

THE GROWTH OF PRIVATE MEDICAL INSURANCE MARKET IN JAPAN

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Abstract. In Japan, aging of population is progressing rapidly, due to rising longevity by the improvement of living condition and medical technology, and birthrate decline by the change of lifestyle.

Therefore, public medical insurance system has been in an extremely severe financial situation, and recently system reform for improvement was implemented, which included the increase in the portion of individually paid medical expense.

Against a background of such a social environment, people's uneasiness for public medical insurance system and consciousness of the need to prepare for the future economic burdens, such as cost of living / medical cost, are growing, which is followed by the expectation for private medical insurance.

In the insurance industry, deregulation was carried out in 2001, and the scope of medical insurance which each life insurance companies and non-life insurance companies could sell was expanded. After that, insurance companies have been developing various kinds of products with their originality and creativity, and the private medical insurance market is expanding greatly.

In this paper, I will introduce the description of the main products of private medical insurance in Japan and the trend of recent new product development, and make remarks about the points that we, as actuaries, should pay attention to facing with product development and risk management.

Key-words: Private Medical Insurance, Deregulation, The Third Sector, Risk Control Methods, Future Uncertainties,

1 Introduction

In Japan, the average life expectancy has been rising in line with changes in life habits and advances in medical technology. At the same time, the birthrate has been on the decline because of changes in peoples' lifestyles. These trends have combined to cause a much more rapid aging rate for the nation's population than is occurring in the rest of the world

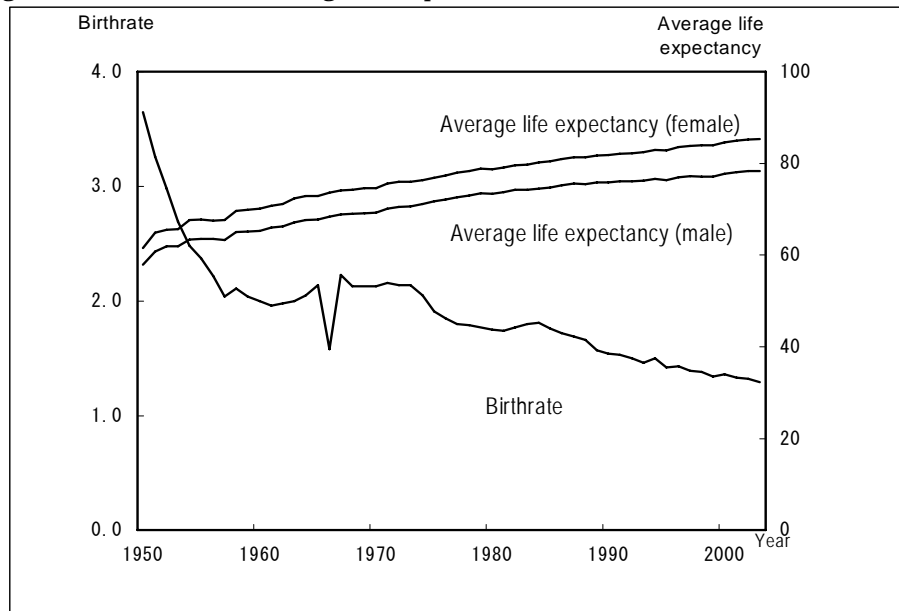
Japan's public medical insurance structure is based on a system of compulsory participation. Under this system, people must participate in one of several programs. (Every individual is obligated to participate in a specific program according to his or her occupation, area of residence, and age.)

The aging of the nation's population has placed public medical insurance on an extremely shaky financial footing. For this reason, steps have been taken to reform the medical insurance system.

The main point of the reform is an increase in the percentage of medical expenses paid by patients. Under Japan's public medical insurance system, each patient is required to pay a certain percentage of his or her own medical expenses. As a result of the reform, the proportion of medical expenses to be paid by a salaried worker has increased from 20 percent to 30 percent.

Therefore, people are feeling increasingly insecure about the public medical insurance system and are becoming more conscious of the need to prepare for future economic burdens (including living expenses and medical expenses). Because of these and other factors, higher expectations are placed on private medical insurance.

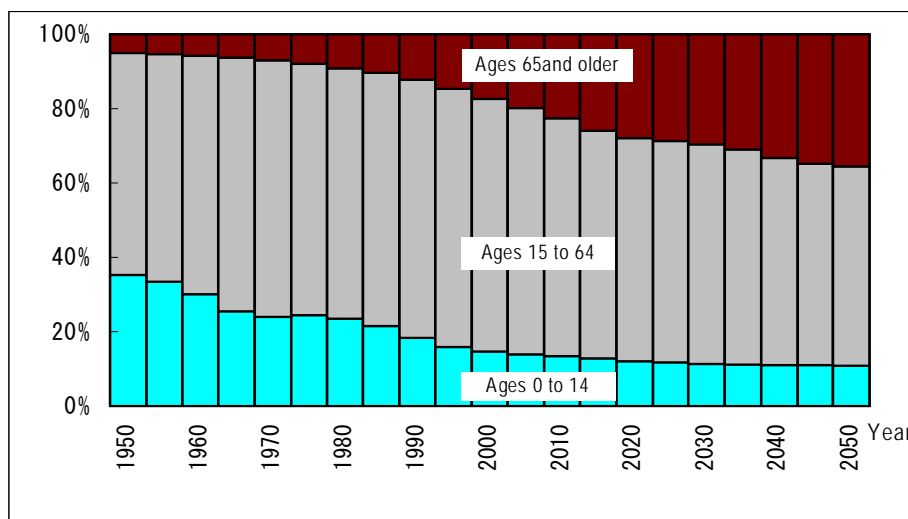
Figure 1. Birthrate and average life expectancies



Sources: "Demographic Survey" results and "Life Tables"
(Ministry of Health, Labour and Welfare)

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Figure 2. Population composition by age group



Source: "Population Statistics of Japan" (National Institute of Population and Social Security Research)

(Note) Figures for 2005 and beyond are projections.

Figure 3. Overview of Japan's public medical insurance system

			Insured	Insurer	Membership
Medical insurance	Health insurance	Government-managed health insurance	Salaried workers, mostly those in small and medium enterprises	Government	Approx. 36 million
		Society-managed health insurance	Salaried workers, mostly those in large enterprises	Health insurance societies	Approx. 31 million
	Mutual aid societies etc		Public employees, school personnel, etc.	Mutual aid societies etc.	Approx. 10 million
	Seamen's insurance		Seamen	Government	
	National health insurance		Persons other than those covered above (self-employed persons etc.)	Municipalities National health insurance societies	Approx. 50 million
Medical care for retired persons	National health insurance		Retired workers eligible for employees' insurance benefits	Municipalities	
Medical care for the elderly	Medical insurance system for the elderly		Persons such as those aged 75 and older and covered by medical insurance	Municipalities	Approx. 13 million

2 Growth of the private medical insurance market

(1) Deregulation

The types of insurance products that insurance companies are permitted to sell are defined by law, as follows (separated into life insurance companies and non-life insurance companies):

Life insurance companies	Non-life insurance companies
<ul style="list-style-type: none"> i. Insurance under which a certain amount of money is paid as an insurance benefit in respect of a person's survival or death ii. Insurance under which a certain amount of money is paid as an insurance benefit in respect of any of the following situations, and under which coverage is provided in respect of loss or damage that may be caused to the person concerned because of any of said situations: <ul style="list-style-type: none"> a. A person's illness b. A person's condition resulting from a bodily injury sustained or an illness suffered c. A person's death resulting directly from a bodily injury d. Any situation similar to "a" or "b" e. Medical treatment received for "a", "b", or "d" iii. (Omitted) 	<ul style="list-style-type: none"> i. Insurance consisting of an agreement to cover loss or damage that may arise from a certain accidental event and requiring the payment of an insurance premium ii. Insurance described in "ii" in the left column iii. Insurance pertaining to a person's death during overseas travel or a person's death resulting directly from an illness suffered by the person during overseas travel

Here, medical insurance fits into Category "ii" above for both life insurance companies and non-life insurance companies. This means that both life insurance companies and non-life insurance companies are permitted to sell this type of insurance product. Medical insurance is therefore deemed to belong to an sector called the "Third Sector", as distinct from the "First Sector" (the sector specific to life insurance) and the "Second Sector" (the sector specific to non-life insurance).

However, regulations had long been in existence to limit the variety of insurance products actually sold in the Third Sector by life insurance companies and non-life insurance companies. As far as medical insurance was concerned, non-life insurance companies were only allowed to sell products that paid an insurance benefit covering the actual loss or damage sustained. In other words, non-life insurance companies were prohibited from selling products that paid a fixed amount of money as an insurance benefit. Life insurance companies (excluding some specific companies) were only permitted to sell medical insurance in the form of an endorsement attached to life insurance, or the like.

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The above regulations have been relaxed over the last ten years in step with the trend toward financial liberalization. In 2001, all regulations governing the sale of insurance products in the Third Sector were abolished.

Figure 4. Main types of insurance

←————— Life insurance companies —————→		
←————— Non-life insurance companies —————→		
First Sector	Third Sector	Second Sector
<ul style="list-style-type: none"> - Term insurance - Endowment insurance - Whole life insurance - Annuity insurance 	<ul style="list-style-type: none"> - Medical insurance - Cancer insurance - Nursing care insurance - Personal accident insurance - Income indemnity insurance 	<ul style="list-style-type: none"> - Automobile insurance - Fire insurance - Liability insurance

(2) Medical insurance sales

Because of the circumstances described below, insurance companies are having difficulty increasing earnings from their conventional products in the First and Second Sectors. To secure new sources of earnings, they have been developing various products and making strong marketing efforts since the deregulation in 2001.

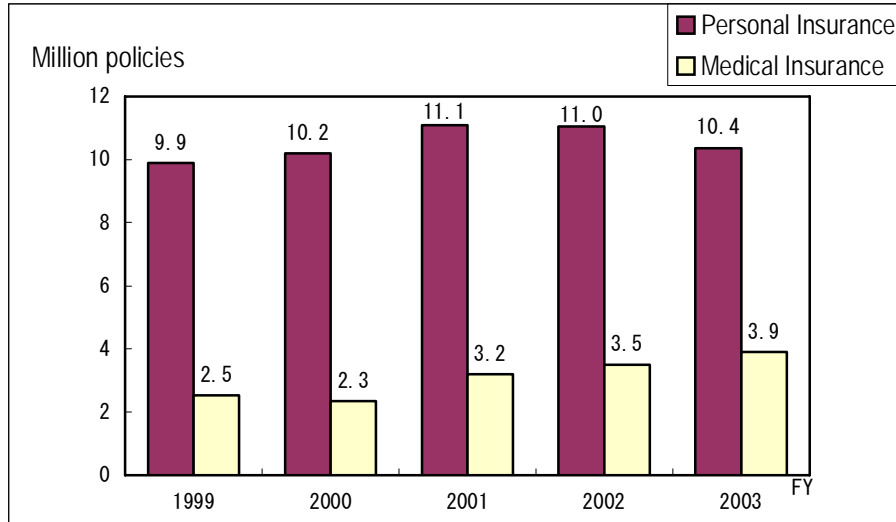
■ Life insurance companies

- Almost everyone has an insurance policy with a death benefit. Moreover, no significant population growth is expected. Winning new customers is therefore becoming increasingly difficult.
- A number of insurance companies collapsed during the economic slump in the 1990s. Consequently, people have a lower degree of confidence in conventional insurance products. (There has been a growing trend in the number of existing policies being cancelled.)

■ Non-life insurance companies

- These insurers are experiencing difficulty in increasing premium income and profitability in their key product area, automobile insurance. Behind this trend is financial liberalization, which has led to intensified competition involving premium rates, and to a surge in the number of newcomers.
- Mainstream medical insurance products provide a fixed amount of indemnity. This means that non-life insurance companies, which previously were only permitted to sell products covering the actual loss or damage sustained, will have opportunities to win new customers.

Figure 5. Number of new life insurance policies



Source: “Policies in Force by Type” (The Life Insurance Association of Japan)

(Note) Medical insurance figures for fiscal 2001 and beyond combine medical insurance and cancer insurance.

3 Characteristics of private medical insurance products

Private medical insurance mainly covers “hospitalization” and “surgery”. Typical coverage can be summarized as follows:

Hospitalization	<ul style="list-style-type: none"> - An insurance benefit is paid if a bodily injury or illness causes the insured to be hospitalized. - The insurance benefit is calculated as follows: [Amount of hospitalization benefit per day] × [Days of hospital treatment] - The hospitalization benefit is paid irrespective of the medical expenses actually incurred.
Surgery	<ul style="list-style-type: none"> - An insurance benefit is paid if a bodily injury or illness causes the insured to undergo one of the surgical operations listed in the insurance policy. - The insurance benefit is calculated as follows: [Hospitalization benefit above] × [Multiplying factor specified for each surgical operation] - A multiplying factor of 10, 20, or 40 is used according to the nature of the surgical operation.

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To add to the basic coverage above, each insurance company is developing very well-thought-out products. Such products are mainly characterized by the following three factors:

(1) Improved coverage

a. Increase in the maximum number of days of hospitalization covered

- The maximum period of a single instance of hospitalization in respect of which an insurance benefit is payable.
- Previously, the period was usually 120 days. Longer periods are currently offered. Examples include 365 days (one year), 730 days (two years), and 1,095 days (three years).

b. Reduction in the period of hospitalization without coverage

- The period of a single instance of hospitalization in respect of which no insurance benefit is payable.
- Previously, the period was usually four days (in which case, an insurance benefit only becomes payable when hospitalization of five or more days is required) or seven days. However, the period has been reduced to such an extent that many of the products currently available cover hospitalization irrespective of its duration.

c. Additional coverage for specific diseases

- Additional coverage is provided for specific diseases including cancer or the three major killer diseases (cancer, acute myocardial infarction, and cerebral apoplexy). For example, an increased sum is paid as a hospitalization benefit, or the usual limit on the number of days of hospitalization covered is waived.

(2) Lower insurance premiums

a. Coverage limited to specific diseases

- Coverage is limited to specific diseases, such as cancer only or the three major killer diseases, in order to set insurance premiums at levels that are more attractive to potential customers.

b. Reduction in the maximum number of days of hospitalization covered

- The maximum number of days covered in respect of a single instance of hospitalization is reduced to 60, in order to keep insurance premiums at reasonable levels.

c. No return of premium for cancellation

- Usually, if an insurance policy is cancelled at some point during the policy period, an amount equivalent to the policy reserves accumulated by the time of the cancellation is refunded. An increasing number of products do not offer such a refund, but instead charge lower insurance premiums.

*Refer to the Appendix at the end of this paper for actuarial details.

(3) Simplified underwriting methods

a. Non-medical application

- A type of insurance policy application where no medical examination by a physician is required. The proposed insured is asked to answer several questions on his or her state of health and medical history. On the basis of the answers provided, approval or disapproval is given. If approval is given, underwriting conditions are set accordingly.
- Non-life insurance companies do not have many physicians in their employ. However, using this application method enables them to enter the medical insurance market at minimum cost. Therefore, a large number of non-life insurance companies have adopted this approach.

<Examples of questions contained in a disclosure form> -----

Question 1:	Have you been examined, tested, treated, or placed on medication by a physician within the last three months?
Question 2:	Within the last five years of the date of this disclosure statement, have you
	(a) been examined, tested, treated, or placed on medication by a physician for a period of seven days or more because of a single disease or injury; or
	(b) undergone or been advised to undergo a surgical operation because of a disease or injury?
Question 3:	Within the last two years of the date of this disclosure statement, has any of your checkups or thorough physical examinations shown any abnormalities?
Question 4:	(a) Do you have any disabilities involving your eyesight, hearing, speech, or mastication?

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- (b) Are any of your limbs and fingers missing or functionally disabled?
- (c) Is your spine (spinal column) deformed or defective?
- Question 5: (Answer only if you are female and 16 years of age or older.)
Does any of the following apply to you?
- (a) Have you been hospitalized or undergone a surgical operation because of an abnormal pregnancy or delivery within the last five years of the date of this disclosure statement?
- (b) Are you pregnant now?
- Question 6: Within the last five years of the date of this disclosure statement, has any similar insurance policy application made by you met with any rejection or policy termination because of your physical condition?
- - The application is rejected if the answer is “yes” to any of Questions 3 through 6.
- If the answer is “yes” to any of Questions 1 through 3, the application may be accepted on condition that the illness or body part concerned be excluded from coverage.

b. Guaranteed issue

- All applicants are allowed to buy an insurance policy without having to undergo a medical examination by a physician or to disclose their state of health.
- This type of insurance is intended to be sold to the middle-aged and elderly, many of whom are prevented from taking out common types of insurance.
- However, to ensure risk control the following adjustments are made in terms of product design and undertaking conditions:
 - (a) Insurance premiums are considerably higher than those charged under common types of medical insurance.
 - (b) The maximum limit of liability is kept at a lower level.
 - (c) No coverage is provided for any illness manifesting itself during a certain period (for example, 90 days) after the effective date of a policy.

- (d) No coverage is provided for any illness manifesting itself before the effective date of a policy.

4 Development of private medical insurance products and management of the risks involved

This section mainly discusses tasks performed by actuaries in relation to insurance companies' development of medical insurance products and management of the risks involved.

Specifically, the discussion is concerned with products with a long policy period (whole life insurance policies), which have a high degree of future uncertainty and require actuaries to apply their professional skills.

(1) Premium rate calculation

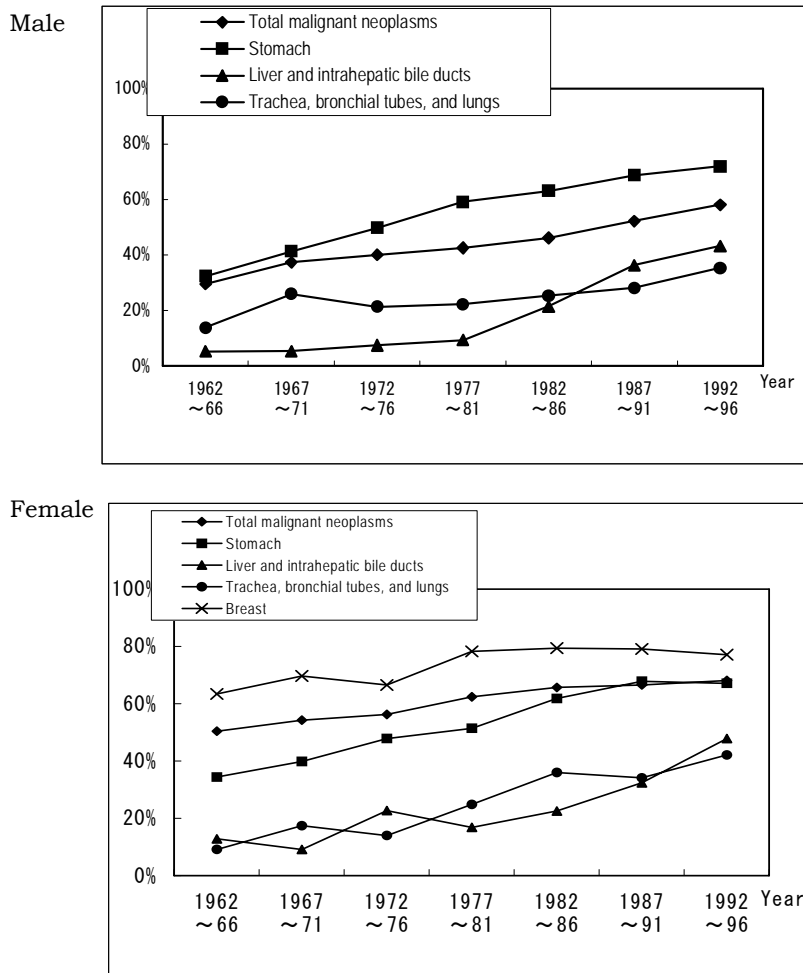
- The amount of publicly available statistical data on medical insurance is limited.
- For this reason, insurance companies usually use their own past performance data to calculate premium rates. Those with no experience in selling medical insurance, such as non-life insurance companies, use public statistics.
- The most frequently used public statistics are "Patient Survey" results published by the Ministry of Health, Labour and Welfare (an administrative agency).
- The survey, conducted every three years, samples medical facilities on a nationwide scale to examine the status of patients on a given day. The results show the number of patients by sex, age, area, type of injury or illness, length of hospitalization, and so forth.
- However, the survey results mentioned above are nothing more than public statistics. If they are to be used for calculating premium rates to be charged for insurance products, the following points must be taken into consideration:
 - a. The data provided may be biased because the survey focuses on one specific day at sampled medical facilities.
 - b. Characteristics specific to the group of persons insured must be identified. For example, if the group consists entirely of healthy persons meeting strict undertaking conditions, the group's hospitalization rate may be lower than that suggested by public statistics. Nevertheless, the group's hospitalization rate may be higher than that based on public statistics because persons opting to insure themselves tend to be anxious about their health in the first place.
 - c. It is hard to predict how changes in benefit payment conditions will affect the degree of risk. An example would be a case where the period of hospitalization without coverage or the maximum number of days of hospitalization covered is changed. In such a case, the resulting increase or decrease in benefit payments cannot be readily

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calculated with accuracy from public statistics.

- Additionally, long policy periods entail an extremely important and difficult issue, which is how best to incorporate “future uncertainties” into premium rates.
- Earnings from medical insurance fluctuate because of the following factors, which are hard to predict:
 - a. Advances in medical technology
 - A higher survival rate leads to a longer treatment period, which increases benefit payments.
 - Technological advances enabling earlier detection of cancer or other diseases bring about a greater number of patients and a longer treatment period, thereby increasing benefit payments.

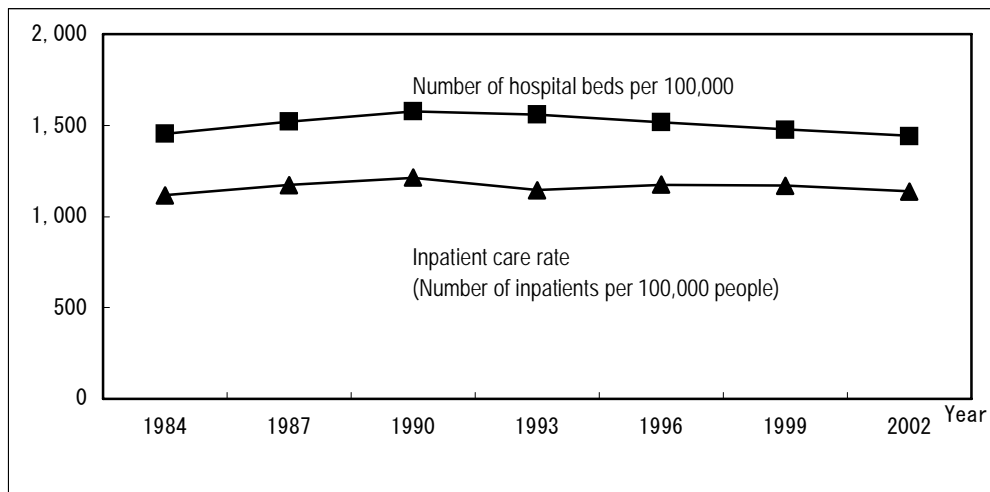
Figure 6. Five-year survival rates of newly diagnosed and hospitalized cancer patients



Source: Data collected by the National Cancer Center Hospital and published in “Cancer Statistics in Japan 2003” (National Cancer Center)

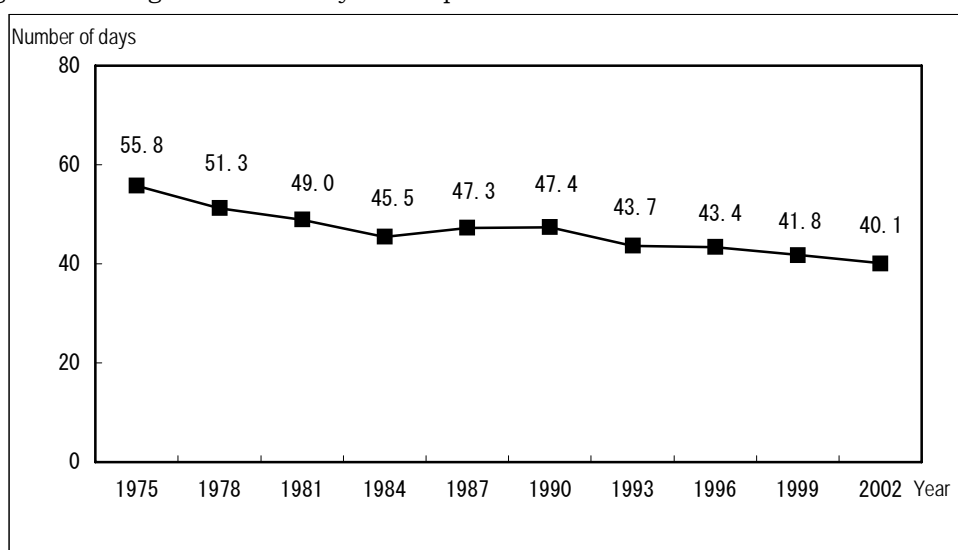
- b. Increase in average life expectancy
 - If the expected mortality rate of insured persons (a measure of their survival in the future) is incorporated into insurance premium calculations, an increase in average life expectancy means a higher-than-expected number of insured persons surviving. In this situation, even if the hospitalization rate remains unchanged, insurance benefit payments increase.
- c. Changes in population structure
 - If the aging of Japan's population continues, the average morbidity rate of the population as a whole rises, increasing benefit payments.
 - However, this does not pose much of a problem if premium rates are graded by age group.
- d. Unknown diseases
 - No statistical data cover unknown diseases. Therefore, an unknown disease with severe symptoms leads to unexpected benefit payments.
- e. State of affairs surrounding the public medical insurance system
 - Japan has a national policy of regulating the number of hospital beds. The policy limits the number of hospital beds available in each area.
 - This means that even if the morbidity rate rises, only a limited number of beds are available. Additionally, medical insurance policies do not pay an insurance benefit unless hospitalization is required. For these reasons, benefit payments do not exceed a certain level.
 - However, if the regulation mentioned above is relaxed or abolished at some future point, the number of inpatients may rise dramatically, leading to an increase in benefit payments.
 - Japan is about to initiate an effort to reduce the number of days of hospital treatment in accordance with another national policy. Any future change in this policy may result in increased benefit payments.

Figure 7. Number of hospital beds and inpatient care rate (per 100,000 people)



Source: "Medical Facility Survey" and "Patient Survey" results (Ministry of Health, Labour and Welfare)

Figure 8. Average number of days of hospital treatment



Source: "Patient Survey" results (Ministry of Health, Labour and Welfare)

- In reality, a certain safety loading factor is applied to each premium rate to cater for the above-mentioned future uncertainties.

(2) Policy reserves

- Insurance products with long policy periods require appropriate premium rate calculations to be made at the time of policy issue. Just as important is setting aside appropriate policy reserves after policy issue so as to cover possible future benefit payments.
- In Japan, the following types of policy reserves are required in respect of medical insurance:

a. Premium reserves

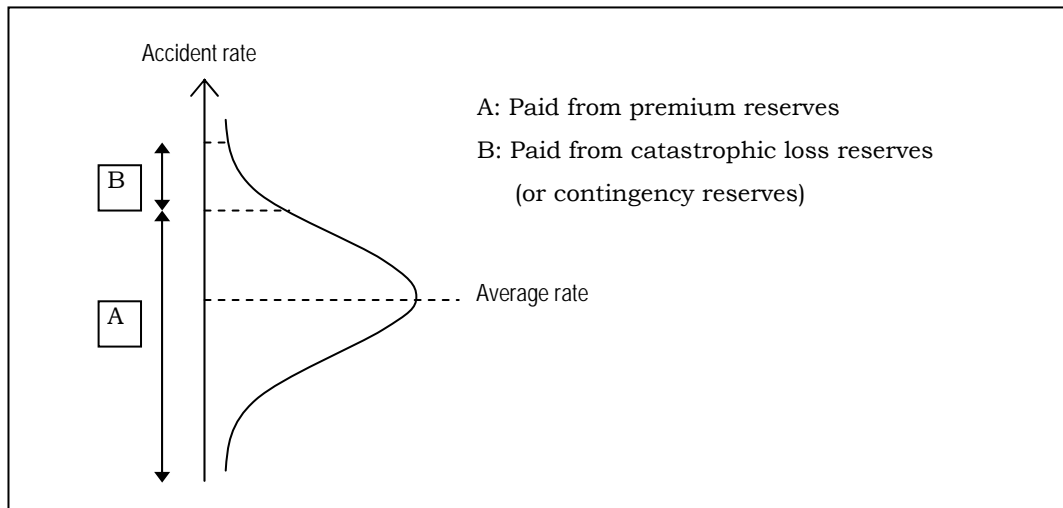
- Reserves held to cover benefit payments arising from risks that are usually predictable.
- An accumulation method and a set of standard basic rates (used for calculating the reserves) are defined by law.
- Currently, the standard basic rates mentioned above consist only of an assumed interest rate and an expected mortality rate, and do not include any hospitalization rate or other actuarial criteria. The necessary legal arrangements will be made in keeping with growth of the medical insurance market.

b. Additional reserves

- Reserves held additionally in cases where the premium reserves described in "a" above are deemed insufficient to cover future benefit payments. An example would be a case where one of the basic rates used for calculating the above-mentioned premium reserves is considered to have changed.

- First, future earnings and benefit payments are projected by stress testing or other means. On the basis of the resulting projections, the sufficiency of the existing policy reserves is then evaluated. By doing so, the necessity for additional reserves is determined.
- c. Catastrophic loss reserves (or contingency reserves)
 - Reserves held in addition to the reserves described in “a” and “b” above to cover benefit payments arising from risks beyond those that are usually predictable.
 - Each life insurance company sets aside an amount calculated by multiplying its total amount of insurance in force by a certain rate. Each non-life insurance company sets aside an amount calculated by multiplying its premium income by a certain rate. The reserved funds are used to cover benefit payments arising from a shock loss.

Figure 9. Conceptual diagram of policy reserves



(3) Follow-up assessment

- Once products are sold, earnings conditions must be checked regularly. If earnings fall or fluctuate, the contributing factors must be analyzed so that the necessary risk control measures can be taken.
- In Japan, no generally agreed rules exist to govern risk management related to medical insurance. Basically, each insurance company is managing risks according to its own rules.
- Commonly used risk control methods include:
 - a. Paying from catastrophic loss reserves (or contingency reserves)
 - b. Setting aside additional reserves
 - c. Changing insurance premiums charged under new policies
 - d. Changing the details of coverage provided by new policies (setting a period without coverage, excluding specific diseases from coverage, etc.)
 - e. Changing the conditions for undertaking new policies (changing the

- maximum limit of liability etc.)
- f. Changing the customer segments targeted by new policies (limiting by age, limiting sales channels, etc.)
- g. Suspending new policy sales

- With long-term medical insurance, another option exists, namely that of exercising the right to change the basic rates applicable to existing policies.
- The use of this option relies on a provision included in insurance policies, in advance. Under the provision, each policyholder's consent is obtained to allow the insurer to change the applicable insurance premium during the policy period if the need arises. Typically, the cause of this change would be defined as a rise or fall in benefit payments, or an increase in average life expectancy. If the insurer wishes to actually change the insurance premium, it does so with the approval of the competent authorities.
- Not all long-term medical insurance policies contain a provision allowing the insurer to change the applicable basic rates. Some insurance companies opt to include such a provision, but others do not.
- However, it should be noted that the right to change basic rates has never actually been exercised thus far. Some hurdles must be cleared before the right can become fully exercisable. For example, most policies do not contain well-defined standards for exercising the right. In addition, the practical ramifications of the use of the right (such as damage to the insurer's social creditability) have not yet been fully considered.

5 Administrative supervision and regulation

- Both life insurance companies and non-life insurance companies are allowed to sell medical insurance. Such sales are governed by rules and regulations set up by individual life insurance companies and non-life insurance companies.
- Certain basic guidelines were put in place when the Third Sector was opened to all insurance companies in 2001. Nevertheless, differences remain among insurance companies in some aspects, including methods for setting aside policy reserves or methods for calculating the solvency margin ratio.
- The Financial Services Agency and others organized a study team in view of (i) the recent growth of the medical insurance market, and (ii) risk characteristics unique to medical insurance (characteristics different from those involved in insurance in the First or Second Sector). The team has discussed how rules specific to insurance in the Third Sector should be designed to govern, among other things, (i) the way policy reserves are set aside, and (ii) the way follow-up assessments are made. The move is expected to be followed in due course by establishment of formal rules.

(As of this writing, the study team is still going through the discussion process. However, the team will have produced some tangible results by the time of the 13th East Asia Actuarial Conference.)

6 Conclusions

- Private medical insurance involves uncertainties that may lead to future fluctuations in the degree of risk. Specifically, such uncertainties arise from factors including external changes (those reflecting advances in medical technology, the state of affairs surrounding the public medical insurance system, and so forth) and the current lack of sufficient statistics.
- We actuaries must endeavor to hone our professional actuarial skills. Doing so is essential to product development and risk management based on an accurate evaluation of the above uncertain risk factors, and to insurance companies' profitability and financial soundness.
- Private medical insurance relies to a large extent on the public medical insurance system operating in the country concerned. It is our wish to contribute to the development of a sound market by learning from examples in other countries.

Appendix: Earnings structure of a product incorporating a surrender ratio for premium calculation purposes

1. Insurance premium

<Conditions>- Policy period: Whole of life

- Hospitalization benefit: 10,000 yen per day
- The maximum number of days covered in respect of a single instance of hospitalization: 120days
- Premium payment method: Annual payment
- Insured's gender: Male

<Symbols> q_x : Expected mortality rate at age x

w_x : Expected surrender ratio at age x

ξ_x : Expected hospitalization rate at age x

T_x : Average number of days of hospital treatment at age x

$$v = \frac{1}{1+i}$$

i : Assumed interest rate (= 1.5%)

α : Safety loading applied to premium (= 0.2)

P_x^A, P_x^B : Premiums at entry age x

Statistics published by a public organization were used to calculate q_x , ξ_x , and T_x .

Premiums

Product A: Product not incorporating a surrender ratio (= with a return of premium for cancellation)

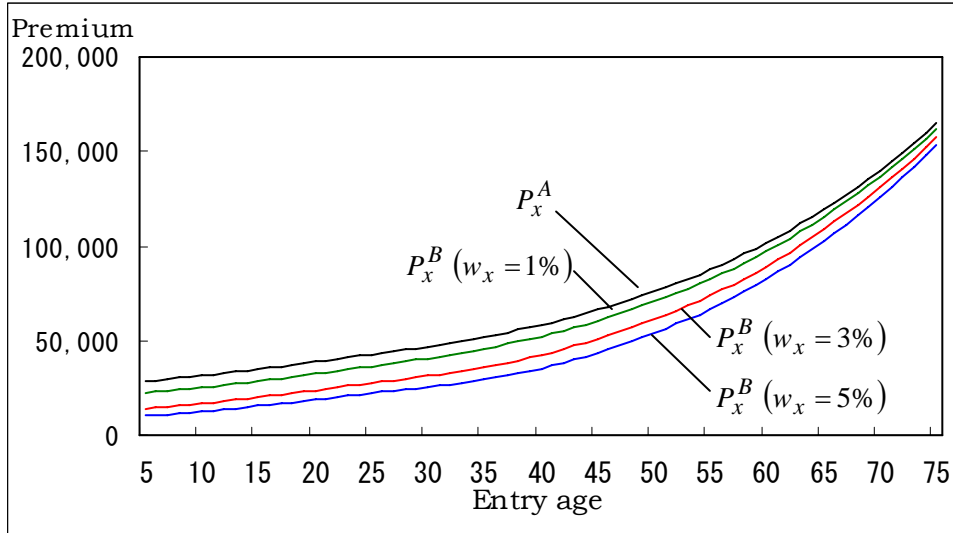
$$P_x^A = \frac{\sum_{t=0}^{\infty} v^t {}_tP_x^A \xi_{x+t} T_{x+t}}{\sum_{t=0}^{\infty} v^t {}_tP_x^A} \times (1 + \alpha) \quad {}_tP_x^A = \prod_{k=0}^{t-1} (1 - q_{x+k}) \quad {}_0P_x^A = 1$$

Product B: Product incorporating a surrender ratio (= without a return of premium for cancellation)

$$P_x^B = \frac{\sum_{t=0}^{\infty} v^t {}_tP_x^B \xi_{x+t} T_{x+t}}{\sum_{t=0}^{\infty} v^t {}_tP_x^B} \times (1 + \alpha) \quad {}_tP_x^B = \prod_{k=0}^{t-1} (1 - q_{x+k} - w_{x+k}) \quad {}_0P_x^B = 1$$

- The higher the expected surrender ratio, the lower the premium becomes.

Figure 10. Premium



Entry age (years old)	20	30	40	50	60
P_x^A	38,639	46,861	58,273	76,056	101,864
$P_x^B (w_x = 1\%)$	32,449	40,655	52,197	70,614	97,391
$P_x^B (w_x = 3\%)$	23,773	31,307	42,352	61,323	89,417
$P_x^B (w_x = 5\%)$	18,786	25,303	35,221	54,004	82,682

2. Earnings simulation

- Product B in "1" (with an entry age of 40 and an expected surrender ratio of 3%) was simulated as follows:

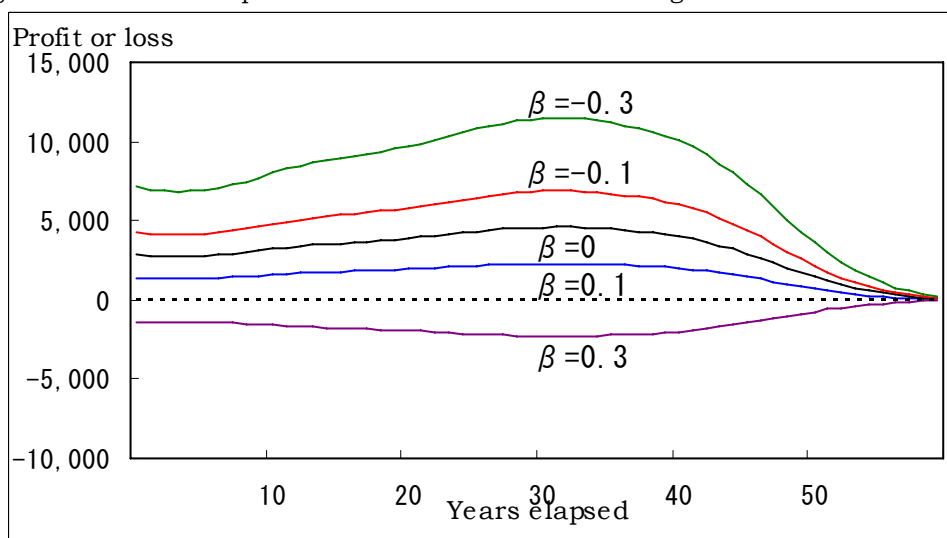
(1) Hospitalization rate variations

$$\xi'_x = (1 + \beta)\xi_x \quad \xi'_x : \text{Actual hospitalization rate}$$

- Earnings fall if the hospitalization rate rises.
- Including a safety loading in the premium is effective to some extent in coping with an increase in the hospitalization rate.

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Figure 11. Effect of hospitalization rate variations on earnings



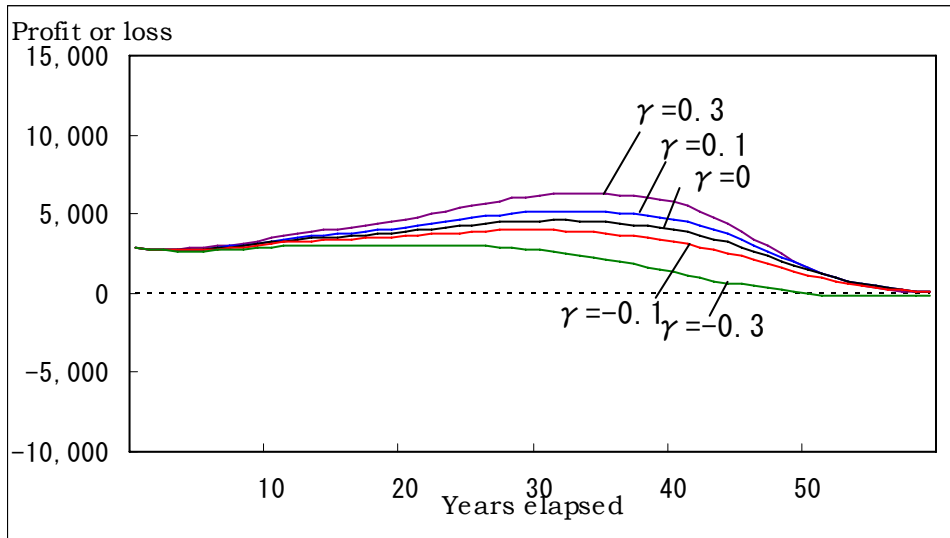
Years elapsed (years)	10	20	30	40	50
$\beta = 0.3$	-1,546	-1,904	-2,278	-2,070	-866
$\beta = 0.1$	1,546	1,904	2,278	2,070	866
$\beta = 0$	3,091	3,809	4,556	4,140	1,731
$\beta = -0.1$	4,637	5,713	6,834	6,209	2,597
$\beta = -0.3$	7,728	9,521	11,390	10,349	4,328

(2) Mortality rate variations

$$q'_x = (1 + \gamma)q_x \quad q'_x : \text{Actual mortality rate}$$

- A decline in the mortality rate causes the number of surviving insured persons to exceed the originally expected level. Therefore, earnings fall even if the hospitalization rate remains unchanged.

Figure 12. Effect of mortality rate variations on earnings



Years elapsed (years)	10	20	30	40	50
$\gamma = 0.3$	3,310	4,533	6,088	5,898	2,042
$\gamma = 0.1$	3,164	4,054	5,092	4,814	1,933
$\gamma = 0$	3,091	3,809	4,556	4,140	1,731
$\gamma = -0.1$	3,018	3,559	3,994	3,365	1,387
$\gamma = -0.3$	2,870	3,047	2,787	1,480	95

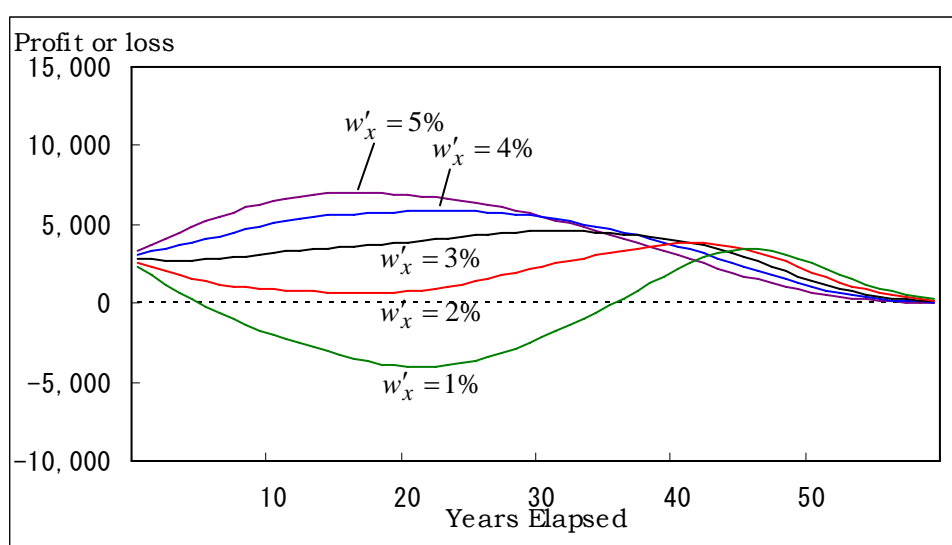
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(3) Surrender ratio variations

w'_x : Actual surrender ratio

- A decline in the surrender ratio causes the number of surviving insured persons to exceed the originally expected level. Therefore, earnings fall even if the hospitalization rate remains unchanged.

Figure 13. Effect of surrender ratio variations on earnings



Years elapsed (years)	10	20	30	40	50
$w'_x = 5\%$	6,306	6,925	5,714	3,292	854
$w'_x = 4\%$	4,873	5,791	5,563	3,865	1,238
$w'_x = 3\%$	3,091	3,809	4,556	4,140	1,731
$w'_x = 2\%$	912	681	2,135	3,683	2,301
$w'_x = 1\%$	-1,717	-3,968	-2,526	1,725	2,828

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