Financing Health Care in Japan: A Fast Aging Population and the Dilemma of Reforms*

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Abstract

This paper is aimed at providing a quantitative analysis of the impact of population aging in Japan on financing its universal health insurance system and potential reform policies. We construct a general equilibrium life cycle economy that is used to study the impact of an aging population on household's work and savings behavior, as well as on aggregate output and welfare. In particular, taking 2010 as an initial steady state, we calculate the transition path predicted by our model as the population structure changes and medical costs increase. We also evaluate various policy alternatives designed to lessen the negative impact of aging on the economy. We show that even though the potential reforms improve the welfare of the future generation significantly, there is a political difficulty to implement any of the reforms.

Keywords: Universal Health Insurance, Population Aging, Japan

JEL Classification: E21, H51, I10

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1 Introduction

This paper aims to provide a quantitative analysis of the impact of population aging on the cost of maintaining a universal health care system. We focus on Japan because it has a public universal health insurance (UHI) system that provides health insurance coverage to all its residents, as in most OECD countries, and its population has been aging dramatically over the past two decades. We study the tax burden associated with financing the UHI and the impact it has on the economy as the population ages. Potential reforms of the UHI and how it is financed will also be evaluated.

The current cost of health care in Japan is relatively low (about 6.6% of GDP or 9.1% of National Income in 2005) compared with other OECD countries. In addition, the Japanese have among the highest life expectancy and lowest infant mortality in the world. The health care system in Japan seems to be in remarkably good shape. However, as the population ages, this low-cost is probably not sustainable with the current framework and financing methods. Japan already has the world's oldest population, and it is projected that 40% will be 65 or older in 2050 (see Figure 1).

The population aging affects the health care system through two channels. First, as the fraction of the population over 65 increases, the fraction that pays taxes and premiums that finance the system decreases. In particular, one quarter of the program's costs are financed by general government revenues, and the rest is paid by premium (a payroll tax) levied on employers and workers, and co-payments made those seeking medical care. It is obvious that the burden of financing health care is mainly on the working-age population (age 15-64), which is projected to shrink to 51% of total population in 2050 with an old-age dependency ratio above 75% (see Figures 1 and 2).[1]

Second, the elderly face higher health risks and need much more care than young people. The data show that the average per-person medical cost for those aged 65 and above is 241.8% as of the average of the total population, and it is about 4 times that of those under age 65. Table 1 presents medical costs per capita for different age groups. A larger elderly population implies higher per capita medical costs. Figure 3 shows the trend of medical costs in Japan. Due to population aging, if the current system is to be maintained, either the government subsidy or the insurance premium, which is a tax on labor income, charged to workers and employers has to increase to finance the extra cost of

[1] Data source: National Institute of Population and Social Security Research, Japan.

the health care system. Either way, the financial burden on the working age population will increase.

In this paper, we construct an equilibrium life cycle model and carry out quantitative exercises to help understand: 1) the impact of demographic change (in particular population aging) on the costs of financing the UHI; 2) the impact of the above changes on household working and saving behavior, as well as on aggregate economic performance; and 3) the effects of potential reforms of the UHI and the methods used to finance the program; 4) how likely are the reforms to happen? Our goal is to identify and compare potential government policy responses to the ongoing changes in the age structure of Japan's population and the impact this will have on the country's health care system. The political difficulty of the reforms will be also discussed by an investigation of welfare changes in current and future generations. Transition paths corresponding to each of potential reforms are considered to provide a precise analysis of the welfare changes for the current generation that affects the political acceptance of the reforms.

We find that the fast population aging increase the aggregate medical care cost, and therefore would increase the burden of financing the UHI – it will need additional 8.8% of labor income in 2050. If the medical price grows faster than productivity by 0.6% per year, as observed in the US, labor tax (including the UHI premium tax) has to increase 13.6 percentage points to finance the UHI in 2050. The high labor tax rate further discourages labor supply when the working-age population is shrinking due to population aging. Potential reforms to reduce the labor tax burden, which are discussed in this paper, include an increase in UHI co-payment and raising consumption tax. We present the welfare gains of the reforms relative to the benchmark where only the labor income tax (including payroll and UHI premium taxes) adjusts to balance the government budget constraint. In this study, we perform both steady state comparison and transition analysis to understand the welfare implications for the future and the current generations, respectively.

The method of our transition analysis is based on Nishiyama and Smetters (2005, 2007), which explicitly consider transition path of fiscal reforms and social security reforms. We find that even though the reforms reduce the tax burden on the working-age population and significantly improve the welfare of the future generation, the current generation will suffer except young persons. In addition, older people would encounter higher welfare loss since they have less or even no time to prepare for the policy changes when they are working. This finding indicates that the reforms are difficult to be supported by the majority of the population.

Previous studies have considered health/medical expenditure shocks in life cycle models. Hubbard, Skinner, and Zeldes (1995) consider medical expenditure shocks, which might cost more than an individual's wealth, and investigate the role of means-tested social insurance system on the savings. French (2005) estimates a life cycle model and studies the effect of uncertain health status on retirement behavior. De Nardi, French and Jones (2010) find that uncertain expensive medical expenditure and the risk of long-living are the main reasons for retirement saving behavior, and the bequest motive has small impact on the old saving. French and Jones (2010) also estimate a life cycle model to study the effects of health insurances on retirement behavior. In the previous studies, the general equilibrium effects are not considered. This study investigates the impacts of population aging and potential reforms, which are likely to change aggregate labor supply and capital stock and lead to price changes. To provide a more precise analysis, we undertake a general equilibrium life cycle model to capture the interaction between individual behavior and aggregate economy.

In the literature, a general equilibrium life cycle framework has been used to study various social programs. One can see Attanasio et al. (2007), Hugget and Parra (2009), and İmrohoroğlu and Kitao (2010), for example. However, without a few exceptions by Jeske and Kitao (2009) and Attanasio et al. (2010), health insurance systems are out of their scope. Attanasio et al. (2010) is a study close to us, which investigates the impact of population aging on financing Medicare, a pubic health insurance program covering individuals aged 65 and above in the US, and potential reforms. Because of the immigrants, population aging in the US is not as fast as in Europe and not comparable with it in Japan. We study Japan that is a good example to understand the impacts of a fast aging population. Moreover, besides evaluating the welfare changes of potential reforms for the further generation (i.e. in the steady state), as in Attanasio et al. (2010), we further discuss the welfare implications of potential reforms to the current generation, whose support is politically crucial to a reform policy, by analyzing the corresponding welfare changes along the transition.

This paper proceeds as follows. In Section 2, we briefly describe the health insurance system in Japan. In Section 3, we construct a general equilibrium life-cycle model. In Section 4, we calibrate parameters to match Japanese economy. In Section 5, we discuss quantitative results. We conclude in Section 6.

2 Health Insurance System in Japan

As in many OECD countries, Japan provides an public universal health insurance system, which covers all of the citizens including employee, self-employed, unemployed, children and retirees. There were already some independent health insurance programs based on jobs and occupations before World War II.[2] The Japanese government re-organized those health insurance programs, and achieved the universal health insurance coverage in 1961.

The actual application of the insurance to any given person is complicated and depends on several factors: age, job/occupation and employment status and so on. There are hundreds of insurers, which are managed by societies or central/local governments, providing health insurance coverage and collecting premiums. Although there exist many different insurers, they are not to choose. The insurer assigned to a specific individual is determined according to the above individual factors. However, all the insurance benefits are set by the government regardless the insurer.

The current public health insurance can be divided into three categories: (a) employment-based health insurance (*Shakai Kenkou Hoken*), (b) community-based health insurance (*Kokumin Kenkou Hoken*) and (c) health insurance for the elderly (*Rojin Kenkou Hoken*).

Most workers are included in the employment-based health insurance system. There are several health insurance schemes based on occupation:

- *Kenko Hoken*: Most employees who work in private sector are covered by Kenko Hoken. Depending on the size of firms they work, there are two types: society-managed health insurance and government-administered health insurance. Employee of large firms are covered by the society-managed health insurance, and those of small firms are covered by the the government-administered health insurance. There were about 1.5 thousand societies under the society-managed employment-based health insurance scheme in 2009.

- *Kyosai Kumiai*: Employees of public sectors (both central and local public sectors) and teachers are covered by Kyosai Kumiai, which is also an society-managed health insurance. There were 76 societies under this scheme in 2009.

[2] For a brief history and effects of the development of universal public health insurance system in Japan, see Kondo and Shigeoka (2011).

The community-based insurance, *Kokumin Kenkou Hoken*, covers people who are not included in the category (a), e.g., the self-employed, the unemployed, irregular employees and retired people.[3] It is organized by local governments. There were about 2 thousand insurers.

Membership of one or the other system is compulsory and not to choose. Monthly premiums are calculated slightly differently for each insurer/socieity but are based mostly on salary (equivalently a labor income tax). The soceities/insurers also receive government subsidies for the insurance payment. The general coverage of the UHI is 70% of medical expenditures (i.e. a 30% co-payment). For senior people aged between 70 to 74, the co-payment rate is reduced 20% except that their income is higher than a threshold.

Health insurance for the elderly was introduced in 1983 to spread the burden of providing health care for this group equally among various health insurance insurers. The health insurance for the elderly provides coverage for persons aged 75 and above. The co-insurance rate (or co-payment rate) of the health insurance is 10% except that the income is above a threshold and it becomes 30%. This insurance is highly subsidized. About 50% of the cost of this health insurance for the elderly is from public subsidy. The subsidy is shared by state, prefectures, and municipalities with a 4:1:1 cost-sharing rule. About 40% of the insurance cost is financed by young people's premiums collected by all the insurers/societies. Only 10% is contributed by the elderly's premium payments.

In total, the government subsidy to the UHI system contributes about 25% of the total medical care cost. The rest is financed by premiums (mainly on young people) and co-payments.

3 Model

A general equilibrium life-cycle model with national health insurance, endogenous labor supply and incomplete markets is constructed in order to carry out our analysis. We focus on the steady state and transition dynamics.

3.1 Demographics

The economy is populated by overlapping generations of individuals of age $j = 1, 2, ..., J$. The lifespan is uncertain. An individual of age j survives until next

[3]Dependent children and spouses are covered by household heads' health insurance.

period with probability ρ_j which depends on her/his age j. When individuals reach age J, then $\rho_J = 0$ and will leave the economy next period. The size of new cohort grows at a rate g. The population of age j is denoted by μ_j, which evolves $\mu_{j+1} = \frac{\rho_j}{1+g}\mu_j$, and the total population is normalized to one, $\sum_{j=1}^{J} \mu_j = 1$.

3.2 Endowment, Income Uncertainty and Preferences

Individuals enter the economy with no assets and are endowed with one unit of time. They can spend the time on market work for earnings or on leisure. If they decide to spend n hours on the market work, their earnings are given as $w\eta_j zn$, where w is the market wage, η_j is the age-specific productivity, and z is idiosyncratic labor productivity that evolves stochastically to characterize the income uncertainty. η_j is zero after retirement age j^{ss}.

Individuals value consumption and leisure over the life-cycle and determine the sequence of consumption and labor supply according to a utility function $u(c,n)$, which is compatible with balance growth path:

$$u\left(c,n\right) = \frac{\left[c^{\sigma}\left(1-n\right)^{1-\sigma}\right]^{1-\gamma}}{1-\gamma};$$

where γ governs the intertemporal elasticity of substitution.

3.3 Health, Medical Expenditure and National Health Care

3.3.1 Heath Status and Medical Expenditure Uncertainty

Agents face exogenous uncertainty about their health status h. The health status evolves according to the Markov chain among three states of good, fair, and bad, $\{h_g, h_f, h_b\}$, with a transition matrix $\pi_j(h', h)$ that depends on age. Individuals face an idiosyncratic medical expenditure shock $x_j(h)$ in each period.

3.3.2 Universal Health Insurance

Agents can partially insure medical expenditure risks with access to health insurance that covers a fraction ω_j of realized medical expenditure x. The public UHI is available to every resident, and financed by an income-related premium (a payroll tax) and government general revenue. The coverage rate of medical expenditures depends on age j. As will be discussed later, the co-payment rate,

$1-\omega_j$, is 30% under age 70 (i.e. a 70% coverage rate), 20% between 70-74, and 10% over age 75.

To consider the effect of future increases in medical costs, we also estimate the growth of medical expenditures q, which implies that individuals pay $(1-\omega_j)qx$. In the benchmark case, q is set equal to one.

3.4 Public Pension

The public pension program provides the elderly with a benefit ss when they reach the eligibility age of j^{ss} and retire. The program is financed by the social security tax τ_{ss} imposed on labor income of the working population.

3.5 Production Technology

On the production side, we assume that there is a continuum of competitive firms operating a technology with constant returns to scale. Aggregate output Y is given by

$$Y = F(K, L) = AK^{\theta}L^{1-\theta},$$

where K and L are the aggregate capital and effective labor employed by the firm's sector and A is total factor productivity which we assume to be constant. Capital depreciates at rate of δ every period and θ denotes the capital income share.

3.6 Financial Market Structure

Individuals can hold assets that are non-state contingent claims to capital. The rate of return earned from these assets is denoted by r. Households can partially insure themselves against any combination of idiosyncratic labor productivity shocks and medical expenditure shocks by accumulating precautionary asset holdings. While they are allowed to insure themselves by accumulating positive asset holdings, they cannot carry debt, $a \geq 0$. This borrowing limit specially affects the asset holding decision of low-wealth households since they cannot smooth their consumption over time when their disposable incomes falls.

3.7 Government

In addition to the UHI and social security, the government also provides means-tested social insurance (public assistance) in this economy. The government guarantees a minimum level of consumption $\underline{c}$ by supplementing the income in case the household's disposable income plus assets (net after medical expenditure) falls below $\underline{c}$. We consider a simple transfer rule proposed by Hubbard et al. (1995). The transfer T will be made if the household's disposable income plus assets (net after medical expenditure) is smaller than a minimum level of consumption. The transfer amount will be exactly equal to the difference.

Government's revenue consists of revenues from different tax instruments, labor income tax τ_l, capital income tax τ_k, consumption tax τ_c, social security tax (pension payment) τ_{ss}, and the UPHI premium p^{med}. The government uses its revenue to finance all public programs and its own consumption G.

3.8 Household's Problem

The states for an agent is summarized by a vector $s = (j, h, a, z)$, where j is age, h is health status, a is asset holdings brought into the period, and z is the idiosyncratic shock to labor productivity. The household's problem can be expressed as:

$$V(s) = \max_{c,n,a'} \left\{ u(c,n) + \rho_j \beta E\left[V(s') \right] \right\},$$

subject to

$$\begin{aligned}
(1+\tau_c)c + a' &= W + T, \\
W &\equiv y(n,j,z) + (1 + (1-\tau_k) r)(a+b) - (1-\omega_j) qx, \\
y(n,j,z) &= (1 - \tau_l - \tau_{ss} - p^{\text{med}}) w \eta_j z n + ss(j) \\
T &= \max\{0, (1+\tau_c)\underline{c} - W\} \\
ss_j &= \begin{cases} ss & \text{if } j \geq j^{ss}, \\ 0 & \text{otherwise.} \end{cases}
\end{aligned}$$

where T is the transfer made by the means-tested social insurance system, which ensures that agents will not fall into an undesired situation with negative wealth and consumption; ss is the social security benefit, and b is the lump sum transfer of accidental bequests. For simplicity, the public pension benefit is constant for all individuals. We assume that the public pension benefit is a constant fraction of efficient labor, ϕwL, where the replacement rate ϕ is endogenously determined from a budget constraint for soical security system.

Accidental bequests are redistributed by a lump-sum transfer:

$$b' = \int (1-\rho_j) a' d\Phi(s).$$

3.9 Government Budget Constraints

The government finances a fraction ψ of the UHI cost with general revenue. Individuals pay for the remaining fraction, $1-\psi$, through the mandatory UHI premium payment. Currently ψ is equal to 0.25 in Japan. The government budget constraint is as follows:

$$\underbrace{\int [\tau_l w \eta_j z n + \tau_k r(a+b) + \tau_c c] d\Phi(s)}_{\text{Tax Revenue}} = \underbrace{\psi \int (\omega_j q x) d\Phi(s)}_{\text{UHI subsidy}} + \int T d\Phi(s) + G$$

$$\underbrace{\int (p^{\text{med}} w \eta_j z n) d\Phi(s)}_{\text{Premium}} = (1-\psi) \int (\omega_j q x) d\Phi(s)$$

where $\Phi(s)$ is a distribution function over state variables. In the benchmark, we set the tax rates (τ_k, and τ_c) equal to the current rates (in 2010) and set G equal to its current value as a percentage of GDP. In experiments with predicted population aging or medical care cost increases, we suppose the government will adjust the payroll tax to balance its budget and keep the values for G, τ_k, and τ_c fixed. This allows us to investigate how large is the extra burden on individuals (measured by changes in τ_l and p^{med}) caused by the cost changes for the UHI.

The social security public pension system is self-financed with a Pay-As-You-Go scheme:

$$\int (\tau_{ss} w \eta_j z n) d\Phi(s) = \int (ss) d\Phi(s).$$

From the assumption that the public pension benefit is a constant fraction of the efficient labor L, the replacement rate ϕ is determined to satisfy $\sum_{j=1}^{jr} \mu_j \tau_{ss} = \sum_{j=jr+1}^{J} \mu_j \phi$.

3.10 Stationary Recursive Competitive Equilibrium

A stationary recursive competitive equilibrium is defined as a set of household decision rules for asset holding a', labor supply n and consumption c; a set of firm decision rules for capital rented K and effective labor employed L; a price system w and r; a government policy of tax rates τ_{ss}, τ_l, τ_k and τ_c, public pension benefits ss, an UHI premium p^{med} and a subsidy ratio ψ; and a distribution of households over the state variables $\Phi(s)$, such that:

a) given the price system, the decision rules of K and L solve the firm's problem;

b) given the price system and the goverment policy, the decision rules (a', n, c) solve the household's problem;

c) government policies $(\tau_{ss}, \tau_k, \tau_l, \tau_c, ss, p^{med}, \psi)$ satisfy the government's budget constraints;

d) $\Phi(s)$ is stationary;

e) all markets clear: $L = \int (\eta_j zn) d\Phi(s)$ and $K' = \int a' d\Phi(s)$ (or $K = \int a d\Phi(s) + b$);

f) resource feasibility condition is satisfied

$$Y = C + K' - (1-\delta)K + qX + G;$$

where C is the aggregate consumption, and X is the aggregate medical expenditure.

4 Calibration

In this section, we describe calibration and parameter selection. Table 4 summarizes some key parameters.

4.1 Preference

We set the subjective discount factor β equal to 0.98 so that the after-tax interest rate and the capital-output ratio K/Y in the model matches recent values for Japan. The elasticity of intertemporal substitution $1/\gamma$ is assumed to be 0.5, i.e., γ is set at 2, and the share of labor supply parameter σ is set at 0.33.

4.2 Production Function

Parameters of the production function, capital's share θ and the depreciation rate δ, are taken from İmrohoroğlu and Sudo (2010). They estimate these parameters from the SNA by extending Hayashi and Prescott (2002)'s calibration to the current Japanese economy. We set the capital share to be 0.377, and the depreciation rate 0.08 respectively.

4.3 Demographics and Survival Probability

A household enters the economy at age 20, retires at 65, and lives at most until 100. The National Institute of Population and Social Security Research (IPSR) provides future projections on Japanese demographic changes. The most recent projection was estimated in 2006, and provides forcasts of demographic changes from 2005 to 2055. The projection consists of three variations on fertility rates, high, medium, and low, and also three variations on mortality rates. Thus, we have nine projections. We use medium variants on both fertility and mortality rates. For stationary state comparison, the survival probabilities $\{\rho_j\}$ are taken from the life table for males in 2010 (*initial* stationary state) and 2050 (*final* stationary state). The population growth rate g is set at 0 in the initial stationary sate, and it is set at -1.5% at final stationary state. Figure 4 and 5 plots the actual and simulated population distribution in 2010 and 2050 respectively. The faction of retired households, which is defined as the ratio of households aged over 65 to those between 20 and 64, in the model (26.43%) is quite close to the actual data (26.75%) in 2010. We assume the negative population growth rate because the actual population distibution is extremelyl aging in 2050. Under the assumption of negative population growth rate, the fraction of retired households in the model (45.0%) is close to the data (44.12%).

4.4 Medical expenditure

Micro-level panel data of medical expenditure are not publicly accessible in Japan. There is no database like the Medical Expenditure Panel Survey (MEPS) in the US, which is widely used to calibrate medical expenditure states and transition probabilities.[4] To do a careful calibration for Japan, our main source is the report of Kan and Suzuki (2005). Kan and Suzuki studied the concentration and

[4]See, for example, Jeske and Kitao (2009) and Attanasio et al. (2010).

the persistence of health care expenditures in Japan. They had a special permit to access the health insurance claim data from 111 Japanese health insurance societies between 1996 and 1998. The data are panel and contain 35,970 individuals with age between 0 to 70.

4.4.1 Transition Probabilities

Kan and Suzuki (2005) analyzed the transition of medical expenditure in 5 age groups (0-17, 18-35, 35-45, 46-55, and above 55). Within each age group, they divided the samples into 10 medical expenditure quantiles and reported the corresponding transitions from 1996 to 1998.

Our purpose is to estimate the annual transition for medical expenditures for each age (from 20 to 100). To have a clear transition patterns over age, we re-classify the 10 quantiles to 3 states of medical expenditures: 'low', 'middle' and 'high'. The category 'low' includes those in the bottom 50% of medical expenditures, the 'middle' contains the 6th quantile to the 9th quantile, and the 'high' category represents the top 10% expenders. The three states are unevenly classified such that they are able to capture the long-tail in the distribution of the medical expenditures and a small probability of incurring very large and catastrophic expenditures.

The original report in Kan and Suzuki (2005) present the transition of medical expenditure in a 2-year period. Because our model period is one year, we transform the 2-year transition matrices to a one-year transition matrices. Table 2 displays the one-year transition of the 3 states. We can observe that the probabilities of transiting to 'low' are monotonically decreasing in age. On the other hand, the probabilities of transiting to 'high' in general show an opposite pattern across age groups. In the computation, we linearly interpolate the transition probabilities so that transition matrices change smoothly over the life-cycle.

The transition probabilities of remaining in the same states over the life cycle are shown in Figure 6. The probability of staying in "low" (the line 'low-low') is monotonically decreasing in age, while the probability of remaining in "high" (the line 'high-high') is monotonically increasing after age 26. In Figure 7, we display the unconditional probabilities of being in the three expenditure states over the life cycle, implied by the transition matrices.

4.4.2 Medical Expenditure States

The "Estimates of National Medical Care Expenditures," which is published by the Ministry of Health, Labor, and Welfare of Japan, provides the data of average medical expenditures by age. For our calibration, we need the expenditure shares of the three states, low (bottom 50% individuals), middle (next 40%) and high (top 10%), in each age. According to Kan and Suzuki (2005), which provides the information of average expenditure shares of 10 quantiles (unconditional on age) from 1996 to 1998, we can calculate the average shares of the three expenditure states in total medical expenditure. We find that the bottom 50% in the distribution ("low") only contributes 7.1% of total medical expenditure, the next 40% of the distribution ("middle") contributes 38.1% of total medical expenditure, and the top 10% people's share of total medical expenditure is as high as 54.8%. We assume that the expenditure shares of the three states are stable across age, and then can compute the medical expenditures of the three states for each age group with the latest (2007) data from the "Estimates of National Medical Care Expenditures." The estimated results are presented in Table 3.

We also linearly interpolate the medical expenditures so that the medical expenditures change smoothly over the life-cycle. Figure 8 shows the estimated medical expenditures of the three states from age 20 to 100.

In the model, we normalize the medical expenditure $x_j(h)$ to match the aggregate medical expenditure-output ratio X/Y, where $X = \int(x)d\Phi(s)$, with the data. We set X/Y as 7.1% in the initial stationary state. Because the aggregate medical expenditure-output ratio increases by year, we determined the target from trend of X/Y after 2000. In the final stationary state and transition paths, X/Y is endogenously determined since both output Y and the price of medical care q change in the experiments.

4.5 Wage shock process

We approximate the labor productivity shock z by AR(1) process:

$$\ln z_{j+1} = \lambda \ln z_j + \varepsilon_j.$$

It is difficult to estimate stochastic hourly wage process without micro data on earnings and hours worked. It is very restricted to use such micro data of Japanese labor market. We use the estimates by Abe and Yamada (2009), who estimate the income process of Japanese households from the National Survey of Family Income and Expenditure, as a target of calibration for income risks. As labor supply in our model is endogenous, the corresponding income inequality is also endogenously determined. We set the skill shock parameters $\{\lambda, \sigma_{\varepsilon}^2\}$ to replicate Japanese income inequality from our model. We approximate the AR(1) process by finite Markov chain from Tauchen (1986)'s method.

We calibrate average labor productivity by age $\{\eta_j\}$ from the Basic Survey on Wage Structure (Chingin Kozo Kihon Tokei Tyosa), which is compiled by the Ministry of Health, Labour, and Welfare. Following the method proposed by Hansen (1993), we compute hourly wage of each age group as in Table 5.[5]

4.6 Health Care, Tax, and Social Security System

4.6.1 Price of Medical Expenditure

We focus on two issues that increase tax burden: aging population and increasing per capita costs of medical care. The medical care cost, which is captured by q, should change from the initial state corresponding to 2010 and is held constant after 2050. Following Attanasio, Kitao, and Violante (2008), we assume that the health care inflation rate is 0.6% per year.[6] Then, the price of medical care increases about 27% in 40 years. Therefore, we set initial price of medical care to be one, $q_{2010} = 1$, and set final price at $q_{2050} = 1.27$.

4.6.2 Health Care System

All citizens are covered by the UHI. Financial sources of medical cost consist of three components: (i) premium, (ii) government subsidy, and (iii) out-of-pocket expenses. The premium covers only a half of total medical expenditure. The average out-of-pocket expense rate is about 15%. The co-insurance rate, $1 - \omega_j$, is 30% under age 70, 20% between 70 and 74, and 10% over 75. As the fraction of individuals who have bad health status increases by age, the average

[5] For details, see also Braun et al. (2007).

[6] This number is deflated by both a general inflation rate and a macroeconomic growth rate. Thus, the *relative* price of medical care cost increases by 0.6% per year. In Japan, from Iwamoto (2006), the medical care cost is estimated to increase 2% per year. However, the number is not adjusted by the macroeconomic growth rate and an average TFP growth rate is estimated to be about 1% in Japan (İmrohoroğlu and Sudo, 2010). Therefore, the estimated health care inflation rate in the US may not differ significantly that in Japan.

out-of-pocket rate is less than 30%. The remaining cost of the UHI is financed by the government's general revenue.

4.6.3 Tax System

We use linear tax rate because our focus in this paper is to quantify the burden of future health care system, and it is difficult to interpret the result if the tax code is nonlinear. Notice that the labor tax rate τ_l balances the government's budget constraint in equation (7). Currently, the consumption tax rate τ_c in Japan is set at 5%.

We calibrate exogenously determined public expenditure G to match G/Y in the model with the data. For example, Government expenditure in 2008 is 84.7 trillion yen, which includes expenditures for public pension and medical care that amount 23.6 trillion yen. Thus, the government expenditure without social security related expenditure is 62.1 trillion yen. As nominal GDP in Japan is about 492 trillion yen, and the G/Y is about 12.43% in 2008. We use the average G/Y from 2000 to 2008, 12.5%.

4.6.4 Social Security System

The payroll tax rate of social security system in 2010 is 16.054%. Thus, we set the payroll tax rate τ_{ss} in the initial steady state to be 16.054%. As a part of social security reforms, the payroll tax rate plans to increase by 0.354% per year and stop to increase in 2018. The payroll tax rate in the final steady state is set at 18.3%. Under the transition paths, we use the increasing tax rates. In all cases, the replacement rate ϕ is endogenously determined in the model.

4.6.5 Social Insurance

Social assistance (lower bound of consumption) $\underline{c}$ is set at 10% of average consumption, which prevents a situation that individuals with low wealth and hit by large medical expenditure shocks could have negative consumption.

5 Analysis

5.1 Impacts of population aging and increased medical cost

We use data from 2010 to set the initial values for the state variables. We investigate the impact of population aging and medical cost increases keeping all other things unchanged.

We first compare tax burdens in a steady state economy with the 2010 demographic structure and in economies with a population structure as projected in 2050. We assume that 2010 is the initial steady state. The benchmark model economy is calibrated to match the tax burden, the medical care cost, the capital-output ratio, population structure and some aggregate variables of Japanese economy in 2010 (the first column of Table 6). The government expenditure to GDP ratio is fixed at 12.5% as in 2010 by assumption. We also assume that the policy of government's subsidy to UHI is fixed: 25% of the total UHI cost ($\psi = 0.25$); the policy of UHI co-insurance rate ω is assumed to be fixed, too. The remaining cost of the UHI is fully financed by the premium (a labor tax) in new steady states. The following scenarios are investigated:

Population aging
In 2050, the elderly dependency ratio is forecasted to approach 80%. Obviously there will be an increase in the UHI cost due to the demographic change – there are more old people, who demand more medical care, but fewer tax/premium payers. In this case, we assume that the de-trended medical price q stays constant from 2010 to 2050 (i.e. the growth of medical price is equal to the aggregate growth along the balanced growth path). Although we assume that government's subsidy policy to UHI (the share of the UHI cost) is fixed, the government still needs additional revenue to finance the share of the increased UHI cost. We assume the government would adjust payroll tax to ensure that it is able to finance the subsidy – 25% of the total UHI cost. We simulate the economy in a steady state with the 2050 population age structure and the above assumptions. The simulation result is presented in the third column of Table 6. The higher UHI cost requires increases in the payroll tax rate and the premium tax. The additional UHI cost in 2050 accounts for a 8.8% labor tax burden (including both payroll tax and premium tax) for young people. This figure is likely to be the lower bound since we assume constant medical cost through 2050.

Aging with increased cost of medical care
If the price growth of medical care (relative to consumption good) is similar to the US, with a 0.6% annual growth rate on top of the productivity growth, the medical care in 2050 will be about 27% more expensive than in 2010. Taking into account this medical price growth, the UHI in 2050 will cause an additional 13.6% tax burden on labor. The result is shown in the 4th column of Table 6. Therefore, including the increased tax burden of social security tax, the total payroll tax for workers will be more than 40%. Because of the high medical care price and declined output, the medical cost output ratio is predicted to be 15.7% in our simulation.

A counterfactual experiment, in which there is only the medical price increase without population aging, is also performed. The result is listed in the second column of Table 6. Only medical price growth, with a 0.6% annual growth rate on top of the productivity growth to 2050, result in an additional 2.5% labor tax burden.

5.2 Reform of UHI policy

To reduce the tax burden on the young and to lessen the distortion on labor supply with the aged population in 2050, we first consider following potential UHI policy alternatives by adjusting the co-payments, which were already increased several times by the government in the past:
a) Having the elderly's (those above 70) co-payment rate adjusted to 30% as young people's;
b) Raising up the general co-payment rate to 35%, 40%, 45%, and 50% instead of the current 30%, and having old people's co-payment rate the same as young people's.

We still assume that government subsidy share of the UHI cost is fixed as in the benchmark, 25%. The remaining cost of UHI is fully financed by the premium tax. Government consumption to GDP ratio is fixed at 12.5%. The government would adjust payroll tax rate to balance its budget.

In addition to tax burden, the welfare effects of the alternative UHI policies are also evaluated. Welfare is measured by expected life time value with equilibrium distribution of all population or of the new-born. Welfare deviation from the steady state with the original policy is calculated by using the certainty equivalent consumption variation (CEV) measure. Given the utility function, CEV for a representative agent can be expressed by the following equation:

$$\text{CEV} = (V_{\text{new}}/V_{\text{original}})^{1/[\sigma(1-\gamma)]} - 1,$$

where V_{new} is the welfare in the economy with a new policy and V_{original} is the welfare in the original economy. The CEV based on all population (i.e. the social average) is defined as:

$$\text{CEV}_{\text{all}} = \left(\frac{\int V_{\text{new}}(j,h,a,z)d\Phi(j,h,a,z)}{\int V_{\text{original}}(j,h,a,z)d\Phi(j,h,a,z)} \right)^{\frac{1}{\sigma(1-\gamma)}} - 1,$$

where Φ is the stationary distribution of population over the state variables. The CEV based on new-born agents is defined as:

$$\text{CEV}_{\text{nb}} = \left(\frac{\int V_{\text{new}}(j=20,h,a,z)d\Phi(j=20,h,a,z)}{\int V_{\text{original}}(j=20,h,a,z)d\Phi(j=20,h,a,z)} \right)^{\frac{1}{\sigma(1-\gamma)}} - 1.$$

The results of the policy experiments are presented in Table 7. We can see that the K/Y ratio increases as the UHI co-payment rate is raised because agents have to accumulate more precautionary savings to guard against the medical expenditure risk by themselves, especially for their old periods.

In addition, the policy reform of increasing co-payment forces old people to share more the medical care cost and lowers down the tax burden on young people. Therefore, we observe significant welfare improvement of the policy reform for the new-born (see CEV for the new-born in Table 7). Moreover, the reduction of labor tax burden will less distort labor supply and improve the welfare. However, the higher co-payment hurts old people who face higher medical expenditure uncertainties. The average welfare of all population would be much smaller than the CEV of new-born households, although these are still positive (see CEV(all population) in Table 7).

5.3 Reform of financing policy

Here we investigate alternative financing policies for the UHI with the aged population. The current consumption tax in Japan is 5%, which is much lower than other developed countries. Some government proposal of increasing consumption tax has attracted a lot of discussion. Therefore, we particularly focus on consumption tax (τ_c), which can be a substitute of labor tax and less distorting labor supply by spreading the tax burden to all of the population. We investigate two potential reforms: Increasing consumption tax rate τ_c to 1) 10% and to 2) 15%, and check the corresponding changes in steady states with the population structure in 2050. The results of the policy experiments are presented in Table 8.

Imposing a higher consumption tax to substitute the labor tax has a redistribution effect across generations: it forces old people to share more tax burden through the consumption tax since they do not pay any kind of labor taxes, and therefore reduces young people's tax burden. The decrease in labor tax burden reduces labor distortion and improves welfare. The policy also affects asset accumulation – people need to save more for their retirement to finance the pricier consumption. So we find higher K/Y ratios in the simulation results with the policy experiments.

In general, the welfare effect of this financing policy reform is similar but much smaller than that with the UHI co-payment increase. The new-born enjoy the reform but the old do not although the overall CEV is positive.

Our finding shows that all the above policy reforms significantly improve the welfare of the future generation with an aged population.

5.4 Decomposition of the Welfare

To have a better understanding on the welfare changes with the reforms, we decompose CEV into a component from the change in distribution and a component form the change in aggregate level. The approach of welfare decomposition is similar to that in Conesa et al. (2009). Table 9 presents the result. We find that both the distribution effect and the level effect are important to account for the welfare changes caused by the above policy reforms. However, the welfare improvements are mainly contributed by the changes in consumption. There is a welfare gain stemming from the leisure distribution over the life-cycle, but a loss caused by the level change in leisure offsets the gain.

5.5 Transition – welfare implication for current generation

In the above we compare welfare changes in different steady states. However, the cost/benefit along with the transition is not considered that has a direct welfare implication to the current generation, who politically determines the policy.

Now we take into account the transitional cost for better understanding the welfare impacts of the alternative polices on the current generation (who lives in 2010). We assume that from the first steady state in 2010, a new policy is implemented in 2011 unexpectedly, and the economy transits to reach the second steady state in 2200. Between 2010 and 2050, the survival probabilities and population growth rates, as well as the population age structure evolve according to the population forecast; after 2050, the demographic factors stop changing and the economy converges to the new steady state in 2200. We compute the equilibrium transitional path between the two steady states. The approach that we use here is similar to Nishiyama and Smetters (2005).[7]

To calculate the welfare along the transition, we need one additional state variable t, the time period (year). The state vector s now becomes: $s = (j, h, a, z, t)$. We calculate CEV by age for those who live in 2010 to understand the impacts of potential policy reforms on the current generation. The CEV of individuals with age $j = j_x$ in 2010 is defined as:

$$CEV_{j_x,\,2010} = \left(\frac{\int V^{\text{new}}(s|j = j_x, t = 2010) d\Phi(s|j = j_x, t = 2010)}{\int V^{\text{original}}(s|j = j_x, t = 2010) d\Phi(s|j = j_x, t = 2010)} \right)^{\frac{1}{\sigma(1-\gamma)}} - 1,$$

where $\Phi(s|j = j_x, t = 2010)$ is the stationary distribution of population over the state space conditional on age j_x in 2010.

We perform a transition analysis for the following three potential policy reforms:

1) a sudden UHI policy change – increasing the elderly's UHI co-payment rate to 30% as young people's from current 20% for age 70-74 and from 10% for age 75 and above *in 2011*;

2) a gradual UHI policy change – increasing the elderly's co-payment rate by 1% per year until it reaches 30% as in policy 1;

3) a sudden financing policy reform – increasing consumption tax to 10% from the current 5% *in 2011*;

4) a gradual financing policy reform – increasing consumption tax to 10% from the current 5% by 1% per year.

The welfare changes by age and health status of individuals living in 2010 are presented by "Policy 1", "Policy 2", "Policy 3", "Policy 4" in Figures 9 – 15. Figures 9 – 12 present welfare changes by age and health status for each policy separately. Figures 13 – 15 compare welfare changes with the four policies for different health status individuals separately.

We first discuss the implication from Policy 1. With the implementation of Policy 1, we find that, the majority of the current population will encounter

[7] See the computational details in the appendix.

welfare losses. Particularly, the result suggests that older individuals would encounter higher losses under the reforms, while younger individuals, especially those younger than 35, might have welfare gains. As in the above steady state comparison, those reforms require old individuals to share more medical care cost than under the current policy and relieve young individuals' tax burden.

We also observe that for those aged 65 and above, the welfare losses are large under Policy 1 – on average above 8% of their life time consumptions except those very old and close to the terminal age. The large loss is because first, the elderly face higher medical shocks and so the increased co-payment hurts them more. Second, most importantly, because the new policy is assumed to be implemented unexpectedly right after 2010, those already retired have no chance to prepare (i.e. accumulate more assets) for the sudden out-of-pocket medical cost increase during the time when they were working. The welfare loss is severe particularly for those with bad health whose medical care cost can be even higher than the average income (see Figures 9 and 15). In this case, the unexpected 10-20% additional co-payments would largely reduce the consumption of those unprepared, retired and high-medical-risk people. The new policy on UHI co-payments in fact forces unhealthy/old people to share more medical cost than healthy people.

As mentioned above, a potential tax tool, consumption tax, is currently considering by the Japanese government. We find that Policy 3, a consumption tax increase that can reduce labor tax rate by a similar proportion in the steady state as with Policy 1, has a much milder impact on current old individuals (Figure 11) although they will still encounter welfare losses. Because the tax is only imposed on non-medical-care consumption, the redistribution between the high-medical-risk and the low-medical-risk is much smaller than the UHI co-payment reform. Hence the welfare changes with different health statuses are not significantly different.

To prevent the disadvantages of a sudden UHI policy reform as discussed above for the Policy 1, we further consider a gradual reform of the UHI policy (Policy 2): the elderly's co-payment rates are increased by one percentage point per year until they reach 30% as that for the young. We find that the welfare (CEV) pattern over age with this gradual reform policy is similar to the consumption tax reform (Policy 3). We also find that a gradual reform on increasing consumption tax (Policy 4) has a welfare effect similar to Policy 3 (Figure 11).

The results suggest that a consumption tax reform might be more politically implementable than a one-time full change in UHI co-payment, which hurts the current elderly largely, although both reduce tax burden for young people. An alternative reform of the UHI policy is a gradual co-payment increase, which allows more time for individuals to prepare for the policy change and prevent the sudden shock to the current old people, can be also considered. A gradual reform on consumption tax does not differ much from an immediate increase.

5.6 Discussion: the political dilemma

Our above analysis indicates a difficulty of the reforms – the majority of the current population will suffer from the reforms even though the welfare improvement for the future generation is significant. To more clearly understand the support of the reforms from the current generation, we calculate the agreement rates with each of the policies discussed in the transition analysis. We assume that if an individual expects a welfare improvement along with the transition of a reform policy, the individual will agree with the reform. Figure 16 presents the agreement rate by age with each reform policy for the current generation (who lives in 2010).

We find that for Policy 1, an increase in the elderly's UHI co-payments, young individuals with age 31 and below are very supportive but none of individuals aged 40 and above will support the reform. The agreement rate of Policy 2, which increases the elderly's UHI co-payments gradually, is even lower, because it loses some support from young individuals although it has a milder negative impact on old individuals. The support to Policy 3 is the highest among the four potential reforms. Most of the individuals aged below 40 will agree with the reform. In addition, the negative impact on old/unhealthy persons is much smaller than Policy 1.

6 Concluding Remarks

We construct a general equilibrium life-cycle economy to study the impact of an aging population (an increased dependency ratio and increased per capita medical expenditures) on household's work and savings behavior, as well as on aggregate output and welfare. We find that with real medical care price fixed at the 2010 level, UHI will still become more costly in 2050 because of the fast population aging that leads to an additional 8.8% labor income tax burden on the young. If the real medical care price grows as in the US at a rate 0.6% on top of the productivity growth annually, the extra tax burden on the young will be 13.6% of labor income. We also evaluate various policy alternatives designed to lessen the negative impact of aging on the economy. Welfare analysis is performed. In particular, taking 2010 as an initial starting point, we calculate the transition path predicted by our model as the population structure changes and medical costs increase, using values for 2050 to construct a terminal steady state. We particularly discuss potential reforms on UHI co-payment policy and government financing policy. We find that reform policies of a UHI co-payment increase and of a consumption tax increase both are able to reduce the tax burden on young people. However, the two reform policies have opposite redistribution effects between the young and the old (as well as between the healthy and the unhealthy). Our findings suggest that a consumption tax reform or a gradual reform of UHI co-payments have a much milder negative impact on old people. However, the total agreement rate of the gradual reform from the current generation is even lower than a one-time full change in UHI co-payments because it loses the support form the young age. A consumption tax reform has a highest agreement rate, although still lower than 50%, and might be more politically implementable.

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Table 1: Medical cost over age groups (2007)

Age Group	Per person medical cost (1,000 yen)	As of total average (%)
Total	267.2	–
Under 65	163.4	61.15
0-14	134.6	50.37
14-44	103.3	38.66
45-64	261.6	97.90
Over 65	646.1	241.80
Over 70	722.2	270.28
Over 75	794.2	297.23

Source: Estimates of National Medical Expenditure, Japan

Table 2: Transition of medical expenditure

age: 0–17		low	middle	high
	low	0.8280	0.1615	0.0105
	middle	0.2309	0.7262	0.0429
	high	0.0400	0.3914	0.5686
age: 18–35		low	middle	high
	low	0.7784	0.2040	0.0176
	middle	0.3087	0.6356	0.0557
	high	0.1137	0.3284	0.5579
age: 36–45		low	middle	high
	low	0.7566	0.2232	0.0202
	middle	0.2817	0.6523	0.0660
	high	0.0603	0.3452	0.5945
age: 46–55		low	middle	high
	low	0.7332	0.2390	0.0278
	middle	0.2130	0.6888	0.0982
	high	0.0399	0.2443	0.7158
age: 56–		low	middle	high
	low	0.6907	0.2849	0.0244
	middle	0.1818	0.6850	0.1332
	high	0.0131	0.1531	0.8338

Note: Calculation based on Kan and Suzuki (2005).

Table 3: Medical Care Expenditure Per Capita 2007 (Unit: 1,000 yen)

Age	mean expenditure	low	middle	high
0 - 4	219.0	31.1	208.4	1200.8
5 - 9	112.6	16.0	107.2	617.4
10 - 14	79.5	11.3	75.7	435.9
15 - 19	65.1	9.2	62.0	357.0
20 - 24	72.6	10.3	69.1	398.1
25 - 29	96.9	13.8	92.2	531.3
30 - 34	111.9	15.9	106.5	613.6
35 - 39	120.6	17.1	114.8	661.3
40 - 44	136.0	19.3	129.4	745.7
45 - 49	164.5	23.4	156.6	902.0
50 - 54	214.1	30.4	203.8	1174.0
55 - 59	293.4	41.7	279.2	1608.8
60 - 64	356.0	50.6	338.8	1952.1
65 - 69	455.4	64.7	433.4	2497.1
70 - 74	590.1	83.8	561.6	3235.7
75 - 79	696.1	98.8	662.5	3816.9
80 - 84	809.5	114.9	770.4	4438.7
Over 85	943.0	133.9	897.5	5170.8
average	267.2	37.9	254.3	1465.1

Source: “Estimates of National Medical Expenditure”
and authors’ calculation.

Parameters		Value
Discount factor	β	0.98
Intertemporal elasticity of substitution	γ	2.0
Share of labor supply	σ	0.33
Capital share	α	0.377
Depreciation rate	δ	0.08
Persistence of labor productivity shock	λ	0.98
Std. dev. of labor productivity shock	σ_ε	0.09
Government share of UHI	ψ	0.25
Price of medical expenditure	q	$\{1, 1.27\}$

Table 4: Parameters of the Model

Age	η_j	Age	η_j
20–24	0.545	45–49	1.243
25–29	0.718	50–54	1.271
30–34	0.884	55–59	1.130
35–39	1.030	60–64	0.770
40–44	1.149	60–64	0.654

Table 5: Age-Efficiency Profile

Table 6: The impact of population aging/increased medical cost on UHI

	Benchmark	Only Price	Only Aging	Aging & Price
Age structure	2010	2010	2050	2050
Medical price	$q = 1$	$q = 1.27$	$q = 1$	$q = 1.27$
Change in K	0.00%	-1.47%	-0.52%	-4.67%
Change in L	0.00%	-0.18%	-16.63%	-17.23%
K/Y	2.520	2.500	2.813	2.752
X/Y	7.1%	9.1%	12.1%	15.7%
G/Y	12.5%	12.5%	12.5%	12.5%
Tax burden				
Social security tax	16.1%	16.1%	18.3%	18.3%
Consumption tax	5.0%	5.0%	5.0%	5.0%
Capital tax	39.8%	39.8%	39.8%	39.8%
Payroll tax	6.2%	6.9%	9.7%	10.9%
Premium	6.9%	8.9%	12.3%	15.9%
Total labor tax burden	13.1%	15.7%	22.0%	26.8%
Increased UHI burden (ratio to labor income)	-	2.5%	8.8%	13.6%

Note: K/Y – capital output ratio; X/Y – medical cost output ratio;
G/Y – government expenditure-output ratio.

Table 7: Alternative UHI policies in 2050– steady state comparison

	Current system	UHI policy reform Co-payment rate				
	$q = 1.27$	30%	35%	40%	45%	50%
Change in K	0.00%	14.00%	19.10%	24.35%	29.86%	35.31%
Change in L	0.00%	2.01%	2.79%	3.52%	4.21%	4.90%
K/Y	2.752	2.949	3.016	3.085	3.156	3.225
X/Y	15.7%	14.8%	14.5%	14.2%	13.9%	13.6%
G/Y	12.4%	12.4%	12.4%	12.4%	12.4%	12.4%
Tax burden						
Social security tax	18.3%	18.3%	18.3	18.3%	18.3%	18.3%
Consumption tax	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
Capital tax	39.8%	39.8%	39.8%	39.8%	39.8%	39.8%
Payroll tax	10.9%	10.8%	10.8%	10.8%	10.8%	10.9%
Premium	15.9%	12.5%	11.3%	10.2%	9.2%	8.2%
Total labor tax burden	26.8%	23.2%	22.1%	21.0%	20.0%	19.1%
Welfare comparison						
CEV(new-born, h =good)	0.00%	9.68%	12.65%	15.50%	18.21%	20.84%
CEV(new-born, h =fair)	0.00%	9.70%	12.66%	15.49%	18.19%	20.80%
CEV(new-born, h =bad)	0.00%	9.76%	12.66%	15.45%	18.09%	20.66%
CEV(all population)	0.00%	1.44%	2.14%	2.72%	3.13%	3.63%

Table 8: Financing policies in 2050– steady state comparison

	Current system	Financing policy reform Consumption tax rate τ_c	
	$\tau_c = 5\%$	10%	15%
Change in K	0.00%	5.20%	10.26%
Change in L	0.00%	1.07%	1.99%
K/Y	2.752	2.821	2.889
X/Y	15.7%	15.3%	15.0%
G/Y	12.4%	12.4%	12.4%
Tax burden			
Social security tax	18.3%	18.3%	18.3%
Consumption tax	5.0%	10.0%	15.0%
Capital tax	39.8%	39.8%	39.8%
Payroll tax	10.9%	6.8%	2.7%
Premium	15.9%	15.5%	15.1%
Total labor tax burden	26.8%	22.3%	17.9%
Welfare comparison			
CEV(new-born, h =good)	0.00%	3.68%	7.02%
CEV(new-born, h =fair)	0.00%	3.69%	7.04%
CEV(new-born, h =bad)	0.00%	3.74%	7.12%
CEV(all population)	0.00%	1.19%	2.14%

Table 9: Decomposition of welfare change

	UHI policy reform Co-payment rate					Financing policy τ_c	
	30%	35%	40%	45%	50%	10%	15%
CEV (total)	9.69%	12.65%	15.49%	18.19%	20.82%	3.69%	7.03%
Level	5.01%	6.82%	8.57%	10.19%	11.87%	1.73%	3.30%
Only c	6.00%	8.30%	10.55%	12.67%	14.90%	2.49%	4.73%
Only n	-0.93%	-1.38%	-1.81%	-2.21%	-2.66%	-0.74%	-1.37%
Distribution	4.80%	5.91%	6.95%	7.94%	8.80%	1.97%	3.71%
Only c	3.36%	4.06%	4.71%	5.33%	5.86%	1.49%	2.80%
Only n	1.42%	1.82%	2.21%	2.58%	2.91%	0.48%	0.89%

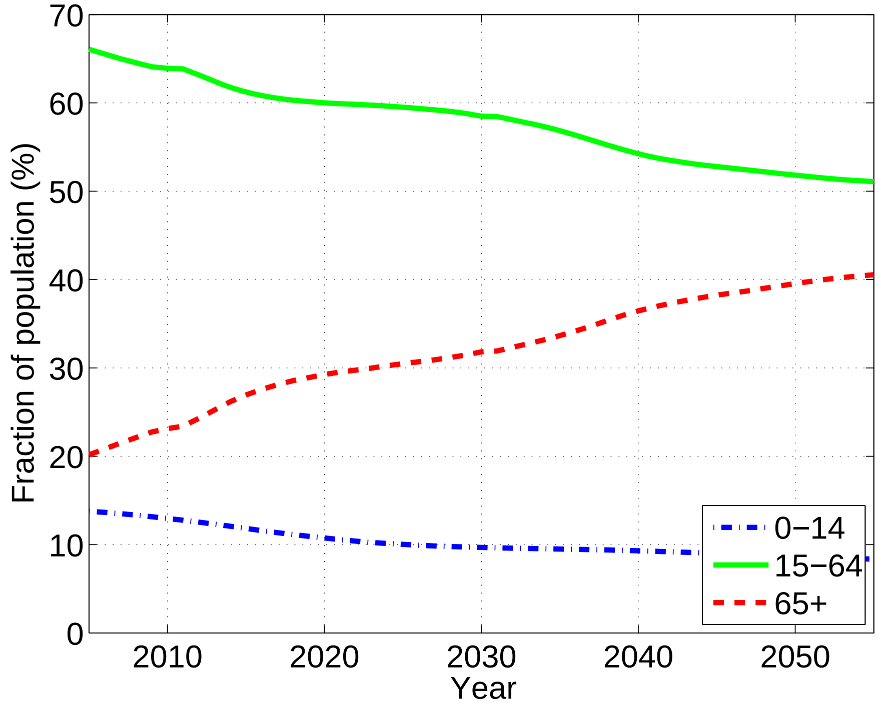

Figure 1: Japan’s population structure 2005 – 2055

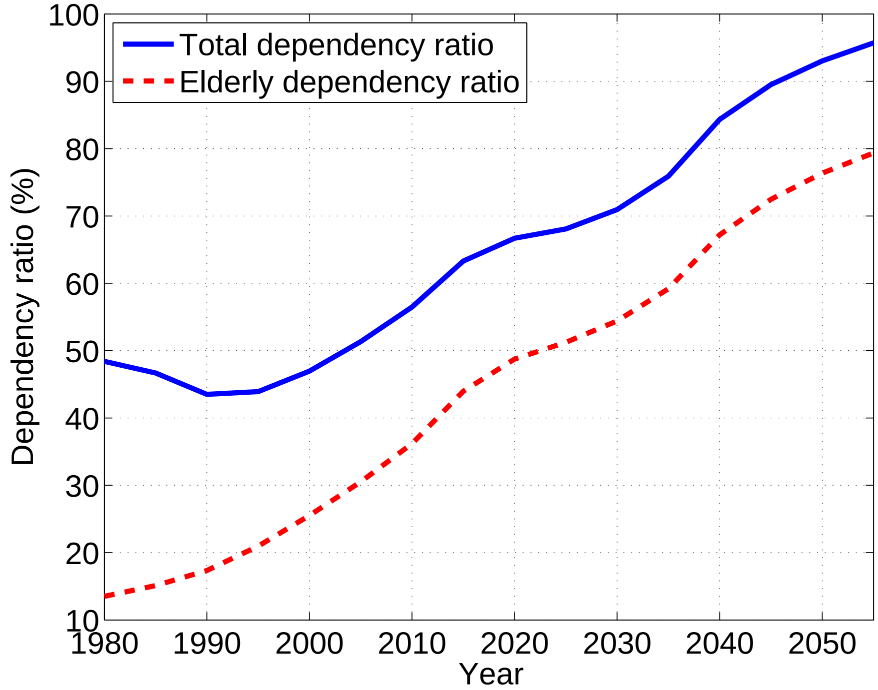

Figure 2: Japan's dependency ratios 1980 – 2055

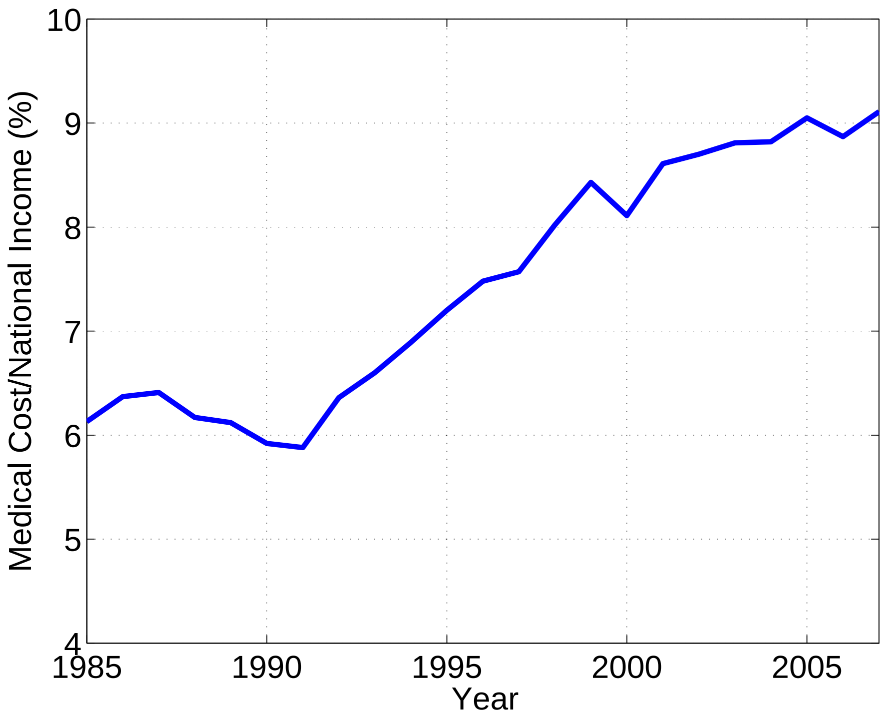

Figure 3: Trend of Japan's medical care cost 1985 – 2007

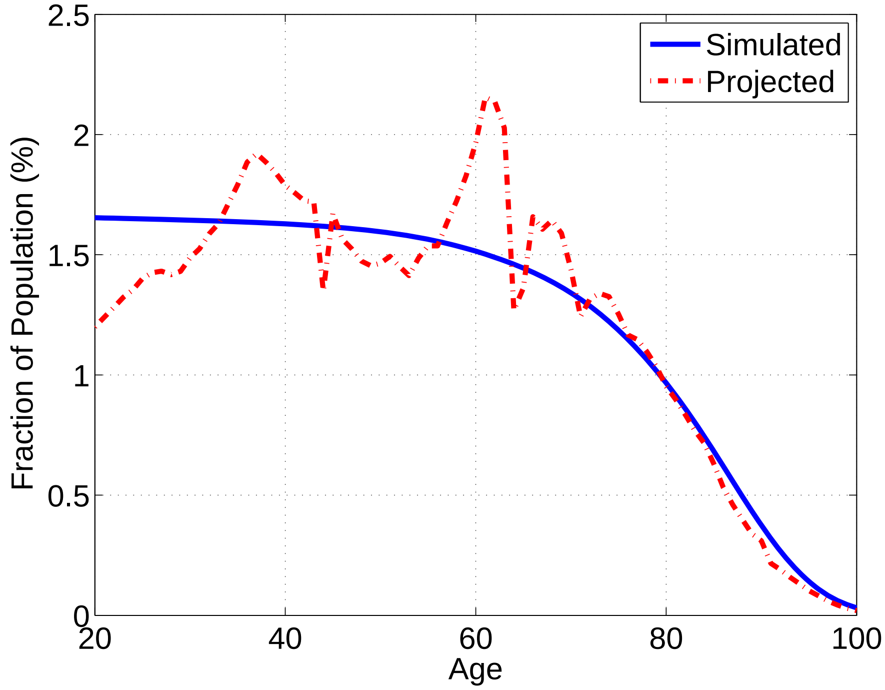

Figure 4: Actual and Simulated Population Distribution in 2010

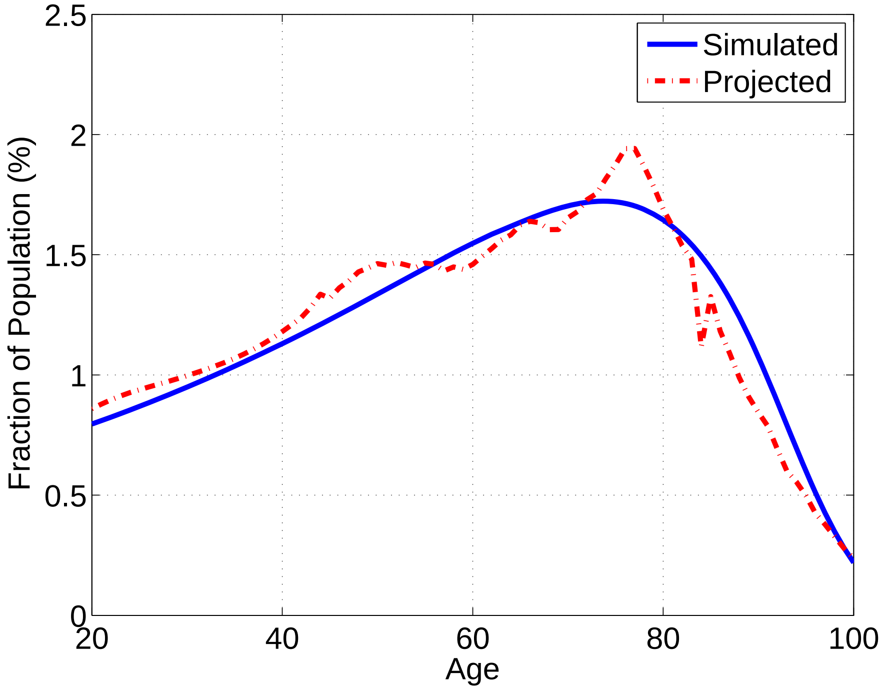

Figure 5: Actual and Simulated Population Distribution in 2050

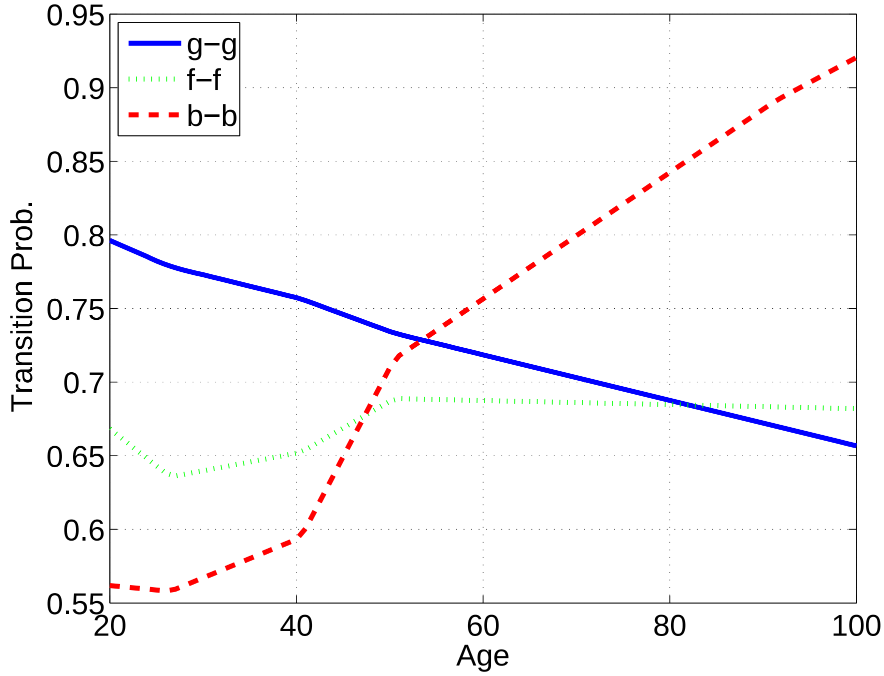

Figure 6: Transition probabilities of remaining in the same state

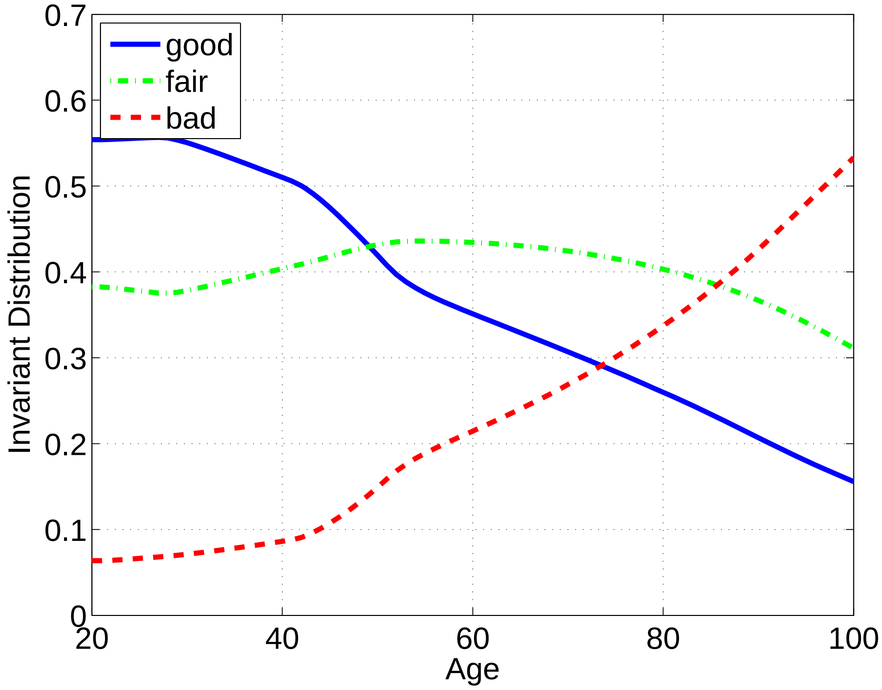

Figure 7: Invariant distribution of the medical expenditure states

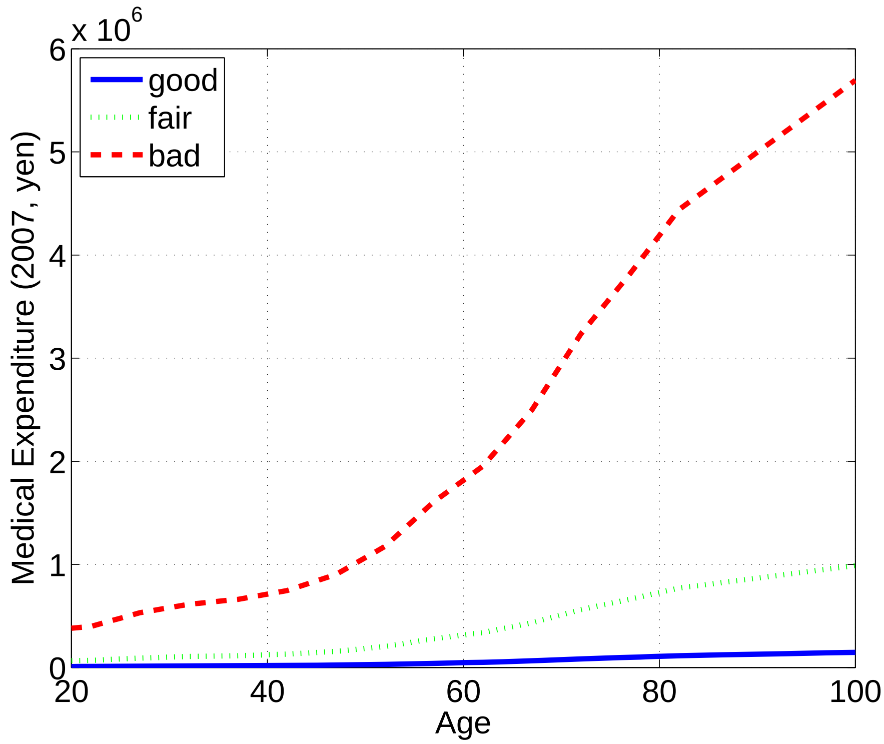

Figure 8: Medical expenditures by age in 2007

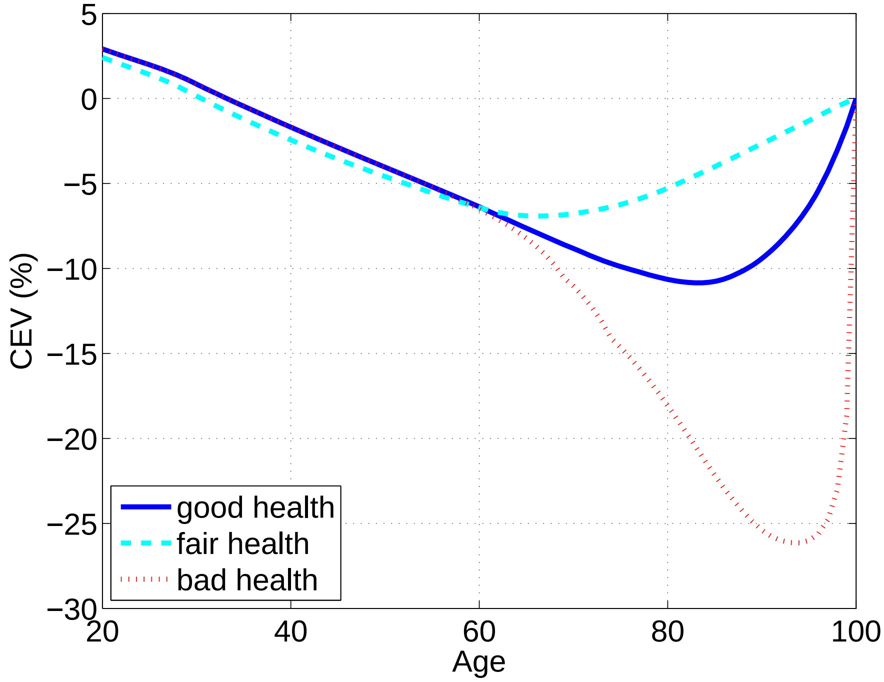

Figure 9: Policy 1 – CEV by age and health status (transition)

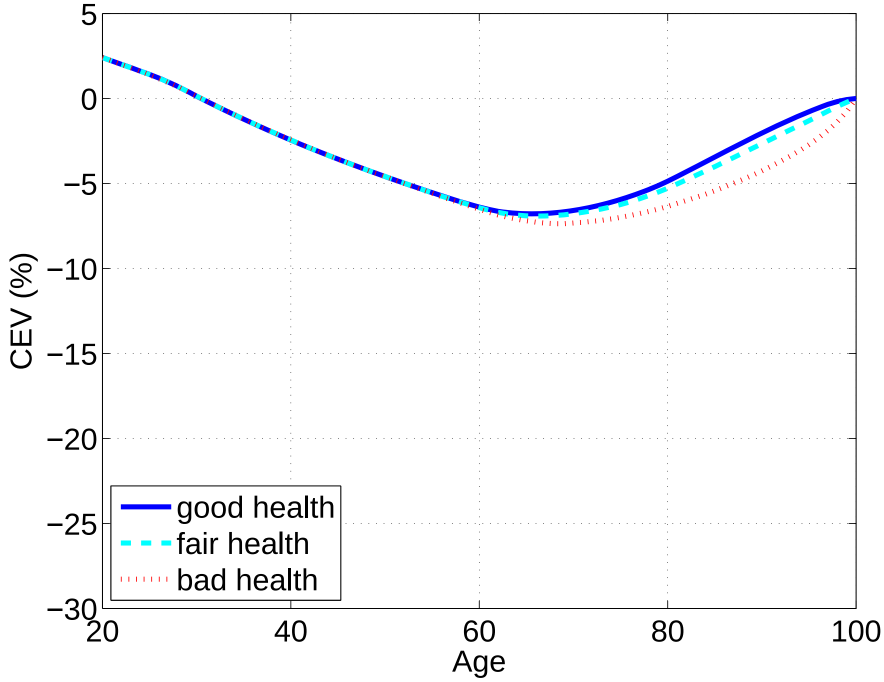

Figure 10: Policy 2 – CEV by age and health status (transition)

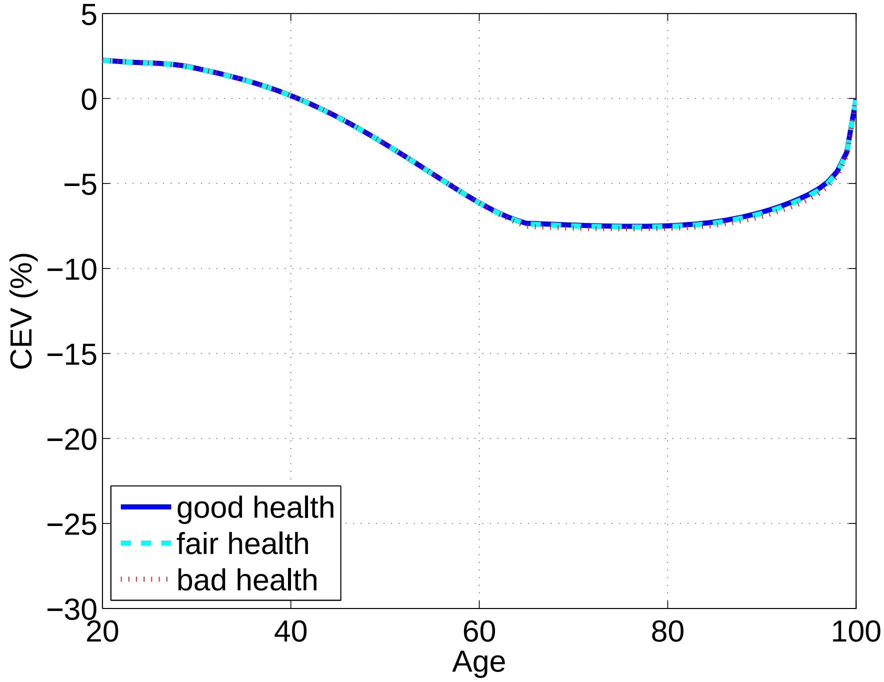

Figure 11: Policy 3 – CEV by age and health status (transition)

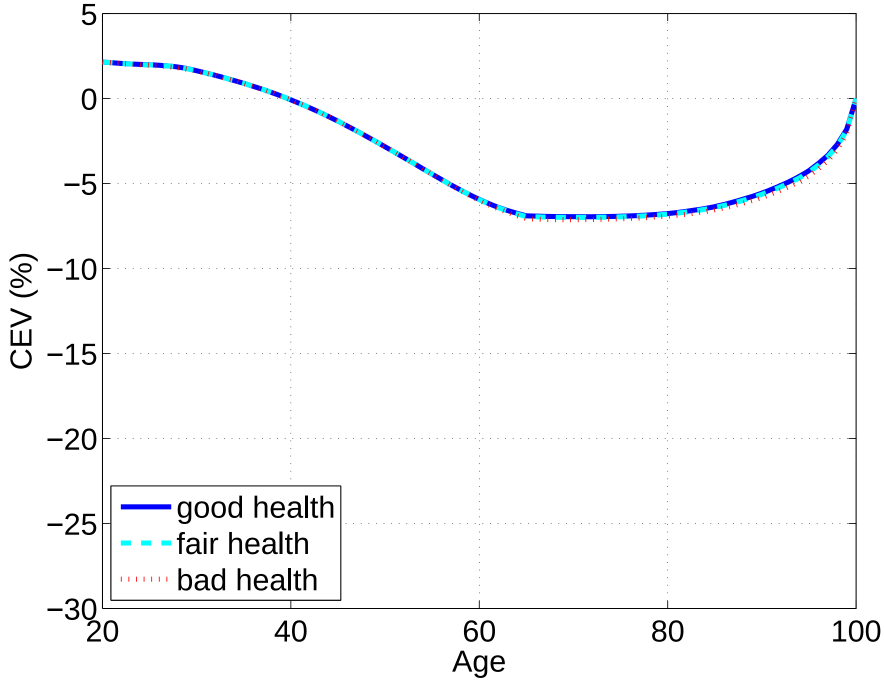

Figure 12: Policy 4 – CEV by age and health status (transition)

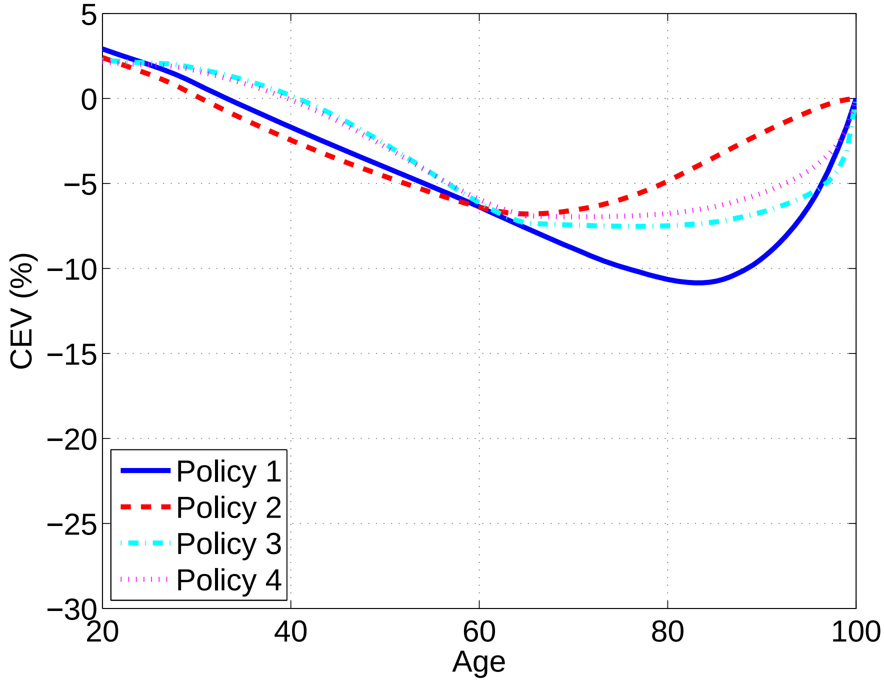

Figure 13: Comparison – CEV by age, good health (transition)

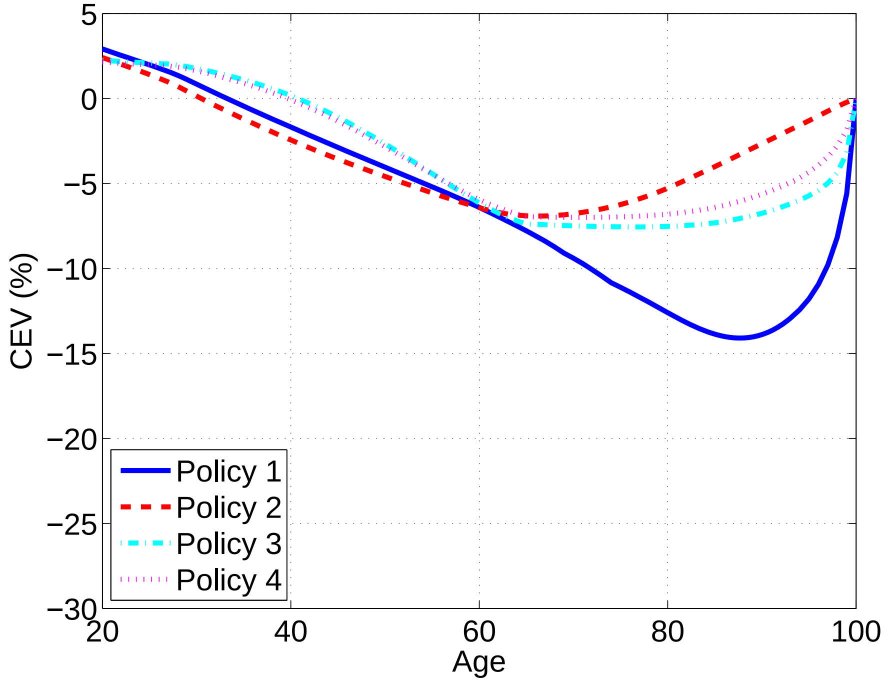

Figure 14: Comparison – CEV by age, fair health (transition)

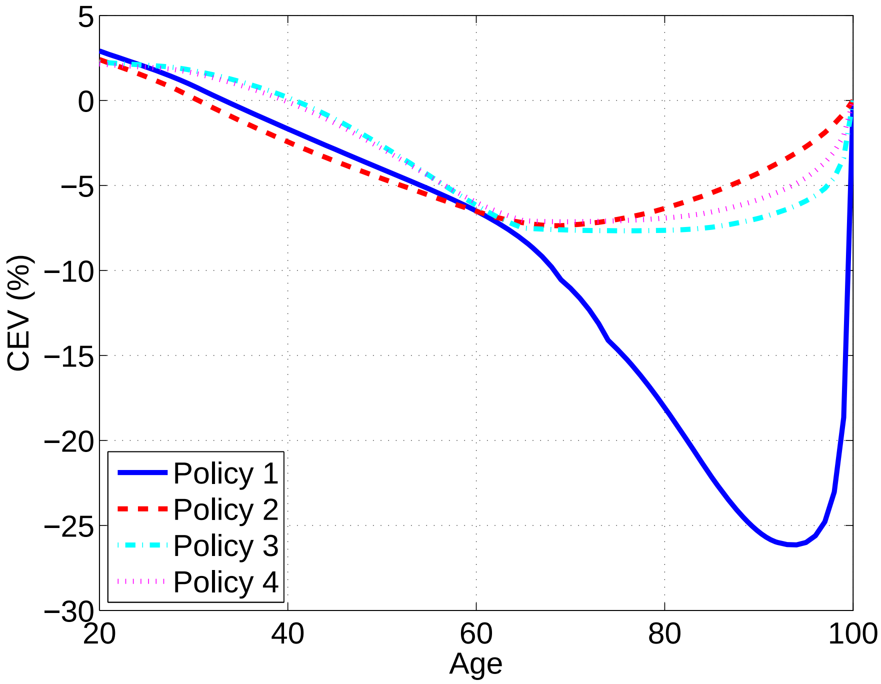

Figure 15: Comparison – CEV by age, bad health (transition)

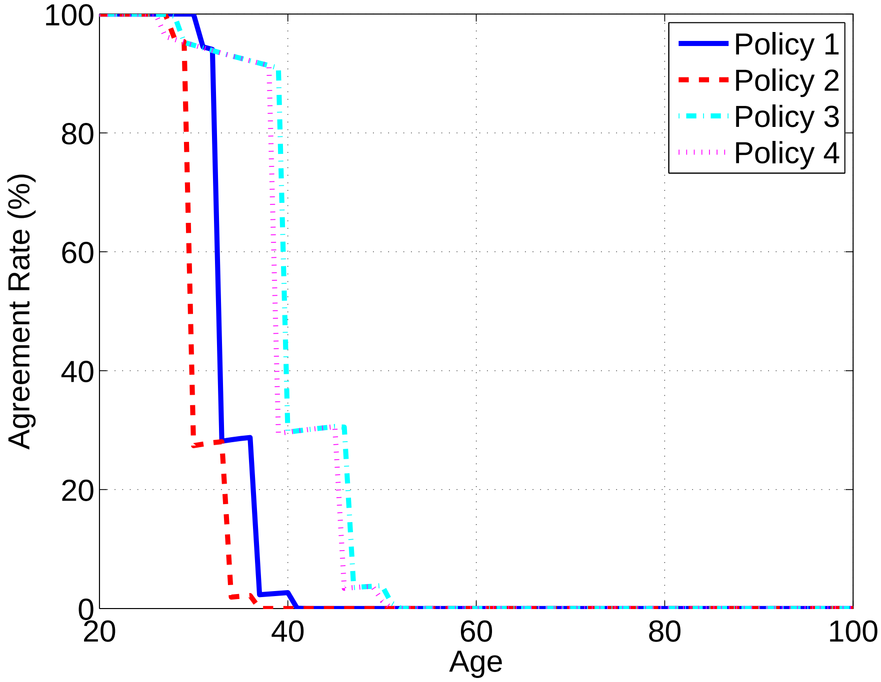

Figure 16: Agreement rates of the reform policies