and feasibility of scaling up community health insurance in low-income setting—Lessons from Armenia. *Social Science & Medicine*, 64, 509–520.
- Rice, T., Lavarreda, S. A., Ponce, N. A., & Brown, E. R. (2005). The impact of private and public health insurance on medication use for adults with chronic diseases. *Medical Care Research and Review*, 62, 231–249. <http://dx.doi.org/10.1177/1077558704273806>
- Selden, T. M. (1993). Uncertainty and health care spending by the poor: The health capital model revisited. *Journal of Health Economics*, 12, 109–115. [http://dx.doi.org/10.1016/0167-6296\(93\)90043-E](http://dx.doi.org/10.1016/0167-6296(93)90043-E)
- Sheshinski, E., & Weiss, Y. (1981). Uncertainty and optimal social security systems. *The Quarterly Journal of Economics*, 96, 189–206. <http://dx.doi.org/10.2307/1882387>
- Sydsæter, K., Strøm, A., & Berck, P. (2005). *Economists' mathematical manual*. New York, NY: Springer. <http://dx.doi.org/10.1007/978-3-540-28518-2>
- Yamada, T., Chen, C. C., Yamada, T., Fahs, M., & Fukawa, T. (2006). Behavioral analysis of the choice of community-based formal home care, informal home care and nursing home care in Japan. *The Geneva Papers on Risk and Insurance Issues and Practice*, 31, 600–632. <http://dx.doi.org/10.1057/palgrave.gpp.2510101>
- Yamada, T., & Yamada, T. (2003). The demand for health checkups under uncertainty. In S. Ogura, T. Tachibanaki, & D. A. Wise (Eds.), *Labor markets and firm benefit policies in Japan and the United States* (pp. 267–314). Chicago, IL: University of Chicago. <http://dx.doi.org/10.7208/chicago/9780226620954.001.0001>
- Zweifel, P., & Breyer, F. (1997). *Health economics*. Oxford: Oxford University Press.



© 2014 The Author(s). This open access article is distributed under a Creative Commons Attribution (CC-BY) 3.0 license.

You are free to:

Share — copy and redistribute the material in any medium or format
Adapt — remix, transform, and build upon the material for any purpose, even commercially.
The licensor cannot revoke these freedoms as long as you follow the license terms.

Under the following terms:

Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made.
You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.
No additional restrictions
You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits.



Cogent Economics & Finance (ISSN: 2332-2039) is published by Cogent OA, part of Taylor & Francis Group.

Publishing with Cogent OA ensures:

- Immediate, universal access to your article on publication
- High visibility and discoverability via the Cogent OA website as well as Taylor & Francis Online
- Download and citation statistics for your article
- Rapid online publication
- Input from, and dialog with, expert editors and editorial boards
- Retention of full copyright of your article
- Guaranteed legacy preservation of your article
- Discounts and waivers for authors in developing regions

Submit your manuscript to a Cogent OA journal at www.CogentOA.com

