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Welfare Effects of Health Insurance Reform: The Role of Elastic Medical Demand

Reona Hagiwara*

Abstract

Some medical demand is inelastic to price changes, but not all. In assessing the effects of public health insurance reform on welfare, I examine the role of medical demand elasticity by developing a computational general equilibrium life-cycle model of the Japanese economy. The model features individual heterogeneity in health, income, and wealth. If all medical demand is inelastic, reforming public health insurance by increasing copayments reduces welfare for all current generations. However, if some medical demand is elastic, as is empirically observed, such a reform would improve welfare for current young generations, including those with poor health and low income. Furthermore, future generations benefit from the reform and their welfare increases significantly.

Keywords: Copayment Increase; Price Elasticity of Medical Demand; Welfare Effects; Overlapping Generations
JEL classification: E21, H51, I13, I31

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1 Introduction

Public universal health insurance is provided in many countries and it aims at enhancing equality of health care, as encouraged by the World Health Organization (WHO). However, as population aging has advanced, health care costs have increased in tandem, which is one of the most important factors that have worsened fiscal balances in many countries. Thus, health insurance reform is a pressing issue facing these countries.

Any public health insurance reform that aims at improving fiscal balances would consider an increase in copayments. Such a reform would have macroeconomic and welfare impacts as individuals react by changing their labor supply and savings to prepare for an increase in the cost of health care. These effects have been already quantified in several papers, including Attanasio et al. (2011), Ihori et al. (2011), Hsu and Lee (2013), McGrattan et al. (2018), and Hsu and Yamada (2019). Nonetheless, by assuming that medical expenditure is totally exogenous, these studies do not focus on elastic medical demand. In general, changes in the price of goods and services affect their demand, and medical demand is no exception. When raising copayments directly affects demand for medical care, the price elasticity of medical demand may be critical in evaluating the effects of the reforms on the macroeconomy and individual welfare.

This is the motivation behind my development of a dynamic general equilibrium model of overlapping generations with heterogeneous individuals that allows for endogenous medical spending and I use this to examine the effects of public health insurance reforms. The model features individual heterogeneity in income, wealth, and health to analyze the effects of the reforms on individuals, including those with low income and poor health who may incur a large burden. Using the model, I examine the effects of health insurance reforms in Japan that propose an increase in copayments. The Japanese economy is an interesting case as it has experienced rapid and significant demographic aging, which is also expected to continue in the future.[1] I study both stationary equilibrium and transitional dynamics, with and without the reform, and quantify the welfare effects of the reform on both future generations and current generations.

I find that the price elasticity of medical demand plays a critical role when assessing

[1] Population aging has led to an increase in total health care expenditure from 4.6% (relative to GDP) in 1990 to 7.9% in 2018. Almost all of these large medical costs have been financed by health insurance premium and public funds (tax). Under these circumstances, the government plans an increase in out-of-pocket copayments to reduce medical costs and mitigate the tax or premium burden on the young.

the effects of public health insurance reform. The supporting evidence is two-fold. First, in the stationary equilibrium analysis, the welfare of future generations is much more improved in the calibrated economy with elastic medical demand than in the counterfactual economy where all medical demand is inelastic. If the copayment rate for the elderly aged 75 and over is raised from 10% to 20%, new-born individuals are better off by 0.99% in the calibrated economy compared with 0.18% in the counterfactual economy, in terms of consumption equivalent variation.

The mechanism underlying this result is as follows. When confronted with uncertainty regarding health status, individuals are exposed to medical expenditure risk. Reforms that raise copayments will increase the burden of medical expenditure, while they will also encourage precautionary savings, increase capital stock, and increase the wage rate. By improving government finances, such reforms will also reduce health insurance premiums which are required to sustain the health care system. Future generations have greater utility because the positive effects of lower premiums and higher wages outweigh the negative effect of the increased medical expenditure risk. In addition, in the calibrated economy, individuals can mitigate the burden of the increase in out-of-pocket medical costs by reducing their own elastic medical demand. This reduction in medical expenditure leads to a further decline in premiums, and therefore overall welfare gains for future generations become larger.

Second, in the analysis of transitional economies, reforms that raise copayments bring smaller welfare costs to those who are currently elderly, unhealthy, or with low educational level in the calibrated economy than in the counterfactual economy. Furthermore, the reforms improve welfare for current young generations in the calibrated economy, including those with poor health and low income. This is in stark contrast with the result in the counterfactual economy, where the reforms reduce welfare for all current generations.

As mentioned above, the reform has both positive and negative effects on individual welfare. The significant negative effect would be inevitable for current old generations, especially those with poor health and low education, who have less time or opportunity to prepare for the increased burden of their large medical expenditure. Nonetheless, in the calibrated economy, the effect of the increased medical burden is mitigated, and the effect of the reduction in the premium becomes greater than in the counterfactual economy because individuals reduce their discretionary medical spending to avoid medical expenditure risk. Hence, the negative welfare effect on current generations becomes smaller.

In particular, with an increase in copayments from 10% to 20%, on average, the loss for those aged above 65 with poor health will be 4.00% in terms of consumption equivalent variation in the calibrated economy, compared with 4.79% in the counterfactual economy. In addition, on average, the loss for those with low education will be 4.52% in the calibrated economy compared with 5.78% in the counterfactual economy. Moreover, compared with the older and retired population, the younger working population have lower medical expenditure and can enjoy greater benefits from the lower premium and the higher wage. As a consequence, the reform has a positive effect on young adults, even if they have poor health or low income. Individuals aged below 39 with poor health and those aged below 34 with low education benefit from the copayment increase.

Although this paper focuses on the Japanese economy, other developed countries with public universal health insurance systems (e.g., France, Germany, Italy, and U.K.) could face similar fiscal challenges to Japan. Some emerging countries, including Brazil, Malaysia, South Africa, and Thailand, have also established public health insurance systems. Understanding the consequences of health insurance reform in Japan would be useful for other countries as well by providing them with insights into the effects of the reform on the aggregate economy and individual welfare.

The rest of the paper is organized as follows. Section 2 considers this paper in relation to the existing literature. Section 3 builds a dynamic, stochastic, general equilibrium, overlapping generations model. Section 4 calibrates the model to the Japanese economy by matching key variables, including the price elasticity of medical demand. Section 5 reports the numerical results and quantitatively compares aggregate features and welfare under the reforms in the steady states. Section 6 presents the transitional dynamics under the reforms, and Section 7 discusses the additional reform. Concluding remarks are given in Section 8.

2 Related Literature

This paper contributes to the literature on the effects of health risk or medical expenditure risk on the decisions of individuals. Kotlikoff (1989) simulates the life-cycle model and finds that uncertainty regarding health expenditure has a large impact on precautionary saving. Hubbard et al. (1994) and Palumbo (1999) study the role of medical expenditure risk in predicting the saving behavior of individuals. De Nardi et al. (2010) and French and Jones (2011) estimate a structural model to analyze how medical expenditure risk affects retirement decisions or savings. Contrary to these studies, this paper develops a general equilibrium model and examines the relation between these risks and households' decisions such as medical consumption and savings over the life-cycle.

This paper also builds on the huge literature on general equilibrium models with heterogeneous individuals and incomplete markets pioneered by Bewley (1986), Aiyagari (1994), and Huggett (1996). The model is often used to study various social security systems, especially the pension system. In an early study, Imrohoroglu et al. (1995) investigate the social security optimal replacement rate that maximizes the social welfare. Other studies, such as Conesa and Krueger (1999), Nishiyama and Smetters (2007), Imrohoroglu and Kitao (2009, 2012), and Kitao (2014), quantify the welfare impact of alternative pension reforms in an economy with idiosyncratic risk.

A general equilibrium life-cycle model has recently been used to analyze health insurance systems. For example, Attanasio et al. (2011) investigate the impact of population aging on the financing of Medicare, the universal health care program for the elderly in the U.S. Hansen et al. (2014) and Conesa et al. (2018) also investigate the role of Medicare using a quantitative model. Other papers study the Affordable Care Act (ACA) or Obamacare (e.g., Pashchenko and Porapakkarm, 2013; Jung and Tran, 2016), Medicaid for the poor (e.g., Kopecky and Koreshkova, 2014; Pashchenko and Porapakkarm, 2019), the purchase of private health insurance (e.g., Jeske and Kitao, 2009; Hsu and Lee, 2013; Hsu et al., 2016), and nursing home expenses (e.g., Kopecky and Koreshkova, 2014).

In contrast, in Japan, there are only a few theoretical and quantitative analyses of public health insurance reform. Ihori et al. (2011) and Braun and Joines (2015) build a life-cycle model with medical systems and examine the economic and welfare impact of higher copayment policies. While both papers abstract from intra-generational heterogeneity, McGrattan et al. (2018) develop a model with income heterogeneity and find that lower-income individuals would experience larger welfare losses under a policy of raising copayments. Hsu and Yamada (2019) construct a model with uncertainty about health/medical expenditure and argue that reforms of universal health insurance are significantly harmful for current generations who are elderly or unhealthy, although welfare for future generations is improved.

Almost all papers mentioned above assume that all medical spending are necessary and unavoidable for individuals. However, much empirical evidence suggests that medical demand and expenditure are affected by shifts in medical prices. These findings imply that the medical spending of individuals has a considerable discretionary component. In the U.S., Manning et al. (1987) and Newhouse et al. (1993) find that high out-of-pocket price reduces medical expenditure and the price elasticity of medical demand is approximately -0.2. Similar results are obtained in subsequent papers by Card et al. (2008, 2009), Chandra et al. (2010), Baicker et al. (2013).

In Japan, Bhattacharya et al. (1996) is the first paper to estimate the price elasticity of medical demand using microdata. Ii and Ohkusa (2002) use original surveyed data and find that the price elasticity of medical services is between -0.36 and -0.23. Kan and Suzuki (2006, 2009), based on a natural experiment, report a smaller elasticity of -0.05. Shigeoka (2014), implementing a regression discontinuity design, argues that the price elasticity for those of age 70 is around -0.2. Fukushima et al. (2016) find that the price elasticity of medical spending by the elderly is -0.16 at the aggregate level.

To analyze precisely the impact of public health insurance reform, my model features elastic medical demand, as observed in many empirical papers. Previous studies incorporate endogenous medical expenses in several ways. The common modeling approach is that of health capital pioneered by Grossman (1972). It assumes that medical spending represents investment in future health and this assumption is used in several papers including Fonseca et al. (2009), Jung and Tran (2016), Yogo (2016), and Halliday et al. (2019). A complementary approach assumes that individuals obtain utility from medical spending itself, and this is employed by several papers such as McClellan and Skinner (2006), De Nardi et al. (2010, 2016), Finkelstein et al. (2013), Bajari et al. (2014), and Pashchenko and Porapakkarm (2019).

This paper adopts the latter approach for two reasons. First, while the health capital approach provides an intuitive theory, most empirical studies find that the effects of medical expenditure on health or mortality are small or insignificant (Newhouse et al., 1993; Baicker et al., 2013; Shigeoka, 2014). Baicker et al. (2013) find that Medicaid coverage does not significantly promote individuals' physical health but can improve mental health through a reduction in anxiety or depression. This is consistent with additional utility from medical spending as in Pashchenko and Porapakkarm (2019).

Second, the health capital model considers all medical spending as direct inputs into the production of good health. However, one purpose of reforms that raise copayments in Japan is to reduce excessive medical expenditure, including unnecessary expenses that do not improve health, and to promote appropriate health care utilization.[2] Hence,

[2]For example, there is unnecessary expenditure associated with visiting multiple medical institutions to treat a disease (*hashigo-jushin*) and visiting emergency departments on holidays or at night despite

it is desirable to isolate such discretionary or avoidable components of medical spending, by using medical expenditure in the utility function approach employed by McClellan and Skinner (2006) and Pashchenko and Porapakkarm (2019), in assessing the impact of the reforms.

3 A Quantitative General Equilibrium Model

In this section, I present a general equilibrium model of overlapping generations with intra-generational heterogeneity in income, wealth, and health status. The model features individuals' decisions on medical spending as well as consumption, labor supply, and savings over the life-cycle, which allows us to quantify the effects of the health insurance reform on individual welfare. Importantly, the model can shed light on a potential role of elastic medical demand, which is the main focus of this paper.

3.1 Demographics

Time is discrete and one period corresponds to a year. The economy is populated by overlapping generations of individuals of model age $j = 1, 2, \cdots, 80$. Individuals enter the economy with no initial assets at actual age 21 ($j = 1$) and retire at age 65 ($j_r + 1 = 45$). They face mortality risk and the maximum age is 100 ($j_f = 80$). The size of new cohorts grows at rate n_t. Let $\psi_{j,t}$ denote the probability that an individual of age j at time t survives to the next period $t+1$. Unconditional probability of living up to age j at time t for those who were born in period $t-j+1$, denoted by $q_{j,t}$, is given as follows:

$$q_{j,t} = \psi_{j-1,t-1}\psi_{j-2,t-2}\cdots\psi_{1,t-j+1}, \tag{1}$$

where the survival probability in the final period of the life is zero, $\psi_{j_f,t} = 0$, and the initial unconditional survival probability is unity, $q_{1,t} = 1$.

3.2 Income Uncertainty and Health Status

There is no aggregate risk in the economy, but individuals face idiosyncratic uncertainty with respect to their individual labor productivity and health status. The labor productivity x_j of age j evolves stochastically according to a Markov chain $\Pi(x_j, x_{j+1})$. At age j, an individual health status h_j can be either "good" ($h_j = g$) or "bad" ($h_j = b$), and

non-severe diseases (*kombini-jushin*).

the health status evolves via a Markov chain $\Pi(h_j, h_{j+1})$. There are no state-contingent securities to insure against these idiosyncratic risks. Individuals, however, can partially insure themselves against the risks by accumulating precautionary savings.

3.3 Endowments and Preferences

Individuals are endowed with one unit of time that can be allocated for work and leisure. During the working age, earnings are given by $w_t \eta_{j,e} x_j l_{j,t}$, where w_t is the wage rate at time t and $l_{j,t}$ is hours of work of age j at time t. In addition, $\eta_{j,e}$ is a labor efficiency profile which depends on age j and innate ability e. I assume that individuals enter the economy with ability e and this ability type is fixed throughout their lifetime. Therefore, individuals' earnings differ due to the idiosyncratic risk and the fixed innate ability.

Individuals choose consumption c_j and leisure $1 - l_j$ in each period, which bring utility:

$$u(c_j, l_j) = \frac{\left[c_j^{\sigma}(1 - l_j)^{1-\sigma}\right]^{1-\gamma}}{1 - \gamma}, \tag{2}$$

where σ is a consumption share in utility and γ is the relative risk aversion.

Individuals also choose medical spending m_j, which has the following features. First, medical spending depends on health status. Individuals with poor health demand more medical services than healthy individuals. Next, a fraction, $1 - \lambda_j$, of medical spending is covered by the government. The actual medical burden for individuals is only $\lambda_j m_j$ and λ_j represents the copayment rate at age j. Finally, medical spending has two components: necessary spending $\overline{m_{j,h}}$ and discretionary spending $m_j - \overline{m_{j,h}}$. While the former component represents essential and unavoidable medical expenses that are exogenous to individuals, which I call medical need, the latter component represents medical expenses that individuals can choose in a discretionary manner. In each period, individuals derive utility from the discretionary medical spending, denoted as

$$v(m_j, \overline{m_{j,h}}) = \varepsilon_{j,h} \frac{(m_j - \overline{m_{j,h}})^{1-\gamma}}{1 - \gamma}, \tag{3}$$

where $\varepsilon_{j,h}$ is a deterministic utility parameter, which depends on age and health status and governs the marginal utility from medical spending.

To summarize, individual's expected lifetime utility is given by

$$U = \mathbb{E}\left[\sum_{j=1}^{j_f} \beta^{j-1} q_j \left\{u\left(c_j, l_j\right) + v\left(m_j, \overline{m_{j,h}}\right)\right\}\right], \tag{4}$$

where $\mathbb{E}$ is the expectation operator and β denotes a subjective discount factor. As shown in equation (1), q_j is the unconditional survival probability.[3]

It is worth emphasizing that individuals are assumed to get utility from medical spending itself. This assumption is used in several papers with endogenous medical expenditure models, such as De Nardi et al. (2010, 2016), Finkelstein et al. (2013), and Bajari et al. (2014). They assume utility from total consumption of medical goods. Contrary to these studies, McClellan and Skinner (2006) and Pashchenko and Porapakkarm (2019) consider that medical spending has both necessary and discretionary components and only discretionary component brings benefits to individuals.

I follow the latter papers to capture both aspects of medical expenditure (risk and consumer choice), which are essential for assessing the welfare impact of the reform on heterogeneous individuals by age, income, and health. Additional utility from discretionary health care spending can be interpreted as all potential benefits derived from the purchase of medical services including improvement in mental health brought by getting a medical examination or happiness achieved by gathering and talking to friends at clinics or hospitals.[4]

3.4 Production Technology

Firms are competitive and produce a homogenous good using capital stock and labor according to a constant returns to scale technology:

$$Y_t = K_t^{\alpha} N_t^{1-\alpha}, \tag{5}$$

[3] I assume that neither health status nor medical spending affect the survival probability, mainly because data on health-dependent mortality rates are not available in Japan. Halliday et al. (2019) find that survival motives for health investment, which captures the rise in medical spending aimed at improving survival prospects, are quantitatively less important.

[4] Lawrence (1985) finds that the number of elderly patients in Japan had increased significantly increased following the institution of free medical care for the elderly in 1973, and notes that this change was brought about by the emergence of *rojin saron* – general socializing with friends at a clinic.

where Y_t is aggregate output, K_t is aggregate capital, N_t is aggregate effective labor, and α is capital's share of output. A homogenous good can be used as either consumption, medical consumption, or investment.

Firms maximize profits by setting marginal productivity of capital and labor equal to their factor prices, respectively:

$$r_t = \alpha K_t^{\alpha-1} N_t^{1-\alpha} - \delta, \quad w_t = (1-\alpha) K_t^{\alpha} N_t^{-\alpha}, \tag{6}$$

where r_t is the interest rate and δ is a depreciation rate of capital.

3.5 Government

The government sector has the general budget and also runs public health insurance and public pension systems.

3.5.1 General budget

The general budget is balanced in every period.[5] Revenues consist of tax on consumption, labor income, capital income, and accidental bequests with the corresponding tax rates given by τ_t^c, τ_t^l, τ_t^k, and τ_t^b, respectively. Expenditures consist of an exogenous government spending G_t and a subsidy for medical care $\varphi_t MB_t$, where MB_t is the medical benefits that are covered by the general budget or the public health insurance system, given by

$$MB_t = \sum_s \{(1-\lambda_{j,t}) m_t(s)\} \mu_{j,t} \Phi_t(s), \tag{7}$$

where $\mu_{j,t}$ denotes the population of age j at time t and $\Phi_t(s)$ is a distribution function over individual state variables $s = \{j, a, e, x, h\}$, where j is age, a is assets, e is a fixed ability, x is an individual labor productivity, and h is health status. The government finances a fraction φ_t of the benefits and the remaining $1-\varphi_t$ of them is financed by public health insurance.

[5]The general budget abstracts away from government debt for simplicity as in Hsu and Yamada (2019) and Fukai et al. (2021) who study the welfare effects of medical expenditure risks and the role of public health insurance in Japan.

Put together, the government's budget constraint is given by

$$G_t + \varphi_t MB_t = \sum_s \left(\tau_t^c c_t(s)\right) \mu_{j,t}\Phi_t(s) + \sum_s \left(\tau_t^l w_t \eta_{j,e} x_j l_t(s)\right) \mu_{j,t}\Phi_t(s) +$$

$$\sum_s \left(\tau_t^k r_t \left(a_t(s) + beq_t\right)\right) \mu_{j,t}\Phi_t(s) + \sum_s \left(\tau_t^b \left(1 - \psi_{j-1,t-1}\right) a_t(s)\right) \mu_{j-1,t-1}\Phi_{t-1}(s), \quad (8)$$

where beq_t is a transfer of accidental bequests. The after-tax bequests left by the deceased are distributed to all survivors in a lump-sum fashion:[6]

$$beq_t = \frac{\sum_s \left[\left(1 - \tau_t^b\right)\left(1 - \psi_{j-1,t-1}\right) a_t(s)\right] \mu_{j-1,t-1}\Phi_{t-1}(s)}{\sum_{j=1}^{j_f} \mu_{j,t}}. \quad (9)$$

3.5.2 Public Health Insurance

Public health insurance is available to all individuals regardless of their age, income level, and health status. The public health insurance system covers the medical benefits that exceed the subsidy from the government with a health insurance premium imposed on labor income:

$$\left(1 - \varphi_t\right) MB_t = \sum_s \left(\tau_t^m w_t \eta_{j,e} x_j l_t(s)\right) \mu_{j,t}\Phi_t(s), \quad (10)$$

where τ_t^m is a health insurance premium. The left-hand side of equation (10) is the medical expenditure financed by the public health insurance sector and the right-hand side is the premium revenue.

3.5.3 Public pension

The government operates a pay-as-you-go public pension system, which is assumed to be self-financed:

$$\sum_s p_{j,e,t}\mu_{j,t}\Phi_t(s) = \sum_s \left(\tau_t^p w_t \eta_{j,e} x_j l_t(s)\right) \mu_{j,t}\Phi_t(s), \quad (11)$$

[6]There are no bequest motives in the model. Horioka (2021) suggests that, in Japan, the selfish life-cycle model with unintended or accidental bequests is more applicable rather than the dynasty or altruism model.

where $p_{j,e,t}$ is pension benefits and τ_t^p is a pension premium. Following Conesa et al. (2018) and Hsu and Yamada (2019), the pension benefits are given by

$$p_{j,e,t} = \begin{cases} 0 & \text{if } j < j_r + 1 \\ \theta_{e,t} w_t N_t & \text{if } j \geq j_r + 1 \end{cases}, \tag{12}$$

where $\theta_{e,t}$ denotes the social security replacement rate conditional on the individual's ability level.[7]

3.6 Individuals Problem

The individuals problem can be formulated recursively, with time scripts omitted for simple exposition. An individual chooses consumption c, labor supply l, medical spending m, and savings $a^{'}$ to maximize the expected discounted sum of utility in the rest of the life. The value function $V(s)$ of an individual in state $s = \{j, a, e, x, h\}$ is given as follows:[8]

$$V(s) = \max_{c,l,m,a^{'}} \left[u(c,l) + v\left(m, \overline{m_{j,h}}\right) + \beta \psi_j \mathbb{E}\left\{V(s')\right\}\right], \tag{13}$$

subject to

$$\begin{aligned} & a^{'} + (1+\tau^c)\, c + \lambda_j m \\ & \quad = \left[1 + \left(1-\tau^k\right) r\right](a + beq) + \left(1 - \tau^l - \tau^p - \tau^m\right) w \eta_{j,e} x_j l + p_{j,e}, \end{aligned} \tag{14}$$

where

$$a^{'} \geq 0, \tag{15}$$

$$c > 0, \quad 0 \leq l \leq 1, \tag{16}$$

where $s^{'} = \left\{j+1, a^{'}, e, x^{'} = x_{j+1}, h^{'} = h_{j+1}\right\}$ is state in the next period. Individuals are not allowed to borrow against future income because of the borrowing constraint (15).

[7] Although pension benefits depend on an individual's past earnings in the actual economy, there is a huge additional burden for computation by introducing a new continuous state variable such as past individual earnings. Thus, I posit that the difference in the benefits arises from the difference in individual's innate ability e, as in Attanasio et al. (2011) and Conesa et al. (2018).

[8] As seen in equation (14), consumption tax is not imposed on medical consumption. In the actual economy, the costs of treatment and drugs covered by public health insurance are tax-free.

3.7 Competitive Equilibrium

A competitive equilibrium for this economy consists of a sequence of individuals' decision rules $\{c_t(s), l_t(s), m_t(s), a_{t+1}(s)\}$, firms' decision rules $\{K_t, N_t\}$, factor prices $\{r_t, w_t\}$, government tax systems $\{\tau_t^c, \tau_t^l, \tau_t^k, \tau_t^b\}$, pension systems $\{\tau_t^p, \theta_{e,t}\}$, health insurance systems $\{\tau_t^m, \lambda_{j,t}, \varphi_t\}$, government consumption G_t, accidental bequests beq_t, and a population distribution over state variables $\Phi_t(s)$ such that:

1. Individuals solve the optimization problems described in Section 3.6.

2. Firms maximize their profits and factor prices are determined competitively.

3. All budget constraints for the government sector are satisfied.

4. The labor and capital markets clear:

$$N_t = \sum_s (\eta_{j,e} x_j l_t(s)) \mu_{j,t} \Phi_t(s), \tag{17}$$

$$K_t = \sum_s (a_t(s) + beq_t) \mu_{j,t} \Phi_t(s). \tag{18}$$

5. The goods market clears:

$$Y_t = C_t + [K_{t+1} - (1-\delta) K_t] + G_t + M_t, \tag{19}$$

where C_t is aggregate consumption, given by

$$C_t = \sum_s c_t(s) \mu_{j,t} \Phi_t(s). \tag{20}$$

Aggregate medical expenditure M_t is financed by the general budget, the public health insurance system, and individuals as follows:

$$M_t = \underbrace{\sum_s \{(1-\lambda_{j,t}) m_t(s)\} \mu_{j,t} \Phi_t(s)}_{=MB_t} + \sum_s (\lambda_{j,t} m_t(s)) \mu_{j,t} \Phi_t(s)$$

$$= \{\varphi_t MB_t + (1-\varphi_t) MB_t\} + \sum_s (\lambda_{j,t} m_t(s)) \mu_{j,t} \Phi_t(s)$$

$$= \underbrace{\varphi_t MB_t}_{\text{Subsidy}} + \underbrace{\sum_s \left(\tau_t^m w_t \eta_{j,e} x_j l_t(s)\right) \mu_{j,t} \Phi_t(s)}_{\text{Premium}} + \underbrace{\sum_s \left(\lambda_{j,t} m_t(s)\right) \mu_{j,t} \Phi_t(s)}_{\text{Out-of-Pockets}}. \tag{21}$$

4 Calibration

This section describes the calibration of parameters. The model parameters consist of two groups. Parameters in the first group are standard in the literature, and their values are summarized in Table 1. Parameters in the second group are specific to this model. Specifically, I calibrate the model to the Japanese economy of 2010 by assuming that the economy is in a steady state, which I call the initial steady state. The model economy is solved from 2010 to 2250 in which the economy reaches the final steady state. The calibrated parameters are summarized in Table 2.

Table 1: Parameters Set Outside the Model

Parameter	Description	Source	Value
Labor productivity process			
ρ	persistence parameter	Hsu and Yamada (2019)	0.98
σ_π	standard deviation	Hsu and Yamada (2019)	0.09
Preference			
γ	risk aversion	Pashchenko and Porapakkarm (2019)	3.0
Production technology			
α	capital share	Imrohoroglu and Sudo (2011)	0.377
δ	capital depreciation	Imrohoroglu and Sudo (2011)	0.08
Government			
G	government spending	MOF (2010)	13.8% of GDP
τ^c	consumption tax	in 2010	5.0%
τ^k	capital income tax	Imrohoroglu and Sudo (2011)	39.8%
τ^b	inheritance tax	Okamoto (2013)	10.0%
τ^p	pension premium	{in 2010, in the final steady state}	{16.1%, 18.3%}
φ	fraction of subsidy	MHLW (2010)	44.0%

4.1 Demographics

In the initial steady state, the population distribution is set to the actual data in 2010, where the data are taken from the National Institute of Population and Social Security Research (IPSS).[9] The growth rate of new cohorts n is set at the IPSS projection up to

[9]Since I use the actual population in 2010, the population in the initial steady state is not stationary. I assume that individuals solve the optimization problem given the survival probabilities of 2010, and

Table 2: Parameters Calibrated Specific to the Model

Parameter	Description	Target	Value
Medical expenditure			
ω	fraction of medical need	price elasticity $= -0.2$	0.5
Utility of medical spending ("good" health)			
$\widehat{\varepsilon_j}\,(g)$	age-dependent component	$\begin{cases} m_{50}/m_1 = 2.95 \\ m_{55}/m_1 = 3.35 \\ m_{80}/m_1 = 3.15 \end{cases}$	$\begin{cases} 0.034 & \text{if } j < 50 \\ 0.024 & \text{if } 50 \leq j < 55 \\ 0.0047 + 0.0002j & \text{if } j \geq 55 \end{cases}$
ε_g	health-dependent component	$m_1 = 49,825\,\mathit{yen}$	1.2E-6
Utility of medical spending ("bad" health)			
$\widehat{\varepsilon_j}\,(b)$	age-dependent component	$\begin{cases} m_{50}/m_1 = 1.62 \\ m_{55}/m_1 = 1.84 \\ m_{80}/m_1 = 1.95 \end{cases}$	$\begin{cases} -0.009 & \text{if } j < 50 \\ -0.015 & \text{if } 50 \leq j < 55 \\ -0.0695 + 0.0009j & \text{if } j \geq 55 \end{cases}$
ε_b	health-dependent component	$m_1 = 1,078,197\,\mathit{yen}$	0.0017
Preference			
β	subjective discount factor	$K/Y = 3.0$	1.0056
σ	weight on consumption	average work time $= 40\%$	0.405
Government			
τ^l	labor income tax	in the initial equilibrium	12.6% in the "Elastic Case" 12.5% in the "Inelastic Case"

2050, and the rate is assumed to change linearly to zero by 2065 and remain constant after 2065. The survival probabilities ψ_j are set to the IPSS estimate up to 2060, and they are assumed to be constant after 2060.

4.2 Health Shock, Medical Need, and Marginal Utility of Medical Spending

This section describes the calibration of the medical need $\overline{m_{j,h}}$ and the preference for medical spending $\varepsilon_{j,h}$, both of which depend on age and health. The calibration is conducted for the model to match the following target values: actual medical expenditure and the estimated price elasticity of medical demand. The calibration procedure consists of two steps. First, the health status in the model is defined, and medical expenditure by age and health is constructed from data. Second, the parameters $\overline{m_{j,h}}$ and $\varepsilon_{j,h}$ are set to match the target values.

aggregate variables are calculated using the actual age-distribution of 2010.

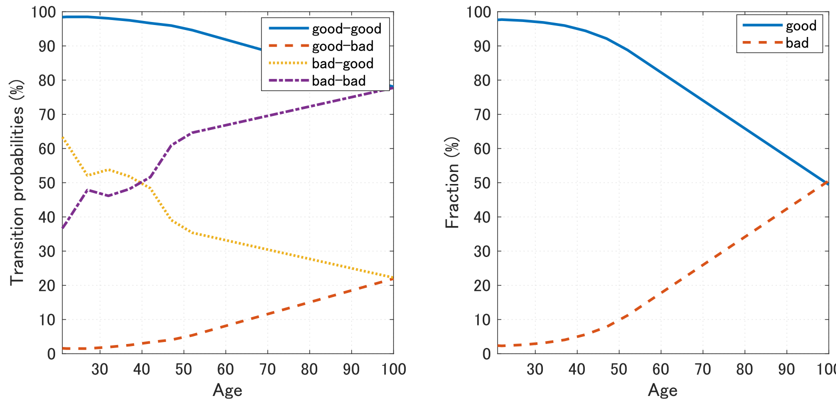

Figure 1: Transition of Health (Left Panel) and Health Distribution (Right Panel)

4.2.1 Transition of Health and Medical Expenses

As mentioned by Hsu and Yamada (2019), micro-level panel data on health and medical expenditure are not publicly accessible in Japan. To obtain the medical expenditure profiles, this paper uses Fukai et al. (2018), who estimate the health expenditure for men of age 0-60 using data from the Claims Database of Japan Medical Data Center (JMDC). They provide the rich micro-based results regarding health distribution and age- and health-dependent medical expenditure. In my model, an individual health status is binary, "good" ($h = g$) or "bad" ($h = b$). The classification of health group is based on the amount of medical expenditure, according to Fukai et al. (2018). The health transition probabilities in my model are set by using the population distribution of health conditions by age group reported by their paper. The calibrated health transition probabilities and health distribution are shown in Figure 1. The probability of transitioning from "good" to "bad" is monotonically increasing with age, whereas that from "bad" to "good" declines with age.

Fukai et al. (2018) also report the distribution of annual medical expenditure by age group. Using these data, the life-cycle profiles of medical expenditure for "good" and "bad" health conditions are calibrated, as shown in Figure 2.[10]

4.2.2 Medical Need and Preference for Medical Spending

In the model, the medical need $\overline{m_{j,h}}$ and the preference for medical spending $\varepsilon_{j,h}$ are the key parameters to determine the price sensitivity of medical demand. Solving the

[10]For more details about the computation of age- and health-dependent medical expenditure, see Appendix A.

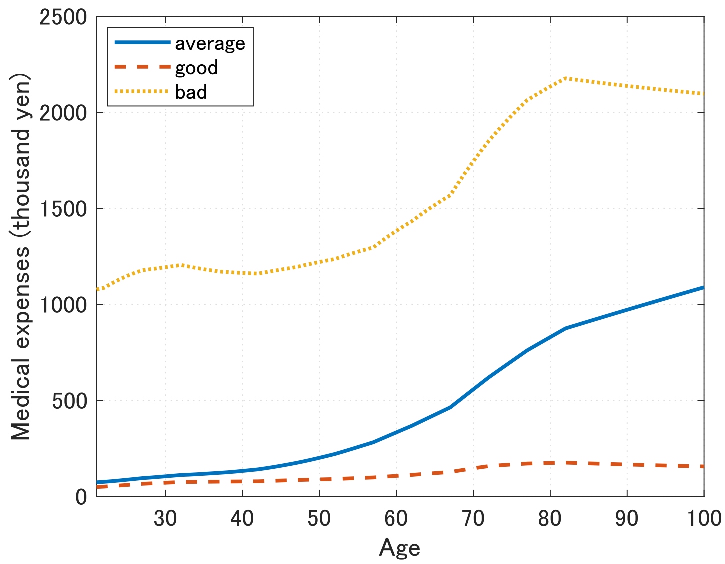

Figure 2: Medical Expenditure by Age and Health

individuals problem described in Section 3.6 yields total medical expenditure as

$$m = \underbrace{\left[\varepsilon_{j,h}\left(\frac{1+\tau^c}{\lambda_j}\right)\left[\frac{c}{\sigma\left\{c^{\sigma}\left(1-l\right)^{1-\sigma}\right\}^{1-\gamma}}\right]\right]^{\frac{1}{\gamma}}}_{\text{Discretionary Medical Expenditure}} + \underbrace{\overline{m_{j,h}}}_{\text{Medical Need}} \quad . \tag{22}$$

Equation (22) indicates that total medical expenditure consists of discretionary medical expenditure and medical need. While the discretionary part depends on medical price λ, the necessary part does not. Since the price elasticity of medical demand is defined as a change in total medical expenditure composed of these two parts in response to price changes, the elasticity in the model is affected by the fraction of necessary spending in total medical spending.

Thus, I calibrate the medical need and the preference parameter for medical spending to match the medical expenditure obtained in Section 4.2.1 and the estimated price elasticity of medical demand in Japan. The target elasticity is -0.2, based on the estimates by Shigoka (2014) and Fukushima et al. (2016). I assume that the medical need is zero in good health, but it is positive in bad health, given by

$$\overline{m_{j,h}} = \begin{cases} 0 & \text{if } h = g \\ \omega \times m_{j,h}^{data} & \text{if } h = b \end{cases} , \tag{23}$$

where ω is the fraction of the medical need in bad health and $m_{j,h}^{data}$ is the medical expenditure estimated in Section 4.2.1. The medical need specification (23) reflects that healthy people are often subject to non-severe diseases such as coughs and abrasions, which would be entirely discretionary medical expenditure; unhealthy people would have necessary and unavoidable medical expenditure for severe diseases or hospitalization.

The parameter for marginal utility of medical spending is assumed to have the following specification:

$$\varepsilon_{j,h} = \exp\left(\widehat{\varepsilon_j}\left(h\right) \times j\right) \times \varepsilon_h, \tag{24}$$

where the first term of the right-hand side captures the growth rate of medical expenses with aging and the second term captures the different amounts of medical expenses by health status.

The calibration is conducted as follows. First, parameter ω in equation (23) is fixed at a certain value. Next, $\varepsilon_{j,h}$ is set as follows. Its component $\widehat{\varepsilon_j}\left(h\right)$ is assumed to take different values for three age groups (below 70, from 70 to 74, and 75 and over) and the two health conditions, and ε_h is assumed to take different values depending on the health condition. In total, there are eight unknown parameters (i.e., $\widehat{\varepsilon_j}\left(h\right)$ for each age group by health and ε_h by health). These parameters are set to match eight moments (i.e., the growth rates of medical expenses from 21 to 70, from 21 to 75, and from 21 to 100 by health, and the amount of medical expenses at age 21 by health). Finally, I calculate the price elasticity of medical demand and check if the average price elasticity is consistent with the value of -0.2.[11] If the elasticity diverges from -0.2, a new value is set for ω and the process is iterated. This iteration method gives the result of $\omega = 0.5$.[12]

[11] We can obtain the price elasticity by comparing the two steady state economies with different copayment rates. The first is the economy with current copayment rates and the second is the economy with increased copayment rates. The price elasticity represents how medical expenditure changes in the second economy compared with the first economy. In the model, older people have smaller elasticity than younger people because they face a higher probability of bad health and larger medical need. This result is consistent with Sawano (2000), who finds that medical demand of the old is less price-elastic than that of the young.

[12] Note that the value of ω is not obtained directly from the data but implicitly induced by the estimated price elasticity. Accordingly, $\omega = 0.5$ indicates that the model successfully generates the price elasticity of -0.2 by assuming that half the medical costs of unhealthy individuals are essential, although the true size of the medical need in the actual economy is not known. Since the main purpose of this paper is to build an economy with the estimated elasticity of Japan, I do not discuss here the direct estimation of medical need.

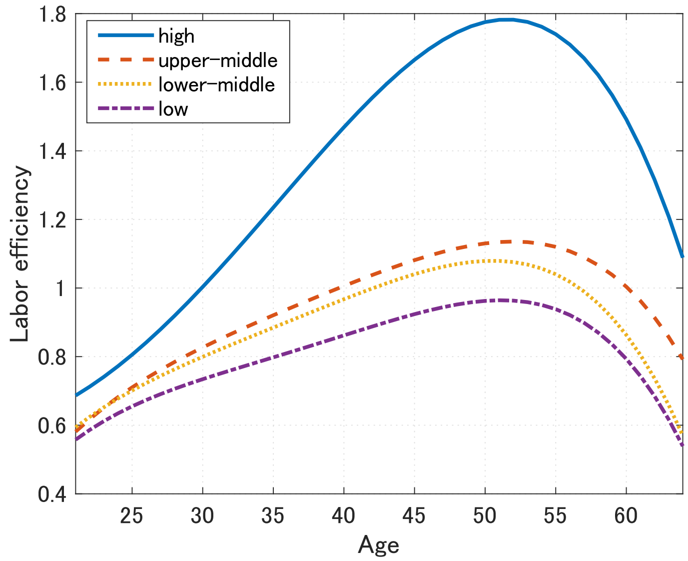

Figure 3: Labor Efficiency Profile by Education

4.3 Endowments and Labor Productivity Shock

The individual labor efficiency $\eta_{j,e}$ is set using data from the Basic Survey on Wage Structure (BSWS) by the Ministry of Health, Labour and Welfare (MHLW). Fixed ability e is assumed to represent an individual's educational level which has four classifications: university or graduate school (high), technical college and junior college (upper-middle), senior high school (lower-middle), and junior high school (low).[13] The estimated wage profiles for each educational level are shown in Figure 3.[14]

The individual labor productivity shock x is approximated by an AR (1) process with a three-state Markov chain using the method of Tauchen (1986):

$$\log(x_{j+1}) = \rho \log(x_j) + \pi_j, \tag{25}$$

where $\pi_j \sim N(0, \sigma_\pi^2)$. Following Hsu and Yamada (2019), persistence parameter ρ is set at 0.98, and standard deviation of the shock σ_π is set at 0.09.

[13] Population share of these workers is calibrated based on the estimates of the BSWS and set at 31.6%, 17.7%, 46.0%, and 4.7%, respectively.

[14] The mean value of the average labor efficiency of each educational level is standardized to one.

4.4 Preferences and Technology

The subjective discount factor β is chosen such that the initial stationary equilibrium of the economy features a capital-output ratio of 3.0. The weight on consumption σ is set so that individuals spend approximately 40% of their disposable time on work. The risk aversion parameter γ is set at 3 as in Pashchenko and Porapakkarm (2019). This value is consistent with the estimates by De Nardi et al. (2010) and Bajari et al. (2014), who find that the risk aversion over consumption is about 2, whereas that over medical spending is around 3.[15] The capital share α is set at 0.377, and the depreciation δ is set at 0.08, based on Imrohoroglu and Sudo (2011).

4.5 Government

4.5.1 Government Expenditure, Taxes, and Social Security

The government spending ratio G/Y is set at 13.82% to match the actual data for 2010.[16] The ratio is assumed to be constant in the model. The consumption tax rate τ^c is set at 5% in the initial steady state. Importantly, the rate is assumed to be endogenously determined to satisfy the government's general budget in the final steady state and during the transition. The capital income tax rate τ^k is set at 39.8% following Imrohoroglu and Sudo (2011), and the inheritance tax rate τ^b is set at 10% according to Okamoto (2013). The labor income tax rate τ^l is set in a way that the government budget (8) holds in the initial steady state. These tax rates are assumed to be constant.

The premium for public pension system τ^p is set to the actual value. Specifically, the premium is 16.058% in 2010, is increased linearly to 18.182% by 2016, and is constant at 18.3% thereafter. The replacement rate θ_e is set to satisfy the pension budget (11). In doing so, the replacement rates are assumed to take different values depending on education and the difference reflects the average labor efficiency of each educational population.

[15] Based on the weight on consumption σ of 0.405, we obtain the risk aversion over consumption $(\gamma - 1)\,\sigma + 1$ of 1.81.

[16] According to the Ministry of Finance (MOF), while Japanese government expenditure in 2010 was 95.3 trillion yen, expenditure on social security and medical care was 28.9 trillion yen. Since nominal GDP in 2010 was 480.2 trillion yen, government expenditure of output is set at 13.82% (=(95.3-28.9)/480.2).

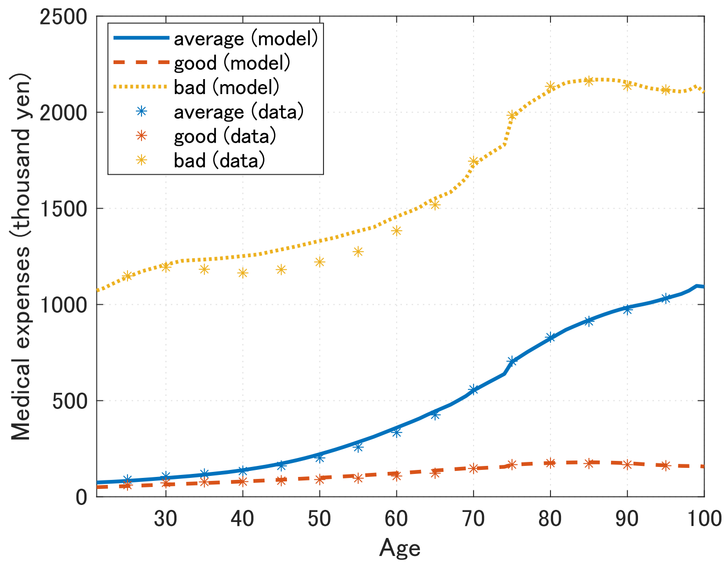

Figure 4: Medical Expenditure over the Life-Cycle (model and data)

4.5.2 Public Health Insurance

All residents are covered by universal health care and they benefit from public health insurance. The copayment rate λ_j currently depends on age: 30% under age 70, 20% between age 70 and 74, and 10% at age 75 and over.[17] Medical benefits, excluding out-of-pockets from total medical expenditure, are financed by the health insurance premium and the government's subsidy. According to the MHLW data, the revenues from the subsidy and the premium in 2010 were 14,261 and 18,132 billion yen, respectively. Thus, the fraction of the government's subsidy φ is set at 44.0% (=14,261/(14,261+18,132)). The premium for public health insurance system τ^m is set to balance the budget for the health insurance system (10).

4.6 Model Fit

Thus calibrated, the model economy resembles very closely the age-profiles of medical expenditure in Japan, as shown in Figure 4. Moreover, the total medical expenditure-to-output ratio in the initial steady state is 7.2%, which also matches the data for 2010.

[17] In the actual economy, the copayment rate is still 30% for those who are over age 70 but have as much income as active workers. However, they represent only 7% of the population, and I therefore omit them.

Table 3: Wealth Distribution

		Data	"Elastic Case"	"Inelastic Case"
Quintiles	1st	0.3%	0.3%	0.3%
	2nd	3.7%	3.2%	3.2%
	3rd	9.8%	9.9%	9.9%
	4th	21.3%	24.2%	24.4%
	5th	64.9%	62.4%	62.2%
Top	1%	10.2%	5.9%	5.8%
	5-1%	19.4%	17.7%	17.7%
	10-5%	15.4%	15.4%	15.4%
Zero wealth		11.0%	7.9%	7.9%

Notes: "Data" shows the results for the year 2014, estimated from Kitao and Yamada (2019).

In the numerical analyses of the paper, I refer to the model economy with elastic medical demand (i.e., price elasticity of -0.2) as the "Elastic Case". I also consider the counterfactual, referred to as the "Inelastic Case" where all medical expenditure is essential (i.e., zero price elasticity). Specifically, the medical expenditure shown in Figure 2 is assumed to be essential in this counterfactual. Comparing the effects of the health insurance reforms in the two economies enables us to shed light on the role of the price elasticity of medical demand.

Table 3 shows the wealth distribution in data and the two model cases. Although the model is not calibrated to match the distribution, the model successfully generates a concentration and right skewness of wealth observed in the data.

5 Steady State Results

The focus of this section is to investigate the long-term impact of public health insurance reforms on the aggregate economy and individual welfare. Specifically, I consider the following three policy reforms regarding the health insurance system and compare the steady state economies under these reforms.[18]

- Benchmark: Maintaining the current health insurance system (i.e., the copayment rates are 30% for those under age 70, 20% for those age 70-74, and 10% for those age 75 and over)

[18]For details of the numerical procedures, see Appendix B.1.

- Reform 1: Raising the copayment rate for those age 75 and over from the current 10% to 20%

- Reform 2: Raising the copayment rate for those age 70-74 from the current 20% to 30%, and for those age 75 and over from the current 10% to 30%

Reform 1 is the scenario that the Japanese government has been discussing, and Reform 2 is the scenario in which a copayment rate of 30% is imposed on those of all ages. To shed light on the role of elastic medical demand, I quantify the impact of the health insurance reforms in two cases: the "Elastic Case" and the "Inelastic Case".

In calculating the steady states under different medical insurance systems, the government budget (8) and the public health insurance budget (10) are satisfied as follows. In the benchmark economy, the consumption tax τ^c is used to balance the government budget (8) and the premium τ^m is adjusted so that the public health insurance budget (10) is balanced. Under Reforms 1 and 2, given the consumption tax computed under the benchmark, the fraction of government subsidy φ is adjusted to satisfy the government budget. As in the benchmark economy, the premium τ^m is used to balance the public health insurance budget.[19]

5.1 Macroeconomic Effects of Reforms

I first discuss the macroeconomic impacts of raising copayments. Table 4 summarizes the long-run effects of the reforms on the aggregate economy. The reform of a rise in copayments substantially increases aggregate capital stock. This is mainly because individuals save more for self-insuring against higher out-of-pocket health costs. The increase in saving is used for accumulating capital, leading to an increase in the aggregate stock of capital. The reform also increases aggregate labor supply, because the rise in copayments improves the health insurance budget and leads to a reduction in the health insurance premium imposed on individual workers. The decrease in the premium stimulates labor supply, leading to an increase in aggregate labor. Consequently, total output increases, and therefore the ratio of medical expenditure to output decreases. Since the rise in capital is greater than that in labor, the capital-labor ratio goes up and the wage rate increases.

[19] The Japanese government aims to reduce the burden of health insurance premiums on younger generations by introducing reforms that raise copayments. This paper therefore assumes that government sector fiscal imbalances are eventually absorbed by health insurance premiums.

Table 4: Long-term Effects of Reforms that Raise Copayments

	"Elastic Case"			"Inelastic Case"		
	Bench	Reform 1	Reform 2	Bench	Reform 1	Reform 2
Consumption tax τ^c	10.8%	10.8%	10.8%	11.2%	11.2%	11.2%
Fraction of subsidy φ	44.0%	46.3%	47.9%	44.0%	43.1%	41.7%
Premium τ^m	5.2%	4.3%	3.7%	5.4%	5.1%	4.7%
Capital K	–	+3.3%	+6.5%	–	+3.5%	+7.9%
Labor N	–	+0.4%	+0.8%	–	+0.5%	+1.0%
Wage rate w	–	+1.1%	+2.1%	–	+1.1%	+2.5%
Medical spending M	–	−5.2%	−8.4%	–	−0.0%	−0.0%
Medical spending of output M/Y	7.1%	6.6%	6.3%	7.5%	7.3%	7.2%
CEV	0.00%	0.99%	1.54%	0.00%	0.18%	0.25%

Notes: Capital, labor, wage rate, and medical spending under Reforms 1 and 2 are expressed in terms of the percent change from those under the benchmark policy. CEV shows the welfare effects.

These patterns are observed similarly in both the elastic case and the inelastic case. However, the health insurance premium declines more in the elastic case than the inelastic case. In both cases, individuals respond to the rise in copayments by increasing precautionary savings as mentioned above, but in the elastic case, the individuals also respond by reducing discretionary medical expenses. This decline in medical demand leads to a decrease in the aggregate medical coverage MB, which in turn improves the budgets of the government and the public health insurance system. Specifically, since the government budget (8) is assumed to be balanced through a change in the fraction of the medical coverage φ, a decline in MB leads to an increase in the government coverage. As a result of the decrease in MB and the increase in the government coverage, the amount of resources that the public health insurance needs to cover – the left-hand side of the health insurance budget (10) – decreases, leading to a greater decline in the premium.

5.2 Welfare Effects of Reforms

Next, I study the effects of the reforms on welfare for future generations. The welfare effects are measured by the Consumption Equivalent Variation (CEV), which represents the percentage change in consumption in the remainder of an individual's life to make them indifferent between the benchmark economy B and the economy under alternative policy A. The CEV based on the ex-ante expected lifetime utility of new-born individuals is given by

$$\text{Elastic Case} : CEV = \left(\frac{\int V^A(s)\, d\Phi^A(s) - \int V_m^B(s)\, d\Phi^B(s)}{\int V^B(s)\, d\Phi^B(s) - \int V_m^B(s)\, d\Phi^B(s)} \right)^{\frac{1}{\sigma(1-\gamma)}} - 1, \qquad (26)$$

$$\text{Inelastic Case} : CEV = \left(\frac{\int V^A(s)\, d\Phi^A(s)}{\int V^B(s)\, d\Phi^B(s)} \right)^{\frac{1}{\sigma(1-\gamma)}} - 1, \qquad (27)$$

where $s = \{j = 1, a = 0, e, x, h\}$ is the new-born individual's state vector. $V(s)$ and $V_m(s)$, respectively, are the expected lifetime utility and the utility from medical spending of an individual of type s, and $\Phi(s)$ is the stationary distribution of the population over type s.

5.2.1 Welfare Effects for All Individuals

Table 4 also shows the welfare effects of the reforms for new-born individuals. Inspection of the last row of the table reveals that, in both the elastic case and the inelastic case, new-born individuals on average have a positive CEV. This implies that reforms that raise copayments can improve the welfare of future generations. However, a much larger gain is expected in the elastic case. For example, under Reform 1, while CEV is 0.99% in the elastic case, it is 0.18% in the inelastic case.

To further investigate why reforms that raise copayments increase the welfare of new-born individuals and why the larger welfare improvements are expected in the elastic case than in the inelastic case, I here decompose the welfare changes by the reform into several components.[20] First, following Conesa et al. (2009), I decompose CEV into three components: one stemming from the change in consumption, one from the change in leisure, and one from the change in medical spending. The consumption component captures a welfare change that would occur if the other individual decisions – leisure and medical spending – do not change. The same is true for each component of leisure and medical spending.

Table 5 presents the results of this welfare decomposition. It shows that the overall welfare improvement is primarily attributed to the change of consumption. The welfare gains from the increase in consumption more than offsets the welfare losses from the decrease in leisure (increase in hours worked) and the decrease in medical spending. Moreover, in the elastic case, total welfare improvement by the reform becomes larger

[20]For details of the calculation of welfare decomposition, see Appendix C.

Table 5: Welfare Decomposition: Consumption, Leisure, and Medical Spending (in CEV)

	"Elastic Case"		"Inelastic Case"	
	Reform 1	Reform 2	Reform 1	Reform 2
All	0.99%	1.54%	0.18%	0.25%
- Consumption	1.73%	3.14%	0.95%	2.10%
- Leisure	−0.58%	−1.23%	−0.76%	−1.81%
- Medical spending	−0.16%	−0.33%	–	–

for the following two reasons. First, leisure declines less, which is led by the smaller increase in labor supply, as shown in Table 4. Second, consumption increases more. In the elastic case, with price-elastic medical demand, the additional effect of decreasing medical spending is generated, although the increases in capital and labor, and therefore those in output, are smaller. The decline in medical spending allows for a greater increase in consumption, because individuals face a choice between consumption goods and medical goods.

Next, following Harenberg and Ludwig (2019), I decompose CEV into two components: the partial equilibrium (PE) effect and the general equilibrium (GE) effect. The PE effect captures the effect under the assumption of fixed prices and consists of the following tax effect and risk exposure effect.[21] The tax effect is the positive effect whereby a reduction in the health insurance premium burden is less distortionary to labor supply and savings. The risk exposure effect is the negative effect whereby a reduction in medical coverage by the government reduces an individual's ability to insure against medical expenditure risk. On the other hand, the GE effect captures the effect from the adjustment in prices and implies that the rise in precautionary savings will increase the wage rate and reduce the interest rate.

Table 6 presents the results of this decomposition. As observed from the table, first, the overall positive welfare effects are brought by larger positive GE effects, although PE effects are negative. Negative PE effects indicate that the burden from the increase in risks outweighs the benefit from the reduction in premiums. However, in total, these welfare losses are overridden by the welfare gains from the GE effects that come from the increase in the wage rate. Second, in the elastic case, the overall welfare improvements are expected to be greater, mainly because the negative PE effect becomes quantita-

[21] Hence, the PE effect captures the welfare change that would occur if the prices $\{r, w\}$ and the law of motion Φ_j do not change.

Table 6: Welfare Decomposition: PE and GE (in CEV)

	"Elastic Case"		"Inelastic Case"	
	Reform 1	Reform 2	Reform 1	Reform 2
All	0.99%	1.54%	0.18%	0.25%
- PE	−2.03%	−4.62%	−3.95%	−9.62%
- GE	3.02%	6.16%	4.13%	9.87%

tively smaller. In the elastic case, the risk exposure effect becomes weaker because of the smaller proportion of unavoidable medical spending. Also, the tax effect becomes stronger because of the larger premium reduction. Hence, the welfare losses from the PE effect will be mitigated.

5.2.2 Welfare Effects for Individuals by Education

Now, I focus on the heterogeneity in welfare effects of the reforms across educational groups. Table 7 reports the welfare effects for those with different educational levels. Differences as well as similarities between the elastic case and the inelastic case are observed from the table. In both cases, individuals with high and upper-middle education enjoy greater welfare improvements than those with lower-middle and low education, because they have higher labor productivity and income and benefit more from the premium reduction. In general, the public health care system gives benefits to those with lower education who cannot fully self-insure against health shock, whereas it poses a large tax burden on those with higher education who earn more labor income. Since reforms that increase copayments imply a shrinking of the role of public health care, they benefit people with higher education but are detrimental to people with lower education.

However, note that, while people with lower-middle and low education have welfare gains in the elastic case, they will face welfare losses in the inelastic case. For example, under Reform 1, CEV for those with low education is 0.82% in the elastic case, compared with -0.10% in the inelastic case. This large discrepancy between the two cases comes from the difference in the price elasticity of medical demand. As mentioned earlier, in the elastic case, reforms that raise copayments bring about a decline in total medical expenditure and much lower health insurance premiums. This is because individuals can mitigate their heavier burden arising from an increase in out-of-pocket spending by reducing their medical demand. Consequently, even for people with lower-middle

Table 7: Long-term Welfare Effects by Education of Reforms that Raise Copayments (in CEV)

	"Elastic Case"		"Inelastic Case"	
	Reform 1	Reform 2	Reform 1	Reform 2
- High	1.23%	2.07%	0.58%	1.17%
- Upper-middle	0.98%	1.51%	0.16%	0.18%
- Lower-middle	0.89%	1.32%	0.03%	−0.12%
- Low	0.82%	1.17%	−0.10%	−0.42%

and low education, the burden of larger out-of-pocket expenses is outweighed by the benefits from lower premiums and higher wages.

6 Transitional Dynamics

The previous section studied the long-term effects of health insurance reforms by comparing two steady states – one with the benchmark health insurance and another with the reformed health insurance. However, this analysis is silent about how the economy reaches a new steady state after the reform is implemented. In this section, I study transitional paths from the initial economy of 2010 to the final steady state, triggered by potential reforms that raise copayments.[22] Using these paths, I investigate the welfare impact of the reforms on current generations in the initial year of 2010.

I assume that, under the benchmark policy, there is no change in the health care system of 2010, and under Reforms 1 and 2, a new policy of the increase in copayments is implemented in 2011. Under all scenarios, demographics evolve according to the population projection described in Section 4.1. The survival rates are set at the IPSS projection up to 2060 and assumed to be constant after 2060. The fertility rates are set at the IPSS projection up to 2050, and assumed to converge to zero by 2065. As life expectancy increases, the dependency ratio (the ratio of the population aged 65 and above to those aged 21-64) is projected to rise from 40% in 2010, to almost 90% in the early 2060s, and to converge to 54% in the long run. During the transition, total population will decrease sharply and eventually shrink to 46 million people, half of the initial population size.

In calculating transitional paths under the benchmark policy, consumption tax τ^c is used to satisfy the government budget (8) every period, whereas the fraction of govern-

[22]For details of the numerical procedures, see Appendix B.2.

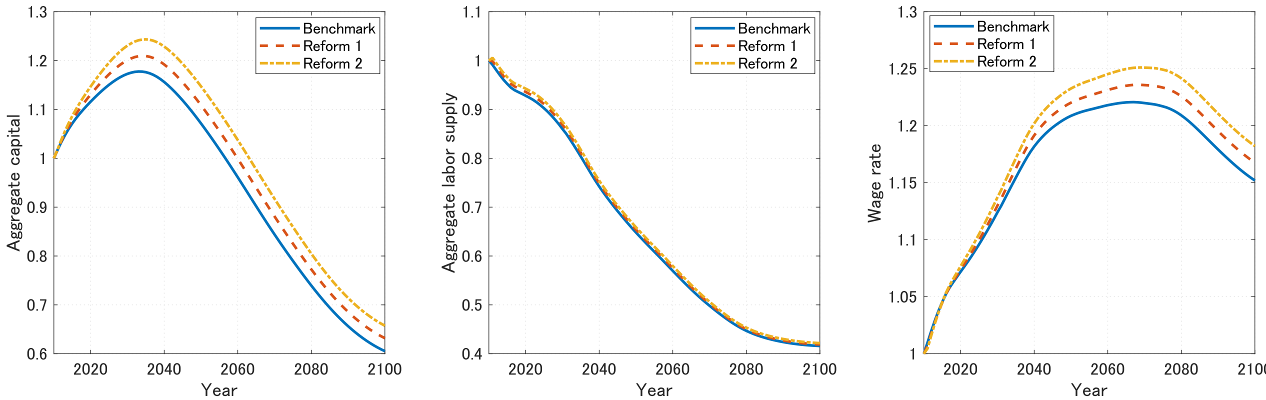

Figure 5: Aggregate Capital, Labor Supply, and Wage Rate during 2010-2100

ment subsidy φ will keep a constant rate.[23] Under Reforms 1 and 2, the government is assumed to follow the same consumption tax path as the benchmark policy and adjust the fraction of subsidy φ to balance its budget. Under all reforms, premium τ^m is used to balance the public health insurance budget (10) every period. All the other fiscal variables will be unchanged throughout the transition.

6.1 Macroeconomic Variables

Figure 5 shows the dynamic paths of aggregate capital, aggregate labor, and wage rate in 2010-2100 in the elastic case. Aggregate capital stock will increase by the early 2030s, but then will continue to decline. The initial rise is because of more savings encouraged by longer life expectancy, and the subsequent decline is due to demographic shifts and a fall in population. Aggregate labor will experience a monotonic decline, because of a fall in working-age population due to the low fertility rate and the retirement of the baby-boom generations. The wage rate rises initially but later declines slowly in line with a decrease in capital. When the copayment rates are raised over time, both aggregate capital and labor are much higher. The increase in capital is mainly because of a rise in precautionary savings, and the increase in labor is a consequence of a rise in hours-worked stimulated by a decline in the health insurance premium. Since the increase in capital is greater than that in labor, the wage rate also becomes higher.

As shown in Figure 6, the ratio of medical expenditure to output rises with aging,

[23] I assume that the consumption tax is endogenously determined every year. Hence, past changes such as the increase from 5% to 8% in 2014 and the increase from 8% to 10% in 2019 are not embedded in my computation.

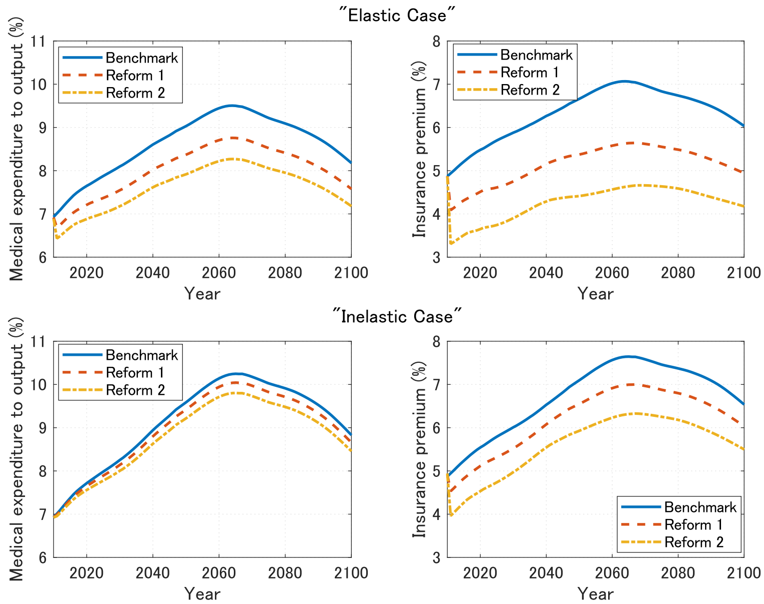

Figure 6: Ratio of Medical Expenditure to Output and Health Insurance Premium during 2010-2100

reaches a peak in the 2060s, and eventually, gradually declines as the dependency ratio declines. Health insurance premiums follow a similar hump-shaped path. Under Reforms 1 and 2, higher capital and labor results in higher output. Thus, the ratios of medical expenditure to output are lower than under the benchmark policy. Moreover, reforms that raise copayments are expected to bring a greater reduction of the ratio in the elastic case than in the inelastic case, since total medical expenditure itself declines in the former case. This decline in medical expenditure leads to a larger drop in premiums under Reforms 1 and 2 in the elastic case.

6.2 Welfare Effects on Current Cohorts

In the steady state analysis in Section 5.2, we observed that reforms that increase copayments improve the welfare of future generations, and a greater welfare gain is expected in the elastic case. In this section, I study the welfare effects of the reforms on individuals who already exist in the initial economy before the reforms. To calculate the welfare of current generations, I introduce a new state vector ss, which adds the time period t to individual state variables $s = \{j, a, e, x, h\}$. The definition of the CEV for current generations, specifically those alive in 2010 ($t = 1$) at age k, is the same as

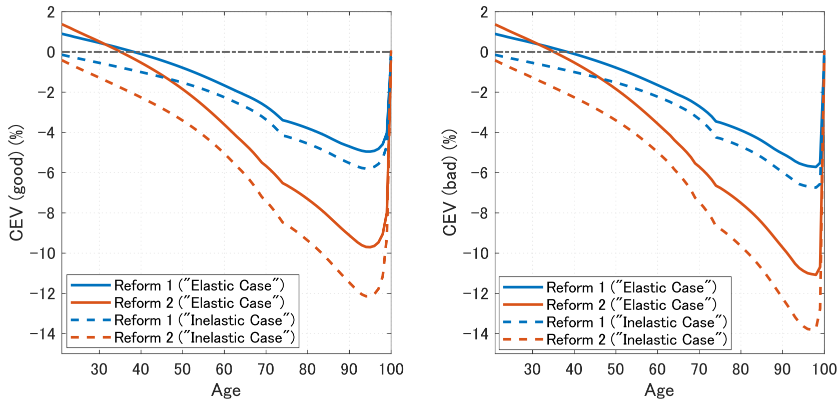

Figure 7: Welfare Effects of Reforms that Raise Copayments on Current Generations by Age and Health

the CEV for future generations in equations (26) and (27), except that the individual's state vector s is replaced by $ss = \{j = k, a, e, x, h, t = 1\}$.

Figure 7 shows the welfare effects on current cohorts who are different in age and health status. In the inelastic case, all generations have lower utility, regardless of their age and health status. Old and unhealthy individuals suffer a greater welfare loss because they are likely to have higher medical expenditure and less opportunity or time to prepare for the increase in copayments. For example, under Reform 1, on average, the loss in good health for those aged below 65 is 1.21%, and for those aged above 65 is 4.45%. In addition, on average, the loss for those aged above 65 is 4.45% in good health compared with 4.79% in poor health.

In the elastic case, however, such negative welfare effects become smaller, since individuals can mitigate the burden of the increase in medical expenditure risk by reducing their discretionary medical spending. When medical demand is elastic to medical price changes, raising copayments brings about a decline in medical demand, and therefore a greater reduction in insurance premiums, making the negative risk exposure effect weaker and the positive tax effect stronger. In particular, under Reform 1, on average, the loss for those aged above 65 with poor health will be 4.00% in the elastic case, compared with 4.79% in the inelastic case. Meanwhile, young individuals under age 39, even those with poor health, improve their utility because of lower premiums and higher wages.

Figure 8 shows the welfare effects on current cohorts who are different in age and educational level. In the inelastic case, all individuals, except for very young people with

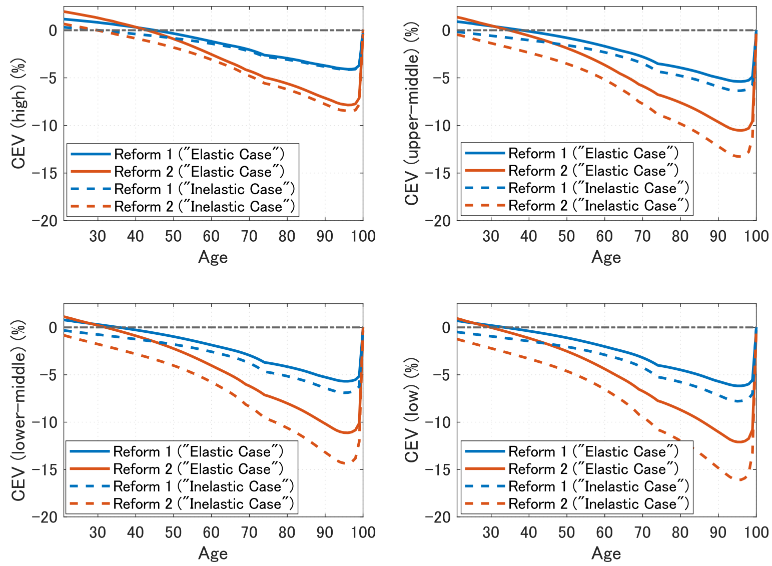

Figure 8: Welfare Effects of Reforms that Raise Copayments on Current Generations by Age and Education

high education, experience welfare losses. The reforms are more detrimental to those with lower-middle and low educational levels, as they have less total income, including labor income and pension benefits, and therefore a larger proportion of medical need in their total income. For individuals with lower education, the benefit from the decline in the premium becomes smaller and the burden of the increase in medical expenditure risk becomes larger. In particular, under Reform 1, on average, while the loss for those above age 65 with high education is 3.08%, that for those with low education is 5.78%.

Nonetheless, in the elastic case, because the decline in medical demand leads to a greater reduction in premiums, the loss for those with low education is mitigated: on average, 4.52% in the elastic case, compared with 5.78% in the inelastic case. Moreover, the reform is beneficial to young individuals, including those under age 36 with lower-middle education and those under age 34 with low education. Since they have smaller medical expenditure and benefit significantly from lower premiums, the reform can improve their welfare.

7 Alternative Policy Experiments

The analyses in Sections 5 and 6 reveal that it may be difficult to get the support from many current generations for reforms that increase copayments, in spite of the positive welfare effects on future generations.[24] Indeed, the Japanese government is concerned about the possibility that raising copayments could increase the burden on the current elderly, especially those with poor health or low income. For this reason, the government plans to raise the copayment rate for the elderly age 75 and over whose annual income is higher than 2 million yen from the second half of 2022. To understand the impact of such reforms with income threshold, I here consider additional experiments as follows:[25]

- Reform 1-1: Raising the copayment rate for those above age 75 with high, upper-middle, and lower-middle education from the current 10% to 20%, while keeping the current rate for those with low education
- Reform 1-2: Raising the copayment rate for those above age 75 with high education from the current 10% to 20%, while keeping the rate for those with all the other levels of education

Regarding income threshold, I use educational levels of the elderly as proxies for their income levels. This is because, in this paper, I assume that all individuals withdraw from the labor market at age 65 permanently and after live on pension benefits which depend on their educational levels.

Table 8 compares the long-term effects of the additional reforms in the elastic case. Under Reform 1-1, individuals with low education gain greater welfare improvements because they do not face increased out-of-pocket medical expenditure, while enjoying the reduction in premiums. However, because of their small medical expenditure, the effects of Reform 1-1 on the macroeconomy and average welfare are not quantitatively different from those of Reform 1. On the other hand, under Reform 1-2, individuals with high education suffer welfare losses. In addition, although all individuals with the other educational levels increase their welfare, the gains are less than those under Reform 1. Since Reform 1-2 brings the copayment increase for only those with high income, the

[24] I discuss the sensitivity of my numerical results to alternative assumptions about the model and calibration in Appendix D.

[25] Reform 1-1 reflects the opinion of the National Federation of Health Insurance Societies (*Kenko hoken kumiai rengokai*) that copayments should be 20% in principle but 10% for those with low income. Meanwhile, Reform 1-2 reflects the opinion of the Japan Medical Association (*Nihon ishikai*) that copayments should be 10% in principle but 20% for those with high income.

Table 8: Long-term Effects of Reforms with Income Threshold

	"Elastic Case"			
	Bench	Reform 1	Reform 1-1	Reform 1-2
Premium τ^m	5.2%	4.3%	4.4%	4.8%
Capital K	–	+3.3%	+3.1%	+1.1%
Medical spending of output M/Y	7.1%	6.6%	6.7%	6.9%
CEV	0.00%	0.99%	0.97%	0.51%
- High education	0.00%	1.23%	1.15%	−0.05%
- Upper-middle education	0.00%	0.98%	0.89%	0.71%
- Lower-middle education	0.00%	0.89%	0.81%	0.70%
- Low education	0.00%	0.82%	1.92%	0.70%

effects of the reduction in the premium will be smaller compared with Reform 1. As a result, positive welfare effects also get smaller.

Figure 9 shows the welfare effects on current cohorts by educational level.[26] Under Reform 1-1, all low-education individuals have greater welfare, while the welfare improvements for young people with other educational levels are slightly less than those of Reform 1. On the other hand, under Reform 1-2, all the current population, including the elderly, but excepting high-education individuals, experience welfare improvements.

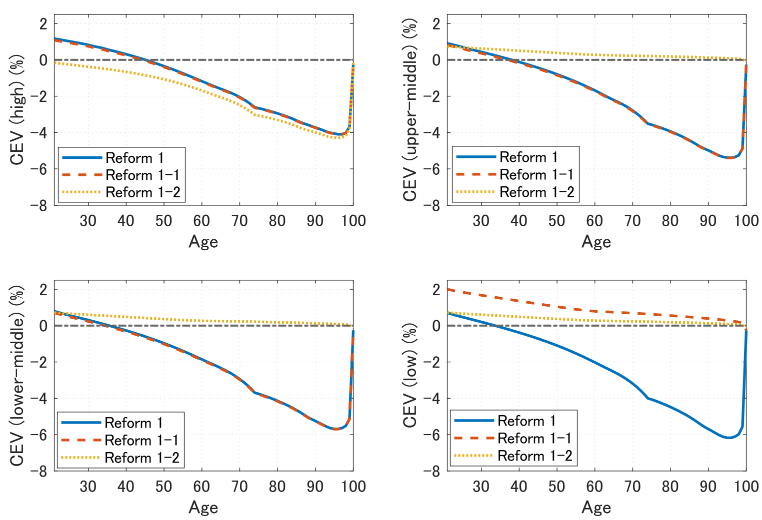

Figure 9: Welfare Effects on Current Generations by Age and Education under Reforms with Income Threshold

[26]Under all reforms, a new policy increased copayments is assumed to have been implemented in 2011.

Accordingly, the copayment increase with income threshold can offer a welfare trade-off between future and current generations. From the viewpoint of ex-ante welfare for new-born individuals, a uniform increase in copayments, such as proposed in Reform 1, is favorable. From the viewpoint of welfare for current cohorts, an increase in copayments for high-income groups only, such as in Reform 1-2, is beneficial.

8 Conclusion

This paper quantifies the welfare effects of public health insurance reforms in Japan that raise copayments. I develop a dynamic stochastic general equilibrium overlapping generations model with heterogeneous individuals who are different in their age, education, labor productivity, wealth, and health status. In particular, I consider two models with different assumptions about medical demand: price-elastic and price-inelastic. While the former model assumes that individuals optimally choose medical spending as well as consumption and labor supply over the life-cycle, the latter model assumes that all medical expenditure is essential and unavoidable for individuals. By examining and comparing the effects of reforms on the welfare of future and current generations, I suggest that the price elasticity of medical demand is significantly important in evaluating the welfare impact.

Reforms that raise copayments increase out-of-pocket medical expenses, and individuals become exposed to more medical expenditure risk. On the other hand, such reforms encourage individuals to save more and increase aggregate capital, leading to a rise in the wage rate. They also allow for a reduction in health insurance premiums by improving the government budget. These reforms bring welfare gains for future generations because the positive effects arising from reduced premiums and increased wages are greater than the negative effects arising from increased medical expenditure risk. However, current generations, especially those in old age, with poor health, or low education, may suffer significant welfare losses.

However, in the economy with elastic medical demand, because the reforms bring about a reduction in medical demand, the negative effect of higher medical expenditure risk is mitigated, and the greater positive effect of the lower premium is realized. Hence, the welfare of future generations is improved much more than in the economy with inelastic medical demand. Moreover, these reforms improve the welfare of current young generations, including unhealthy and low-education individuals, whereas the welfare of all current generations deteriorates in the economy with inelastic medical demand. These contrasting results reveal that, by not taking into account the elastic medical demand as observed in the actual economy, we may underestimate the positive effects of reforms that raise copayments while emphasizing their negative effects.

I also note that my model abstracts from the relation between health status and labor efficiency or survival probability, mainly because of the difficulty of accessing micro-level data in Japan. In addition, the healthcare system and medical services in the actual economy are more complex than this paper has assumed: high-cost medical expense benefits (*kogaku ryoyohi seido*), medical deductions (*iryohi kojo*), private health insurance, and hospitalization. These important extensions to investigate precisely the policy impacts are left in future research.

References

[1] Aiyagari, S.R. (1994) "Uninsured idiosyncratic risk and aggregate saving," *Quarterly Journal of Economics*, Vol.109, No.3, 659-684.

[2] Attanasio, O.P., S. Kitao, and G.L. Violante (2011) "Financing Medicare: A General Equilibrium Analysis," In *Demography and the Economy*, edited by J.B. Shoven, Chicago: University of Chicago Press, 333-370.

[3] Baicker, K., S. Taubman, H. Allen, M. Bernstein, J. Gruber, J.P. Newhouse, E. Schneider., B. Wright, A. Zaslavsky, and A. Finkelstein (2013) "The Oregon experiment: effects of Medicaid on clinical outcomes," *New England Journal of Medicine*, Vol.368, Issue 18, 1713-1722.

[4] Bajari, P., C. Dalton, H. Hong, and A. Khwaja (2014) "Moral hazard, adverse selection, and health expenditures: A semiparametric analysis," *RAND Journal of Economics*, Vol.45, No.4, 747-763.

[5] Bewley, T. (1986) "Stationary monetary equilibrium with a continuum of independently fluctuating consumers," In *Contributions to Mathematical Economics in Honor of Gerard Debreu*, edited by W. Hildenbrand and A. Mas-Colell, North-Holland.

[6] Bhattacharya, J., W.B. Vogt, A. Yoshikawa, and T. Nakahara (1996) "The Utilization of Outpatient Medical Services in Japan," *Journal of Human Resources*, Vol.31, No.2, 450-476.

[7] Braun, R.A., and D.H. Joines (2015) "The Implications of a Greying Japan for Government Policy," *Journal of Economic Dynamics and Control*, Vol.57, 1-23.

[8] Card, D., C. Dobkin, and N. Maestas (2008) "The Impact of Nearly Universal Insurance Coverage on Health Care Utilization: Evidence from Medicare," *American Economic Review*, Vol.98, No.5, 2242-2258.

[9] Card, D., C. Dobkin, and N. Maestas (2009) "Does Medicare Save Lives?," *Quarterly Journal of Economics*, Vol.124, Issue 2, 597-636.

[10] Carroll, C.D. (2006) "The Method of Endogenous Gridpoints for Solving Dynamic Stochastic Optimization Problems," *Economics Letters*, Vol.91, 312-320.

[11] Chandra, A., J. Gruber, and R. McKnight (2010) "Patient Cost-Sharing and Hospitalization Offsets in the Elderly," *American Economic Review*, Vol.100, No.1, 193-213.

[12] Colombo, F., and N. Tapay (2004) "Private health insurance in OECD countries: the benefits and costs for individuals and health systems," OECD Health Working Paper, No.15.

[13] Conesa, J.C., and D. Krueger (1999) "Social Security Reform with Heterogeneous Agents," *Review of Economic Dynamics*, Vol.2, Issue 4, 757-795.

[14] Conesa, J.C., S. Kitao, and D. Krueger (2009) "Taxing Capital? Not a Bad Idea after All!," *American Economic Review*, Vol.99, No.1, 25-48.

[15] Conesa, J.C., D. Costa, P. Kamali, T.J. Kehoe, V.M. Nygard, G. Raveendranathan, and A. Saxena (2018) "Macroeconomic effects of Medicare," *Journal of the Economics of Aging*, Vol.11, 27-40.

[16] De Nardi, M., E. French, and J.B. Jones (2010) "Why Do the Elderly Save? The Role of Medical Expenses," *Journal of Political Economy*, Vol.118, 39-75.

[17] De Nardi, M., E. French, and J.B. Jones (2016) "Medicaid Insurance in Old Age," *American Economic Review*, Vol.106, No.11, 3480-3520.

[18] Finkelstein, A., E.F. Luttmer, and M.J. Notowidigdo (2013) "What good is wealth without health? The effect of health on the marginal utility of consumption," *Journal of the European Economic Association*, Vol.11 (S1), 221-258.

[19] Fonseca, R., P. Michaud, T. Galama, and A. Kapteyn (2009) "On the Rise of Health Spending and Longevity," IZA Discussion Papers 4622, Institute of Labor Economics (IZA).

[20] French, E., and J.B. Jones (2011) "The effects of health insurance and self-insurance on retirement behavior," *Econometrica*, Vol.79, Issue 3, 693-732.

[21] Fukai, T., H. Ichimura, and K. Kanazawa (2018) "Quantifying Health Shocks over the Life Cycle," RIETI Discussion Paper Series 18-E-014.

[22] Fukai, T., H. Ichimura, S. Kitao, and M. Mikoshiba (2021) “Medical Expenditures over the Life Cycle: Persistent Risks and Insurance,” RIETI Discussion Paper Series 21-E-073.

[23] Fukushima, K., S. Mizuoka, S. Yamamoto, and T. Iizuka (2016) “Patient cost sharing and medical expenditures for the Elderly,” *Journal of Health Economics*, Vol.45, 115-130.

[24] Grossman, M. (1972) “On the concept of health capital and the demand for health,” *Journal of Political Economy*, Vol.80, No.2, 223-255.

[25] Halliday, T., H. He, L. Ning, and H. Zhang (2019) “Health Investment over the Life-Cycle,” *Macroeconomic Dynamics*, Vol.23, Issue 1, 178-215.

[26] Hansen, G.D., M. Hsu, and J. Lee (2014) “Health insurance reform: The impact of a Medicare buy-in,” *Journal of Economic Dynamics and Control*, Vol.45, 315-329.

[27] Harenberg, D., and A. Ludwig (2019) “Idiosyncratic Risk, Aggregate Risk, and the Welfare Effects of Social Security,” *International Economic Review*, Vol.60, Issue 2, 661-692.

[28] Horioka, C.Y. (2021) “Is the selfish life-cycle model more applicable in Japan and, if so, why? A literature survey,” *Review of Economics of the Household*, Vol.19, 157-187.

[29] Hsu, M., and J. Lee (2013) “The Provision of Public Universal Health Insurance: Impacts on Private Insurance, Asset Holdings and Welfare,” *Macroeconomic Dynamics*, Vol.17, Issue 6, 1252-1280.

[30] Hsu, M., P.L. Liao, and C.C. Lin (2016) “Revisiting Private Health Insurance and Precautionary Saving - A Theoretical and Empirical Analysis,” Working Paper.

[31] Hsu, M., and T. Yamada (2019) “Population Aging, Health Care, and Fiscal Policy Reform: The Challenges for Japan,” *The Scandinavian Journal of Economics*, Vol.121, Issue 2, 547-577.

[32] Hubbard, R.G., J. Skinner, and S.P. Zeldes (1994) “The importance of precautionary motives in explaining individual and aggregate saving,” *Carnegie-Rochester Conference Series on Public Policy*, Vol.40, 59-125.

[33] Huggett, M. (1996) "Wealth distribution in life-cycle economies," *Journal of Monetary Economics*, Vol.38, 469-494.

[34] Ihori, T., R.R. Kato, M. Kawade, and S. Bessho (2011) "Health insurance reform and economic growth: Simulation analysis in Japan," *Japan and the World Economy*, Vol.23, 227-239.

[35] Ii, M., and Y. Ohkusa (2002) "Should the Coinsurance Rate Be Increased in the Case of the Common Cold? An Analysis Based on an Original Survey," *Journal of the Japanese and International Economies*, Vol.16, Issue 3, 353-371.

[36] Ii, M., and S. Bessho (2006) "*Iryo no kisoteki jisshobunseki to seisaku: Sabei* [Empirical Analysis and Public Policy of Healthcare: A Survey]," *Financial Review*, No.80, 117-156 (in Japanese).

[37] Imrohoroglu, A., S. Imrohoroglu, and D.H. Joines (1995) "A life cycle analysis of social security," *Economic Theory*, Vol.6, 83-114.

[38] Imrohoroglu, S., and S. Kitao (2009) "Labor supply elasticity and social security reform," *Journal of Public Economics*, Vol.93, Issue 7-8, 867-878.

[39] Imrohoroglu, S., and S. Kitao (2012) "Social Security Reforms: Benefit Claiming, Labor Force Participation, and Long-Run Sustainability," *American Economic Journal: Macroeconomics*, Vol.4, No.3, 96-127.

[40] Imrohoroglu, S., and N. Sudo (2011) "Productivity and Fiscal Policy in Japan: Short-Term Forecasts from the Standard Growth Model," *Monetary and Economic Studies,* Vol.29, 73-106.

[41] Jeske, K., and S. Kitao (2009) "U.S. tax policy and health insurance demand: Can a regressive policy improve welfare?," *Journal of Monetary Economics*, Vol.56, Issue 2, 210-221.

[42] Jung, J., and C. Tran (2016) "Market Inefficiency, Insurance Mandate and Welfare: U.S. Health Care Reform 2010," *Review of Economic Dynamics*, Vol.20, 132-159.

[43] Kan, M., and W. Suzuki (2006) "The demand for medical care in Japan: initial findings from a Japanese natural experiment," *Applied Economics Letters*, Vol.13, Issue 5, 273-277.

[44] Kan, M., and W. Suzuki (2009) "Effects of cost sharing on the demand for physician services in Japan: Evidence from a natural experiment," *Japan and the World Economy*, Vol.22, Issue 1, 1-12.

[45] Kitao, S. (2014) "Sustainable social security: Four options," *Review of Economic Dynamics*, Vol.17, Issue 4, 756-779.

[46] Kitao, S., and T. Yamada, (2019) "Dimensions of Inequality in Japan: Distributions of Earnings, Income, and Wealth between 1984 and 2014," RIETI Discussion Paper Series 19-E-034.

[47] Kopecky K.A., and T. Koreshkova (2014) "The Impact of Medical and Nursing Home Expenses on Savings," *American Economic Journal: Macroeconomics*, Vol.6, No.3, 29-72.

[48] Kotlikoff, L.J. (1989) "Health expenditures and precautionary savings," NBER Working Paper No.2008.

[49] Krueger, D., and A. Ludwig (2007) "On the Consequences of Demographic Change for Rates of Returns to Capital, and the Distribution of Wealth and Welfare," *Journal of Monetary Economics*, Vol.54, 49-87.

[50] Lawrence, T.L. (1985) "HEALTH CARE FACILITIES FOR THE ELDERLY IN JAPAN," *International Journal of Health Services*, Vol.15, No.4, 677-697.

[51] Manning, W.G., J.P. Newhouse, N. Duan, E.B. Keeler, and A. Leibowitz (1987) "Health Insurance and the Demand for Medical Care: Evidence from a Randomized Experiment," *American Economic Review*, Vol.77, No.3, 251-277.

[52] McClellan, M., and J. Skinner (2006) "The incidence of Medicare," *Journal of Public Economics*, Vol.90, Issue 1-2, 257-276.

[53] McGrattan, E.R., K. Miyachi, and A. Peralta-Alva (2018) "On Financing Retirement, Health, and Long-term Care in Japan," IMF Working Paper No.18/249.

[54] Newhouse, J.P. (1993) *Free for all? Lessons from the RAND Health Insurance Experiment*, Harvard University Press.

[55] Nishiyama, S., and K. Smetters (2007) "Does Social Security Privatization Produce Efficiency Gains?," *Quarterly Journal of Economics*, Vol.122, Issue 4, 1677-1719.

[56] Okamoto, A. (2013) "Simulating Public Pension Reforms in an Aging Japan: Welfare Analysis with LSRA Transfers," *Public Policy Review*, Vol.9, No.4, 597-632.

[57] Palumbo, M.G. (1999) "Uncertain Medical Expenses and Precautionary Saving Near the End of the Life Cycle," *Review of Economic Studies*, Vol.66, Issue 2, 395-421.

[58] Pashchenko, S., and P. Porapakkarm (2013) "Quantitative analysis of health insurance reform: Separating regulation from redistribution," *Review of Economic Dynamics*, Vol.16, Issue 3, 383-404.

[59] Pashchenko, S., and P. Porapakkarm (2019) "Reducing medical spending of the publicly insured: the case for a cash-out option," *American Economic Journal: Economic Policy*, Vol.11, No.3, 390-426.

[60] Sawano, K. (2000) "*Koreishairyo ni okeru jikofutan no yakuwari - Teigakujikofutansei to teiritsujikofutansei-* [Co-payment, Coinsurance rate and the Elderly Care in Japan]," *Iryō to syakai*, Vol.10, No.2, 115-138 (in Japanese).

[61] Shigeoka, H. (2014) "The effect of patient cost sharing on utilization, health, and risk protection," *American Economic Review*, Vol.104, No.7, 2152-2184.

[62] Tauchen, G. (1986) "Finite state Markov-chain approximations to univariate and vector autoregressions," *Economic Letters*, Vol.20, 177-181.

[63] Yogo, M. (2016) "Portfolio Choice in Retirement: Health Risk and the Demand for Annuities, Housing and Risky Assets," *Journal of Monetary Economics*, Vol.80, 17-34.

Appendix

A Calculation of Medical Expenditure Profiles

In this paper, I compute age- and health-dependent medical expenditure as follows. First, using the population distribution by age and health group reported by Fukai et al. (2018), I calculate the population share of those with "good" health and "bad" health. Their paper classified people into five health groups according to annual medical expenditure: 0-7,800 yen for Q1 (best health condition), 7,801-24,000 yen for Q2, 24,001-54,000 yen for Q3, 54,001-266,999 yen for Q4, and 267,000 yen and over for Q5 (worst health condition). I assume that "good" and "bad" health groups in my model correspond to Q1-Q4 and Q5 groups in their paper. For example, in the age group 20-24, there are 98% with "good" health and 2% with "bad" health.

Next, by combining these population share with the distribution of medical expenditure by age group, I calculate medical expenditure by age and health group. Fukai et al. (2018) also present the average medical expenditure in the percentiles of each age group: 1%, 5%, 10%, 25%, 50%, 75%, 90%, 95% (top 5%), and 99% (top 1%). First, in all age groups, I linearly interpolate these medical expenditures and obtain the medical expenditure by health group. Second, I linearly interpolate the medical expenditure of each age group over age and then obtain the age- and health-dependent medical expenditure.

However, there was a gap between these calculated medical expenditures and average health care expenditure in 2010 reported by the MHLW. For this reason, finally, given the health distribution, I recalibrate the medical expenditures in the model so that they match the actual medical costs.

B Computational Algorithm

B.1 Computation of the Steady States

The numerical method of the stationary equilibriums is basically the same as Huggett (1996). For example, consider the final steady state under the benchmark policy. We find a set of capital-labor ratio K/N that leads to the equilibrium prices $\{r, w\}$, consumption tax τ^c that balances the government budget, and health insurance premium τ^m that balances the public health insurance budget. Computational steps are described below.

1. Guess aggregate capital K^{ini} and aggregate labor supply N^{ini}, and calculate factor prices $\{r, w\}$. Set initial values of consumption tax $(\tau^c)^{ini}$ and premium $(\tau^m)^{ini}$.

2. Given $\{r, w\}$ and government policies $\{G/Y, \tau^l, \tau^k, \tau^b, \tau^p, \theta_e, \lambda_j, \varphi\}$, compute policy functions using the Endogenous Grid Method (EGM) backwardly.

3. Compute the population distribution function Φ from policy functions.

4. Using the distribution function, calculate aggregate variables such as capital K^{new}, labor supply N^{new}, consumption C, and medical expenditure M.

5. Find the consumption tax $(\tau^c)^{new}$ so that the budget constraint of the government sector holds.

6. Find the premium $(\tau^m)^{new}$ so that the budget constraint of the sector of public health insurance holds.

7. If K^{ini}, N^{ini}, $(\tau^c)^{ini}$, and $(\tau^m)^{ini}$ are close to K^{new}, N^{new}, $(\tau^c)^{new}$, and $(\tau^m)^{new}$, respectively, then stop the computation. Otherwise, update these initial values, and restart from Step 2.

B.2 Computation of the Transitional Dynamics

For example, consider the benchmark policy. Given the initial steady state in 2010 $(t = 1)$ and the final steady state in 2250 $(t = T)$ computed by the above algorithms, we find the transition path between the two steady states as follows.

1. Guess aggregate capital $\left\{(K_t)^{ini}\right\}_{t=1}^{T}$, aggregate labor supply $\left\{(N_t)^{ini}\right\}_{t=1}^{T}$, and bequests $\left\{(beq_t)^{ini}\right\}_{t=1}^{T}$, and calculate a sequence of factor prices $\{r_t, w_t\}_{t=1}^{T}$. Set initial sequences of consumption tax $\left\{(\tau_t^c)^{ini}\right\}_{t=1}^{T}$ and premium $\left\{(\tau_t^m)^{ini}\right\}_{t=1}^{T}$.

2. Given $\{r_t, w_t\}$ and government policies $\left\{(G/Y)_t, \tau_t^l, \tau_t^k, \tau_t^b, \tau_t^p, \theta_{e,t}, \lambda_{j,t}, \varphi_t\right\}_{t=1}^{T}$, compute a sequence of policy functions using the EGM backwardly from 2250 to 2010.

3. Given the policy functions computed in Step 2, calculate the population distribution function Φ_t from 2010 onwards.

4. Using the distribution function, calculate aggregate capital $\{(K_t)^{new}\}_{t=1}^{T}$, aggregate labor supply $\{(N_t)^{new}\}_{t=1}^{T}$, bequests $\{(beq_t)^{new}\}_{t=1}^{T}$, aggregate consumption $\{C_t\}_{t=1}^{T}$, and total medical expenditure $\{M_t\}_{t=1}^{T}$.

5. Find the consumption tax $\{(\tau_t^c)^{new}\}_{t=1}^{T}$ so that the government sector satisfies its budget every period.

6. Find the premium $\{(\tau_t^m)^{new}\}_{t=1}^{T}$ so that the public health insurance sector satisfies its budget every period.

7. If $\left\{(K_t)^{ini}\right\}$, $\left\{(N_t)^{ini}\right\}$, $\left\{(beq_t)^{ini}\right\}$, $\left\{(\tau_t^c)^{ini}\right\}$, and $\left\{(\tau_t^m)^{ini}\right\}$ are close to $\{(K_t)^{new}\}$, $\{(N_t)^{new}\}$, $\{(beq_t)^{new}\}$, $\{(\tau_t^c)^{new}\}$, and $\{(\tau_t^m)^{new}\}$, respectively, then stop the computation. Otherwise, update the initial sequences of K_t, N_t, beq_t, τ_t^c, and τ_t^m, and restart from Step 2.

C Welfare Decomposition of CEV

C.1 Consumption, Leisure, and Medical Spending Effects

Consider the elastic case. The decomposition of welfare into the components arising from changes in consumption, leisure, and medical spending is as follows.[27]

$$(1+CEV) = \left[\frac{W\left(c^A, l^A, m^A\right)}{W\left(c^B, l^B, m^B\right)}\right]^{\frac{1}{\sigma(1-\gamma)}} = (1+CEV_c)\,(1+CEV_l)\,(1+CEV_m)\,, \quad (28)$$

where

$$W(c,l,m) = \int V(s)\, d\Phi(s) - \int V_m^B(s)\, d\Phi^B(s)\,, \quad (29)$$

$$CEV_c = \left[\frac{W\left(c^A, l^B, m^B\right)}{W\left(c^B, l^B, m^B\right)}\right]^{\frac{1}{\sigma(1-\gamma)}} - 1, \quad (30)$$

[27] In the inelastic case, CEV can be decomposed into two parts: that arising from changes in consumption, and that arising from changes in leisure.

$$(1+CEV) = \left[\frac{W\left(c^A, l^A\right)}{W\left(c^B, l^B\right)}\right]^{\frac{1}{\sigma(1-\gamma)}} = (1+CEV_c)\,(1+CEV_l)\,.$$

$$CEV_l = \left[\frac{W\left(c^A, l^A, m^B\right)}{W\left(c^A, l^B, m^B\right)}\right]^{\frac{1}{\sigma(1-\gamma)}} - 1, \tag{31}$$

$$CEV_m = \left[\frac{W\left(c^A, l^A, m^A\right)}{W\left(c^A, l^A, m^B\right)}\right]^{\frac{1}{\sigma(1-\gamma)}} - 1, \tag{32}$$

where CEV_c, CEV_l, and CEV_m respectively, denote the contributions from consumption, from leisure, and from medical spending.

C.2 Partial Equilibrium and General Equilibrium Effects

The decomposition of welfare into partial equilibrium (PE) and general equilibrium (GE) effects is as follows.

$$CEV = CEV_{PE} + CEV_{GE}, \tag{33}$$

where

$$CEV_{PE} = \left[\left[\frac{W\left(c^A, l^A, m^A\right)}{W\left(c^B, l^B, m^B\right)}\right]^{\frac{1}{\sigma(1-\gamma)}} - 1 \middle| r = r^B, w = w^B, \Phi(s) = \Phi^B(s)\right], \tag{34}$$

where CEV_{PE} and CEV_{GE}, respectively, denote the contributions from the PE effect and from the GE effect.

D Robustness Analysis

D.1 Price Elasticity of Medical Demand

The main analysis in this paper focuses on a calibrated economy with price elasticity of -0.2 estimated from Shigeoka (2014) and Fukushima et al. (2016). However, some empirical papers report a wider range of elasticity in Japan.[28] I assess the effects of public health insurance reform under economies with alternative price elasticity levels

[28]For example, Bhattacharya et al. (1996) find the price elasticity of demand for outpatient care to be between -0.54 and -0.12 and Ii and Ohkusa (2002) report the price elasticity for medical services to be between -0.36 and -0.23. For the empirical literature on the price elasticity of medical demand in Japan, see Ii and Bessho (2006).

Table 9: Sensitivity Analysis: Price Elasticity of Medical Demand

	Elasticity=-0.3			"Elastic Case" (Elasticity=-0.2)		
	Bench	Reform 1	Reform 2	Bench	Reform 1	Reform 2
τ^m	5.0%	3.9%	3.2%	5.2%	4.3%	3.7%
M/Y	6.9%	6.2%	5.8%	7.1%	6.6%	6.3%
CEV	0.00%	1.38%	2.16%	0.00%	0.99%	1.54%
- High education	0.00%	1.55%	2.50%	0.00%	1.23%	2.07%
- Low education	0.00%	1.27%	1.93%	0.00%	0.82%	1.17%
	Elasticity=-0.1			"Inelastic Case" (Zero elasticity)		
	Bench	Reform 1	Reform 2	Bench	Reform 1	Reform 2
τ^m	5.3%	4.7%	4.3%	5.4%	5.1%	4.7%
M/Y	7.3%	7.0%	6.8%	7.5%	7.3%	7.2%
CEV	0.00%	0.55%	0.83%	0.00%	0.18%	0.25%
- High education	0.00%	0.88%	1.59%	0.00%	0.58%	1.17%
- Low education	0.00%	0.31%	0.28%	0.00%	-0.10%	-0.42%

of -0.3 and -0.1.[29] The former economy considers the situation where medical demand is more price-elastic than the calibrated economy (namely, the elastic case). On the other hand, the latter economy considers the situation where the elasticity level lies between the level of the calibrated economy and that of the counterfactual economy (namely, the inelastic case).

Table 9 shows the results under these alternative economies with different elasticities. Under the economy with higher elasticity, reforms that increase copayments bring a greater reduction in medical expenditure and a greater decline in health insurance premiums. The main reason is that individuals reduce their large discretionary medical spending to avoid the increased medical expenditure risk when medical demand is more sensitive to price changes. Consequently, welfare improvements are expected to be greater. In contrast, even with the smaller elasticity of -0.1, welfare gains are expected to be larger than in the inelastic case. Moreover, CEV for those with low education also takes positive values.

Thus, although the quantitative results depend on the elasticity value, considering non-zero elasticity provides us with the qualitative result that raising copayments brings more benefits for future generations and, in addition, positive effects even for those with low education.

[29] I recalibrate the fraction of the medical need ω and the preference for medical spending $\varepsilon_{j,h}$ to match the medical expenditure $m_{j,h}^{data}$ and the price elasticity. For example, ω takes the values of 0.15 when the elasticity is -0.3 and 0.85 when the elasticity is -0.1, respectively.

Table 10: Sensitivity Analysis: Risk Aversion

		"Elastic Case"			"Inelastic Case"		
		Bench	Reform 1	Reform 2	Bench	Reform 1	Reform 2
$\gamma = 2$	τ^m	5.4%	4.5%	3.8%	5.6%	5.2%	4.7%
	K	–	+2.8%	+5.8%	–	+3.0%	+6.7%
	CEV	0.00%	1.03%	1.68%	0.00%	0.38%	0.72%
$\gamma = 3$ (Baseline)	τ^m	5.2%	4.3%	3.7%	5.4%	5.1%	4.7%
	K	–	+3.3%	+6.5%	–	+3.5%	+7.9%
	CEV	0.00%	0.99%	1.54%	0.00%	0.18%	0.25%
$\gamma = 4$	τ^m	5.0%	4.2%	3.6%	5.3%	5.0%	4.7%
	K	–	+3.6%	+7.1%	–	+3.9%	+8.8%
	CEV	0.00%	0.91%	1.37%	0.00%	0.02%	–0.15%

D.2 Risk Aversion

In my model, the effects of reforms that raise copayments may depend on the relative risk aversion γ because public health insurance plays an important role in helping risk-averse individuals smooth their consumption over the life-cycle. I experiment with two additional values of the risk aversion at 2 (less risk-averse), and 4 (more risk-averse), as opposed to 3 in the baseline case.[30]

Table 10 summarizes the results for alternative values of γ. With higher risk aversion, individuals have more precautionary savings to self-insure against higher out-of-pocket health costs. As a result, the reform further increases aggregate capital stock, leading more rise in the wage rate. Note that, despite the stronger GE effect from the increased wage, the reform brings smaller welfare improvements for more risk-averse individuals. Furthermore, in the inelastic case with $\gamma = 4$, even future generations suffer welfare losses. These results indicate that there are large negative PE effects when individuals favor lower medical expenditure risk. This can be attributed mainly to the significantly large risk exposure effect caused by a decline in medical coverage by the government, given that the reform brings almost the same tax effect of premium reduction between the cases with different risk aversion.

[30]Besides the values of ω and $\varepsilon_{j,h}$, the discount factor β is also recalibrated to match the capital-output ratio of 3.0. The value is set at 0.9963 with $\gamma = 2$, and 1.0144 with $\gamma = 4$, respectively.

D.3 Social Welfare Programs

The baseline model does not include government transfers such as safety-net programs, which guarantee each individual a minimum subsistence level of consumption. If the economy includes such a program, some poor individuals would rely on this, especially in the inelastic case where all medical expenditure is an unavoidable risk. Hence, even though an additional tax burden would be required to sustain the program, the welfare costs of the reform for low income households would be smaller. However, the quantitative results may not change much, because the population share of low-education households is very small in the baseline calibration, approximately 5%.

D.4 Private Health Insurance

There is no private health insurance market in the baseline model. The main reason is that, in Japan, private schemes have played a small and supplementary role. Colombo and Tapay (2004) overview the private health insurance markets in OECD countries and show that the proportion of Japanese total medical expenditure covered by private health insurance is only 0.3%.

However, when raising copayments reduces health coverage by the government, the role of private health insurance may be more important for individuals who become exposed to larger medical expenditure risk. Hsu et al. (2016) develop a general equilibrium life-cycle model and find that there is a negative relation between household saving and private insurance under the economy with a small social welfare program. According to their findings, in my model without such program, private health insurance can provide an alternative method to mitigate the burden of the reduction in health insurance coverage. Thus, in an economy with private health insurance, the reforms would increase aggregate savings and the wage rate less than I have expected in my main analysis, and bring smaller welfare improvements.

D.5 Tax Adjustment

One of my main findings in the baseline simulation is that raising copayments allows for a greater reduction of the premium in the elastic case than in the inelastic case. The reasons for this are twofold, as mentioned in Section 5.1. First, individuals reduce their discretionary medical expenses. Second, the government increases the proportion of subsidy for medical care to adjust its fiscal imbalance.

If I allow the government to use the consumption tax to balance its budget, instead of the proportion of the medical subsidy, the first channel remains, but the second channel disappears. In this case, because the difference in the tax effect of premium reduction between the elastic case and the inelastic case would become smaller, the welfare improvements of current young generations in the elastic case could be quantitatively smaller than the baseline simulation. On the other hand, both young and old people benefit from a decline in consumption tax, since the tax is levied equally on all residents, regardless of age. Consequently, with a consumption tax adjustment relative to a proportion of the subsidy adjustment, the welfare loss for the elderly would also become smaller.

Nonetheless, government financing policy does not affect the main results that more benefit and less burden are brought about by an increase in copayments in the elastic case than in the inelastic case, because the results are basically attributed to the first channel of reducing the amount of medical expenditure. In the elastic case, individuals can mitigate the risk of increased out-of-pocket costs by curbing medical demand, and the decline in medical expenditure leads to a larger reduction in medical benefits, thereby lowering the premium.