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Fiscal Consolidation and Intergenerational Inequality in Japan

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Abstract

For Japan, the ongoing severe fiscal condition requires urgent attention. To redress this situation, certain policy options are available: for instance, tax policy shift, pension system reform, and accelerating the economic growth. In this study, I quantify these policy changes required for achieving fiscal consolidation on the basis of an overlapping generations (OLG) model that considers multiple generations and provide a policy comparison of these options using the utility of each generation as a criterion. The simulation results suggest that a drastic policy change is necessary. If the consolidation were to depend only on the increase in consumption tax, the tax rate should be about 30%. In the case of pension system reform, its replacement rate should be cut to less than half of that in the current system. Among the policy options, pension reform seems to be suitable from the viewpoint of intergenerational equality and long-term economic growth.

JEL Classification: E24, E27, E62
Keyword: Fiscal consolidation; Demographic change; Policy comparison

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1 Introduction

Japan is among the countries facing the severest fiscal condition. The Japanese government's net financial liability was more than 100% of its nominal GDP in 2009, and Organisation for Economic Co-operation and Development (OECD) forecasts it would reach 150% in 2014 (Figure 1).

Several studies investigate the reason for Japan's rapidly accelerating debt accumulation. Some suggest that the economic slump during the 1990s has caused the severe fiscal condition since then owing to the resulting tax revenue decrease, while others insist the excess government expenditure in the early 1990s is the cause of the huge deficit [1]. However, the most important factor that contributed to the debt accumulation was the drastic increase in social security expenditure. As seen in the analysis provided by the Ministry of Finance of Japan (MOF) [2], which decomposes the causes of debt accumulation, the total increase in government debt from the end of FY1990 to FY2013[3] is about JPY 571 trillion. It reports that, among them, the decrease in tax revenues and the increase in public expenditure account for 26% and 10% of this debt increase, respectively. The impact of increase in social security expenditure exceeds that of these two factors: it explains 33% of the total debt accumulation. Moreover, the negative impacts of social security expenditure on fiscal deficit have evolved over the years. Given the forecast of future population distribution (Figure 2), the expenditure on social security is estimated to grow steadily in case the current social security system is not reconstructed.

On considering this fiscal condition and the estimated future demographic structure in Japan, resent studies have insisted that a high tax rate relative to the current system is needed for achieving fiscal consolidation. Doi et al. (2011) concludes that the percentage of government revenue must rise permanently to 40–47% of GDP in the future from the 33% in 2010 to stabilize the debt-to-GDP ratio. Imrohoroglu and Sudo (2011) insist that even an annual growth rate of 3% in GDP over the

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[1]Fukuda and Yamada (2011) investigates the relationship between the size of the Japanese government's fiscal stimulus and stock prices and find that taking the stock prices as the policy target resulted in the excess expenditure.

[2]It is available at `http://www.mof.go.jp/budget/fiscalcondition/relateddata/sy01423.pdf` (in Japanese).

[3]The value in FY2013 is based on the budget for that year.

next 20 years, combined with a new consumption tax rate of 15%, may be insufficient to achieve a consistent primary surplus. Moreover, Imrohoroglu and Hansen (2012) simulate the future Japanese fiscal situation and report a nearly permanent increase in consumption tax of about 30% is needed for fiscal consolidation.

One significant issue is that because these studies depend on a simple model or representative agent model and exclude the detailed pension system, they might have underestimated the impact of demographic change. To overcome this problem, Braun and Joines (2011) calculate the consumption tax rate sufficient for fiscal soundness on the basis of the model in Braun et al. (2009). They use the OLG model, which contains rich descriptions of the demographic structure, and report that the consumption tax rate should be raised to 33% according to the baseline simulation.

Thus, in this strand of previous research, there seemed to be consensus that a drastic policy shit is required in case fiscal consolidation is to be financed by an increase in the consumption tax rate. However, in this regard, other policy options could be considered as well. For example, increasing other tax rates or reducing pension payments are two such options. Although the Japanese government has decided to increase the consumption tax rate to 10% gradually, we must reexamine the other policy options. For this purpose, this study merges the impacts of policy reforms not only in the case of consumption tax, but also in other cases. In essence, I consider five policy options: increasing the tax rates on consumption, labor income, and capital income; decreasing the pension replacement rate; and increasing the technology growth rate. I quantify the amount needed for consolidation using the OLG model.

After obtaining quantitative results, we may want to know qualitative ones, that is, the order of suitability of these options. By considering policy comparisons for the Japanese fiscal system, Okamoto (2007) investigates the optimal way to sustain the fiscal condition in an aging Japanese economy using households' discounted utility as a judging criterion. As pointed out in this study, however, its simulation concentrates on the stationary equilibrium and the results obtained in such a case are different from those for the transition path. By taking this analysis one step further, this study calculates the utility of each generation, classified

by birth year, during the transition path. I compare the policy options from the viewpoint of intergenerational equality using utility as the evaluation standard. These analyses provide important policy lessons for the Japanese economy.

This remainder of paper is organized as follows. Sections 2 and 3 describe the model and method of simulation, respectively. Section 4 provides the simulation results, and Section 5 concludes.

2   The Model

This section provides the model setting. It is based on the general equilibrium OLG model of Braun et al. (2009) with heterogeneity in each generation. It consists of three agents, a household, firm, and government. Time is discretized by year t ($t = T_s, \ldots, T_e$).

2.1   Demographics

In order to capture the impact of demographic change on the fiscal condition in Japan, I introduce a detailed population structure. Japan's demographic distribution is replicated by the following Markov process.

$$
\begin{bmatrix}
\mu_{S_s,t+1} \\
\vdots \\
\vdots \\
\mu_{S_e,t+1}
\end{bmatrix}
=
\begin{bmatrix}
n_{S_s,t} & 0 & 0 & \ldots & 0 & 0 \\
\psi_{S_s,t} & 0 & 0 & \ldots & 0 & 0 \\
0 & \psi_{S_s+1,t} & 0 & \ldots & 0 & 0 \\
\ldots & \ldots & \ldots & \ldots & \ldots & \ldots \\
0 & 0 & 0 & \ldots & \psi_{S_e-1,t} & 0
\end{bmatrix}
\begin{bmatrix}
\mu_{S_s,t} \\
\vdots \\
\vdots \\
\mu_{S_e,t}
\end{bmatrix}, \quad (1)
$$

where $\mu_{s,t}$ is the population size of age s ($s = S_s, \ldots, S_e$) generation at year t. $\psi_{s,t}$ and $n_{s_s,t}$ stand for the conditional survival probability of age s generation and population growth rate of age s_s generation at year t, respectively. Given the initial distribution, survival probability, and population growth rate of age s_s generation exogenously, equation (1) creates Japan's demographic distribution. As is pointed out, I consider heterogeneity in each generation. The type of household is represented by i ($i = 1, \ldots, I$). $\mu_{j,t}^i$ in equation (2) is the size of type i agent whose

age is j at year t, and κ^i defines the share of type i household against $\mu_{j,t}$. Thus, the sum of $\mu_{j,t}^i$ is the total population size of the country at year t (N_t).

$$\mu_{j,t}^i = \kappa^i \mu_{j,t}, \, N_t = \sum_{j=1}^{J} \sum_{i=1}^{I} \mu_{j,t}^i. \tag{2}$$

In my calculation, I normalize the size of the total population at an initial year to 1 and define the country-wide population growth rate as n_t

$$N_{T_s} = 1, n_t = \frac{N_{t+1}}{N_t} - 1. \tag{3}$$

2.2 Household

A household's problem is finite. In the model, the age of the representative household is represented by $j(j = 1, \ldots, L_r, \ldots, J)$. Each household enters into the economy at age 20 ($j = 1$) and works during age $j = J_r - 1$. After retirement, she lives by dis-saving her assets and receiving pension payments until age $j = J$. Throughout her lifetime, every household faces an uninsurable probability of death. The discounted sum of the lifetime utility of a type i household at age 1 at year $m(t = m + j - 1)$ is as follows:

$$U_m^i = \sum_{j=1}^{J} \beta^{j-1} \pi_{j,t} u \left(c_{j,t}^i, l_{j,t}^i \right), \tag{4}$$

where β is the discount factor and $\pi_{j,t}$ is the unconditional survival probability. $u(\cdot)$ is an instantaneous utility function. $c_{j,t}^i$ and $l_{j,t}^i$ are the consumption and labor input of an age j, type i agent. The budget constraint at year t and age j is equation (5).

$$\begin{aligned}
(1 + \tau_{c,t}) c_{j,t}^i + a_{j+1,t+1}^i &= \{1 + (1 - \tau_{r,t}) r_t\} a_{j,t}^i \\
&+ (1 - \tau_{w,t}) w_t e_{j,t}^i l_{j,t}^i \Gamma(j < J_r) + b_{j,t} \Gamma(j \geq J_r),
\end{aligned} \tag{5}$$

where $a_{j,t}^i$ is asset holdings at the beginning of year t. I assume that households enters into the economy without holding any assets and do not leave any intentional bequests. Then, the following condition holds:

$$a_{1,t} = a_{J+1,t} = 0. \tag{6}$$

r_t, w_t are the factor prices. $\tau_{c,t}, \tau_{r,t}$ and $\tau_{w,t}$ are the tax rates on consumption, capital income, and labor income, respectively. $b_{j,t}$ is the pension benefit. $\Gamma(\cdot)$ takes 1 if the condition in parenthesis is satisfied and 0 otherwise. The remaining factor $e_{j,t}^i$ is the labor efficiency of a type i household, which is the source of heterogeneity in a generation. Since agents with higher efficiency gain higher labor incomes, it generates the income classes of households. A household determines her profiles of consumption, asset, and labor input by maximizing the lifetime utility (4) under the constraint (5).

2.3 Firm

A representative firm has a standard Cobb–Douglas production technology:

$$Y_t = Z_t K_t^{\theta} L_t^{1-\theta}, \tag{7}$$

where Y_t is the output, Z_t is the total factor productivity (TFP), K_t is the aggregate capital stock, L_t is the aggregate labor input at year t, and parameter θ is the capital share. Capital depreciates at a rate δ_t, and hence, capital transition follows equation (8)

$$K_{t+1} = I_t + (1 - \delta_t)K_t, \tag{8}$$

where I_t denotes investment. Since goods' markets are perfectly competitive, the factor prices are defied as follows:

$$
\begin{aligned}
w_t &= (1 - \theta)Z_t \left(\frac{K_t}{L_t}\right)^{\theta}, \\
r_t &= \theta Z_t \left(\frac{K_t}{L_t}\right)^{\theta-1} - \delta_t,
\end{aligned}
\tag{9}
$$

where w_t represents the wage rate and r_t is the rental rate on capital.

2.4 The government

The government has three roles in the model. First, it collects taxes imposed on consumption, capital income, and labor income. Therefore,

the general government tax revenue at time t (T_t) is the sum of tax payments by all households existing at that time.

$$T_t = \sum_{j=1}^{J}\sum_{i=1}^{I} \tau_{c,t} c_{j,t}^{i} \mu_{j,t}^{i} + \sum_{j=2}^{J}\sum_{i=1}^{I} \tau_{r,t} r_t a_t \mu_{j,t}^{i} + \sum_{j=1}^{J_r-1}\sum_{i=1}^{I} \tau_{w,t} w_t l_{j,t}^{i} \mu_{j,t}^{i}. \quad (10)$$

Second, it runs the pay-as-you-go pension system. The pension payment for retired households is equation (11).

$$b_{j,t} = \phi_t \frac{\sum_{j=1}^{J_r-1} w_t l_{j,t}^{i} \mu_{j,t}^{i}}{\sum_{j=1}^{J_r} \mu_{j,t}}, \quad (11)$$

where ϕ_t is a pension replacement rate[4] at year t. The total pension expenditure of the government is described in the following equation:

$$P_t = \sum_{j=J_r}^{J} b_{j,t} \mu_{j,t}. \quad (12)$$

The final role is that of government spending. The government plays these roles under its budget constraint, that is, equation (13).

$$D_{t+1} + T_t + B_t = (1 + r_t) D_t + G_t + P_t. \quad (13)$$

On the left-hand side of the equation is the general government's revenue and on the other, is its expenditure. D_t is the government debt outstanding at year t and B_t is a bequest [5].

2.5 Market clearing

Before describing market clearing conditions, I define the relationships between aggregate and individual variables. For an arbitrary individual variable $x_{j,t}^{i}$, the aggregated variable is described as X_t. For example, aggregate consumption, asset and labor input are defined as follows.

$$C_t = \sum_{j=1}^{J}\sum_{i=1}^{I} c_{j,t}^{i} \mu_{j,t}^{i},$$

$$L_t = \sum_{j=J_r}^{J}\sum_{i=1}^{I} l_{j,t}^{i} \mu_{j,t}^{i}. \quad (14)$$

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[4]It stands for a ratio of pension payments for retired households against the average before-tax labor income of workers.

[5]One rationale is that a collected bequest is in government revenue

The aggregate asset plus government debt is equal to the aggregate capital stock, and thus, the asset market clearing condition is equation (15).

$$A_t + D_t = K_t. \tag{15}$$

The standard goods market clearing condition is as follows:

$$Y_t = C_t + I_t + G_t. \tag{16}$$

3 Simulation Method

In this section, I explain the method used to solve the model described thus far. After providing the targets or sources of parameters and exogenous variables, I briefly illustrate how to solve the model.

3.1 Calibration and settings

I assume an instantaneous utility function in equation (4) as logarithmic.

$$u(c_t, l_t) = \log(c_{j,t}^i) + \epsilon \log(\bar{l}_{j,t} - l_{j,t}^i), \tag{17}$$

where ϵ is a parameter that determines leisure share and $\bar{l}_{j,t}$ is time endowment for an age j agent at year t. Note that individual labor input is endogenously solved in my settings.

The other parameters are listed in Table 1. The discount factor β is targeted to the average values of the capital–output ratio to match the actual value from 1970 to 2007. Leisure share ϵ is set to match the average of annual hours worked per working population from 1970 to 2008.

As to the settings of year and age, the initial period is 2010 and a household lives from 20 to 95 years in the benchmark simulation (Table 2). For the calculation of population distribution, however, I set the initial year to 1955 ($S_s = 1955$) and calculate the distribution of age 0–95. It improves the fitness of the population distribution generated by the model to the actual distribution by taking numerous samples. As to the terminal year in the simulation, it is set to 2200 ($S_e = 2200$) for both calculations. Taking long periods ensures the convergence to the terminal stationary equilibrium.

3.2 Data

Within aggregate variables, $\{C_t, K_t, A_t, L_t\}$ are endogenously solved. The others are exogenous variables or variables calculated by combining other variables. Table 3 summarizes the source of exogenous variables. For data on demographic structure and government debt, I used historical and estimated values; the other data are historical values.

Demographic: Historical data concerning demographics are from the Human Mortality Database (HMD) for 1955–2009. For estimating values from 2011 to 2060, I use "Population Projection for Japan: 2011-2060 (January 2012)" by National Institute of Population and Social Security Research (IPSS). As regards population distribution at 2010, it is sourced from "Population Estimates" by the Ministry of Health, Labour and Welfare (MHLW).

Technology: I applied the dataset from Miyazawa and Yamada (2012) to produce the TFP growth rate. It is calculated as a Solow residual depending on the Cobb–Douglas production function (Equation (7)). Miyazawa and Yamada (2012) provided the details for the construction of TFP.

Individual productivity: In the simulation, households are classified by age (j) and labor efficiency ($i = 1, \ldots, 4$). The latter is the type of household in the model and is defined as the educational background. Figure 3 plots the labor efficiency by type at year 2010 (e_j^i), and it is sourced from "Basic Survey on Wage Structure" provided by the MHLW.

Government: The government spending–output ratio is also from Miyazawa and Yamada (2012). The historical data for the debt–output ratio are from "Economic Outlook 93" by OECD. Estimation values from 2011 to 2014 are also from OECD. I assume that the estimated values from 2015 are along with the government fiscal consolidation plan. The Japanese Cabinet decided "Basic Policies for Economics and Fiscal Management and Reform" in 2013. It aimed to cut the ratio of primary deficit to GDP of the national and local governments in half between FY2010 and FY2015 and achieve a surplus

by FY2020. Following this plan, the estimated debt–output ratio is assumed to stop increasing from 2020 (Figure 4). One of the main motivations of this study is to calculate the tax rates and growth rate needed for achieving such a government fiscal consolidation plan. The tax rates are from a updated version of Mendoza et al. (1994), and the replacement rates of the pension system in Equation (11) are based on the value of projections in "Financial Verification in 2009 (standard household)" by the MHLW.

3.3 Calculations

Given the exogenous variables and parameters, I calculate the path of endogenous variables. The procedure is as follows.

1. Calculate the population distribution using Equation (1).

2. Calculate the initial and terminal stationary equilibrium.

3. Guess the transition path of $\{K_t, L_t, X_t\}^6$, where X_t is a variable that adjusted to sustain fiscal condition.

4. The given parameters, exogenous variables and population distribution, solve the household problems for individual consumption, labor input, and asset holding ($\{c_{j,t}^i, l_{j,t}^i, a_{j,t}^i\}$).

5. Aggregate the individual variables obtained at step 4 and check the resource constraint, labor market clearing condition, asset market clearing condition, and government budget constraint[7].

6. If these four constraints are satisfied, the solution is achieved. Otherwise, update the initial guess in step 3 and repeat steps 3–6.

To calculate the initial stationary equilibrium, I use the actual asset distribution at 2010 and for the initial guess at step 3, we interpolate between the values of initial and terminal stationary equilibrium linearly.

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[6]After obtaining the values of aggregate capital and labor, I can calculate the factor prices needed for solving the household problem.

[7]From Walras' Law, one of these conditions is automatically satisfied.

4   Simulation Results

The two main objectives of this study are to quantify the impact of policy changes for achieving Japan's fiscal consolidation and to compare policy options based on generations' utility. Since such exercises should depend on a model that can explain some aspects of an actual economy, I start by checking the performance of the model described so far and then move to the main analyses.

4.1   Model's performance

To examine the fitness of the model to historical data, I set a simulation period from 1970 to 2200. The model includes a lump-sum tax (transfer). Therefore, the government budget constraint is satisfied by adjusting it. In addition, the initial asset distribution is sourced from Hayahi et al. (1988). These settings are in line with those in Braun et al. (2009). Figures 5–7 plot the model-generated main variables, growth rate of output, capital–output ratio, and annual hours worked per working population. In comparison, I depict the actual data and the results of Braun et al. (2009) simultaneously. Note that there are two main differences between my model settings and that of Braun et al. (2009). First, I use a different data set. Although Braun et al. (2009) used the dataset constructed by Hayashi and Prescott (2002), my simulation is based on the dataset from Miyazawa and Yamada (2012) as I briefly explained in the previous section[8]. Second, Braun et al. (2009) did not consider the heterogeneity within generations. In my model, however, households are classified not only by age but also by labor efficiency. In Figure 6, the capital–output ratio of my model is relatively high compared to that of Braun et al. (2009). This tendency is caused by the heterogeneity in my model. Since capital accumulation is affected by the high labor efficiency type agent in my setting, the level of aggregate capital is higher than that of Braun et

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[8]As previous studies applying large-scale OLG models to the Japanese economy (Braun et al. (2009) and Chen et al. (2007), for example) showed, the TFP growth rate is a major driving factor that determines the movement of macro variables. Thus, a minor difference in TFP construction affects the simulations' outcomes.

al. (2009). Thus, my model can replicate the actual output growth and capital–output ratio relatively well.

4.2   Settings in benchmark simulation

In this subsection, I explain the conditions assumed in the main calculation. In the benchmark simulation, I set 2010–2200 as the simulation period. I assume that the initial stationary equilibrium is the one in which exogenous variables are set to the average values during 2000–2007, while the population distribution and debt–output ratio are the actual one in 2010. The values assumed in the initial stationary equilibrium are presented in Table 4. From the initial stationary equilibrium, I calculate the transition path to the terminal stationary equilibrium. During the transition path, the values of exogenous variables do not change from the values in the initial stationary equilibrium, other than in the case of variables concerning population and the debt–output ratio. Since variables for population are based on population estimates and the debt–output ratio is from the government plan, the results mainly enhance the effects of changes in demographics and tax policies. As to the future value of demographics, the estimation by IPSS is from 2010 to 2060. I assume that after 2060, the survival rate and birth rate remain at the values in 2060 and the population distribution smoothly converges to stationary distribution after that. For the estimated value of the debt–output ratio, since the government's estimation also ends in 2020, I assume the value after that period is kept to that of 2020.

In order to achieve fiscal consolidation in line with the government projection, we must assume that some exogenous variables in the government budget constraint of the technology growth rate should be adjusted. Therefore, I consider the following five scenarios:

 (i) Increasing tax rate on consumption (τ_c)

 (ii) Increasing tax rate on labor income (τ_w)

 (iii) Increasing tax rate on capital income (τ_r)

 (iv) Increasing growth rate of TFP (γ)

(v) Decreasing pension replacement rate (ϕ)

With these scenarios, I calculate tax rates or growth rates to smooth fiscal conditions and compare these policies using the utility of generations as a criterion.

4.3 Quantitative analysis

Thus far, I confirmed the performance of the model and summarized the settings for the main analyses. Now, I consider the first problem: by how much do we need to increase the tax rates or growth rate to redress Japan's fiscal problem? I execute the required simulations under the assumption that the fiscal consolidation is achieved following the government's plan. I explain the results scenario by scenario.

Table 5 presents the results. It reports the average tax rates, TFP growth rate, and pension replacement rate needed for fiscal consolidation. It also depicts the actual tax or growth rates between 2000 and 2007.

(i) consumption tax: Line 1 of Table 5 reports the results of scenario (i). Although the tax rate on consumption was 10.5% in 2000–2007, it should be increased to more than 15% immediately in the 2010s. Finally, it should be nearly 30% in the 2030s: these values coincide with that in the previous literature.

(ii) labor income tax: The labor income tax rate should be more than 50% in the 2030s. As Figure 2 shows, the working-age population in Japan will decrease steadily. When we rely on the labor income tax for the funds required for consolidation, we cast a higher burden on the declining working generations.

(iii) capital income tax: As to the case of capital income tax, its rate should be increased to incredibly high rate. In my settings, the capital market is complete, and hence, the rental rate for capital equals the interest rate on government debt. Therefore, in case (iii), the government suffers from a huge burden of interest payment on increasing the capital income tax. Further, the problems related to an aging population become more severe over the years. Increasing the capital income tax impedes capital accumulation.

(iv) TFP growth: Note that I cannot achieve a solution in the simulations in the case of scenarios (iv). This means a growth rate of technology that satisfies the government budget constraint without bailing the other equilibrium conditions does not exist. Imrohoroglu and Sudo (2011) show that even if the government adopted a mixed policy of 2% TFP growth rate with 15% consumption tax, it might be insufficient for fiscal consolidation. My model simulation reconfirmed this finding. It indicates that it is impossible to attain a sound fiscal condition through increasing the technology growth even if a growth miracle occurs. However, notice that there are differences between my assumptions and that of Imrohoroglu and Sudo (2011). While my model assumes an overlapping generations household structure, Imrohoroglu and Sudo (2011) use the representative agent model. Therefore, they neither capture the impact of demographic change to the extent required nor consider that of the pension system. The results of Imrohoroglu and Sudo (2011) seem to underestimate the impact of demographic shifts.

(v): replacement rate: In the final scenario, I consider the case that the government changes the pension system through decreasing the replacement rate of pension payments (ϕ in equation (11)). In 2004, the Japanese government decided that the replacement rate would be kept to more than 50% in the future representative household in the revised pension system. In the simulation, however, to calculate the value required for fiscal consolidation, I remove this government-decided rate. Line 6 of Table 5 shows the result of scenario (v) that reports the replacement rate should be 22.5% in the 2030s. Seeing that its average value during 2000–2007 was more than 50%, the rate may need to be cut by more than half in the future.

4.4 Policy comparison

In the previous subsection, I provided quantitative results that showed that drastic policy changes are needed for achieving fiscal consolidation in the future. The second question is determining, within such policy shifts, the one that is favorable. For this purpose, I calculate the discounted sum

of lifetime utility (Equation (4)) of the household that represents each generation. Using it as an evaluation standard, I compare the impacts of policy changes.

Figure 8 plots the level of lifetime utilities of generations with type 1 labor-efficiency under four scenarios (scenarios (i), (ii), (iii) and (v)). The horizontal axis depicts the household's birth year and the vertical axis, its utility level. In comparison, the lifetime utility of a household born in 1911 under scenario (i) is normalized to unity. For example, the utility of the generation born in 1980 is around 0.95 in scenario (i). This means that the lifetime utility of the 1980 generation is 5% lower than that of the 1911 generation when the fiscal consolidation is achieved by increasing the consumption tax rate. Note that the simulation starts from 2010. Therefore, the individual variables (consumption, labor input, and asset holding) before 2010 are fixed to the values at the initial stationary equilibrium and the difference in the utilities of households is derived from their utility maximization problems after 2010.

As Figure 8 shows, the four policy changes, namely, in relation to the consumption tax, labor income tax, capital income tax and replacement rate, have different impacts on each generation's utility. For the generations born before after around 1970, scenario (ii) is the most preferable and scenario (v) is the worst. In contrast, for the generations born after around 1970, the order of preference is scenario (v), (i), (ii), and (iii).

The interpretation of the policy effects on older generations is straightforward. An increment in labor income tax is preferable for the generations who have already retired in 2010 because they do not suffer direct damage to their utility. In contrast, the fall in replacement rate is the worst scenario for them. Since the agent cannot foresee the policy changes before 2010, a drop in pension payment distorts the consumption smoothing of the retired generation.

For the generations employed in 2010 and for the future generations, the reform by cutting pension payments brings the highest utility in the four scenarios. There are two intuitive explanations for this result. First, the pension reform policy forces all generations, including the retired, to share the pain of fiscal consolidation. It lightens the burden of fiscal consolidation upon the shoulders of future generations. Second, it en-

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hances economic growth. Figure 9 plots the output level under the four
scenarios. In the figure, the output level in 2010 under scenario (i) is nor-
malized to 1. The increase in consumption tax hinders economic growth
for the first 5–10 years relative to scenario (ii). From the viewpoint of
long-term growth, however, taxing consumption is better than taxing la-
bor or capital income tax. Moreover, cutting pension payments enhances
the economic growth from the short run to the long run, relative to the
other cases.

As to increase in labor and capital income tax (scenario (ii) and (iii)),
the future generations suffer from a serious utility loss under these sce-
narios. For example, the lifetime utility of the generation to be born in
2020 would only be 75% and 65% of that of the generation born in 1911 if
scenario (ii) and (iii) were to be selected, respectively. As Figure 2 shows,
the aging of population structure is estimated to become increasingly se-
vere. The working population in the 2020s will be about 13% lesser than
that in 2010. Taxing labor or capital income is not preferable policy for
the future generations in a reducing-population economy. Moreover, as I
pointed out in previous subsection, increase in tax rate on capital income
enlarges the burden of interest payment on the government. Taxing cap-
ital income is the worst policy in an economy that has accumulated huge
debt.

Note that there exists a severe preference gap between the retired gen-
erations and future generations. While the most preferable policy for the
older generations is scenario (ii), the policy that brings the highest level
of utility for the future generations is scenario (v). When we calculate the
size of population agreeing to an increase in the labor income tax and that
agreeing with the policy that decreases the replacement rate in 2010 [9] , 73
million prefer scenario (ii) and 28 million prefer scenario (v). This means
that in the economy with "selfish" households that the model assumed,
the preferable policy for the future generations and long-run economic
growth (scenario (v)) may not be chosen through a democratic policy
decision based on the current population distribution.

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[9]They coincide with the size of households who are 40–99 years old (were born in
1911–1970) and 20–37 years old (were born in 1973–1990) in 2010, respectively.

4.5 Policy implications

As indicated by the simulation results, cutting the pension replacement rate is the preferable policy shift from the viewpoint of intergenerational equality and long-run economic growth. However, the results also show that a consensus to agree with pension reform cannot be achieved if households are selfish. Without these results, we may tend to believe that it is hard to realize the policy to cut the pension payments of the current retired generation. Thus, the current government policy, that is, combining pension system reform with increasing consumption tax may be the preferable way.

The other implication is about labor and capital income tax. As both the quantitative analysis and policy comparison showed, increasing the labor income tax is undesirable for the future generations in an economy in which the size of working-age generations is shrinking.

5   Conclusions

This study examined two questions concerning Japan's fiscal reconstruction. First, I calculated the quantity needed to redress the fiscal condition using an OLG model that considers multiple generations. The results imply that for fiscal consolidation, it is necessary to change the tax or pension system drastically. When the consolidation fund is entirely dependent on an increase in the consumption tax rate, its rate is estimated to be nearly 30% in 2030s. This value almost coincides with that in the previous literature. The second question was identifying out of all feasible policy options, the one preferable for each generation. This study clarified the serious gap between older and future generations in their preferences. I also pointed out that pension system reform is the one preferable option, considering intergenerational equality.

This research could be improved in two ways. The first one is considering other policy choice criteria. In this study, I used the discounted sum of lifetime utility; however, using discounted utility underestimates the instantaneous utility of older generations. The other is the use of heterogeneity within generations. Although the tax and part of pension

systems that the model described are linear and simple, the actual systems are non-linear and more complicated. For example, the tax rate on labor income changes by the income class discontinuously and pension payments depend on the lifetime income. Considering such non-linear systems would change the results or order of policy preferences and contribute to good use of the heterogeneity of generations.

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Table 1: Value, target and source of parameters

	Parameters	Value	Target or source
β	discount factor	0.985	Capital–output ratio $\approx$ avg. 1970-2007
ϵ	leisure share	0.361	Annual hours worked per working population $\approx$ avg. 1970-2008
θ	capital share	0.36	Miyazawa and Yamada (2012)

Table 2: Settings

	Settings	Value	
Calculation for population distribution			
T_s	initial year	1955	
T_e	terminal year	2200	
S_s	initial age	0	
S_e	terminal age	99	
Calculation for household problems			
Jr	retirement age	46	65 years old in actual economy
J	terminal age	76	95 years old in actual economy

Table 3: Settings and source of exogenous variables

	Exogenous variables	Source
Demographics		
μ_0	pop. growth rate of age 0 generations	
μ_{s,T_s}	initial pop. dist.	HMD, IPSS (forecast)
$\psi_{s,t}$	survival rate	
Production		
Z	Total Factor Productivity	Miyazawa and Yamada (2012)
Government		
G/Y	government spending output ratio	Miyazawa and Yamada (2012)
D/Y	debt output ratio	OECD
τ_c	tax rate on consumption	Mendoza et al. (1994)
τ_r	tax rate on capital income	Mendoza et al. (1994)
τ_w	tax rate on labor income	Mendoza et al. (1994)
ϕ	replacement rate	MHLW (2009)

Table 4: Settings at initial Stationary Equilibrium for benchmark simulation

	Exogenous variables	Value
$\gamma - 1$	growth rate of TFP	0.0161
G/Y	government spending output ratio	0.1792
τ_c	tax rate on consumption	0.06
τ_r	tax rate on capital income	0.2744
τ_w	tax rate on labor income	0.4261
ϕ	replacement rate	0.53

Table 5: Average tax, growth and replacement rates to achieve fiscal consolidation

scenarios	adjustment	2000–2007	2010s	2020s	2030s
(i)	consumption tax	6.00%	16.12%	23.84%	29.94%
(ii)	labor income tax	27.44%	38.92%	46.78%	54.95%
(iii)	capital income tax	42.61%	65.74%	77.94%	87.19%
(iv)	TFP growth	1.61%	(no solution)		
(v)	pen. rep. rate	53.0%	35.30%	26.99%	22.48%

Note: The values in column '2000-2007' are actual rate.
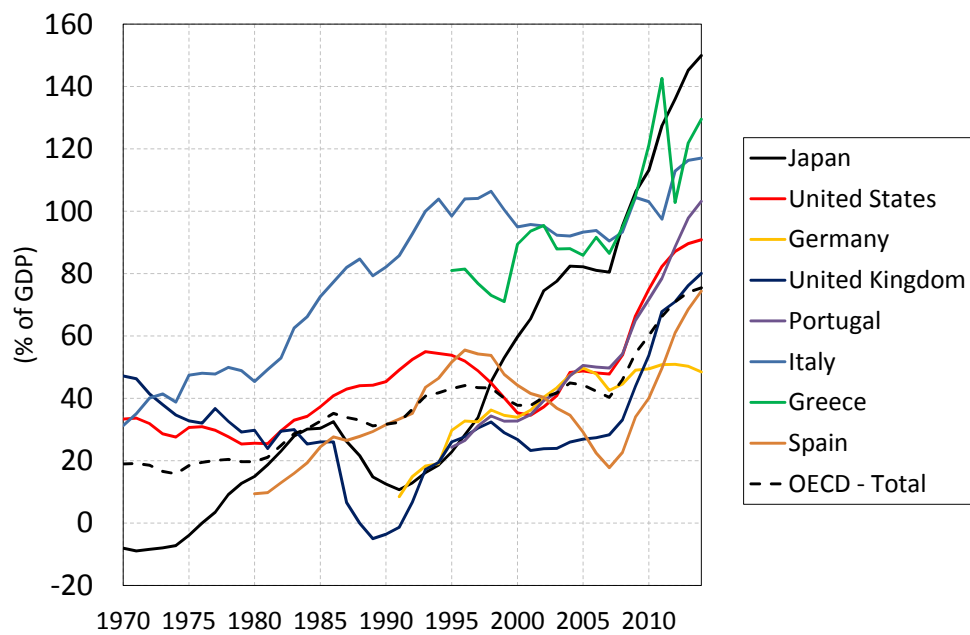
Figure 1: General government net financial liabilities as a percentage of GDP

Source: OECD "Economic Outlook No. 93"
Note: Estimates start after 2012.
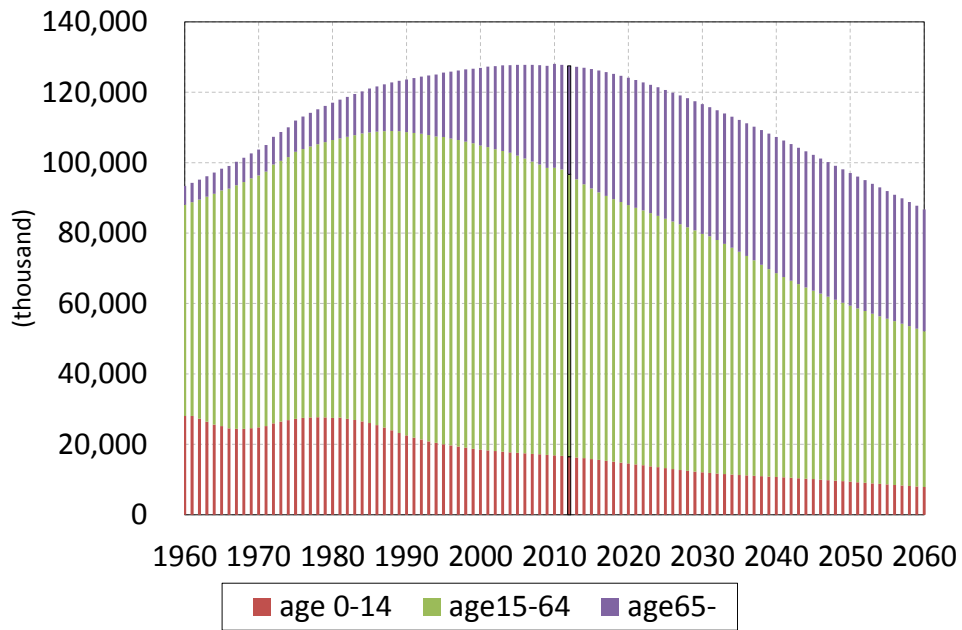
Figure 2: Population distribution in Japan
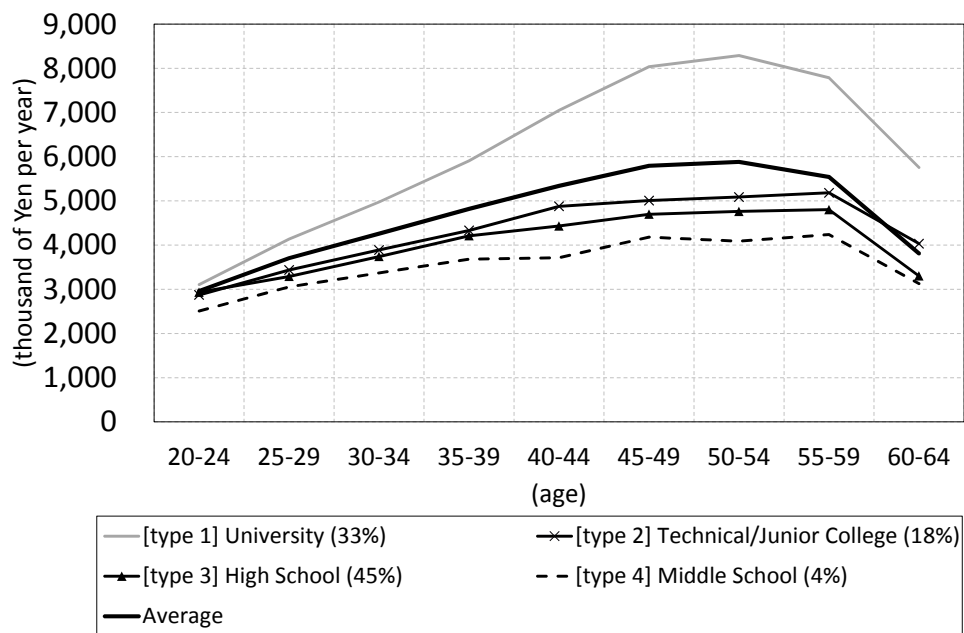
Figure 3: Type of labor efficiency

Source: MHLW "Basic Survey on Wage Structure 2012"
Note: The parentheses in the legend is the share of each class in 2012.
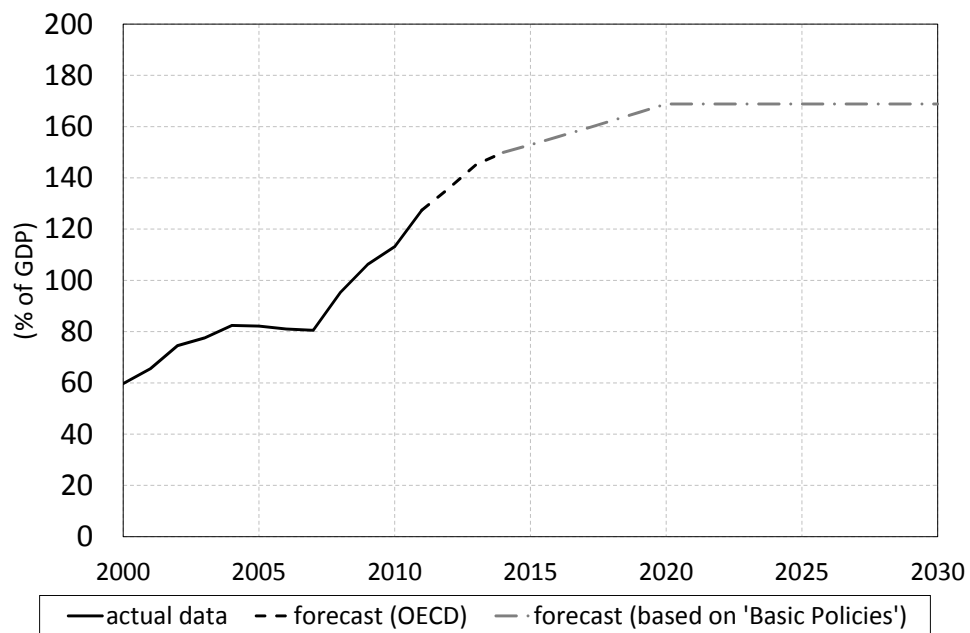
Figure 4: Projection of debt output ratio

Source: OECD "Economic Outlook No. 93"
Note:
[2012-2014] Projection by OECD
[2015-] Assumption based on "Basic Policies for Economic and Fiscal Management and Reform" by Japanese Government
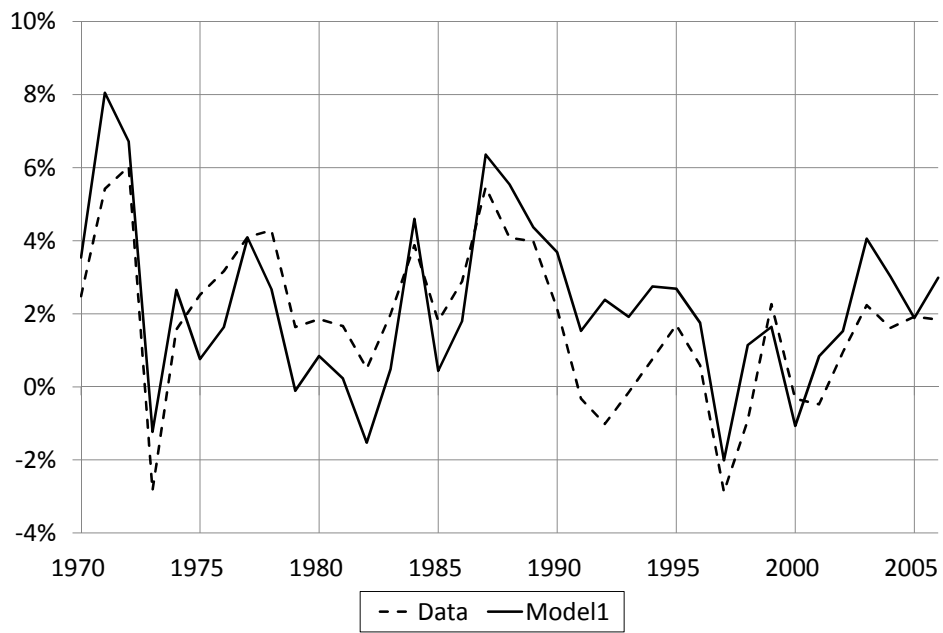
Figure 5: Growth rate of output per capita
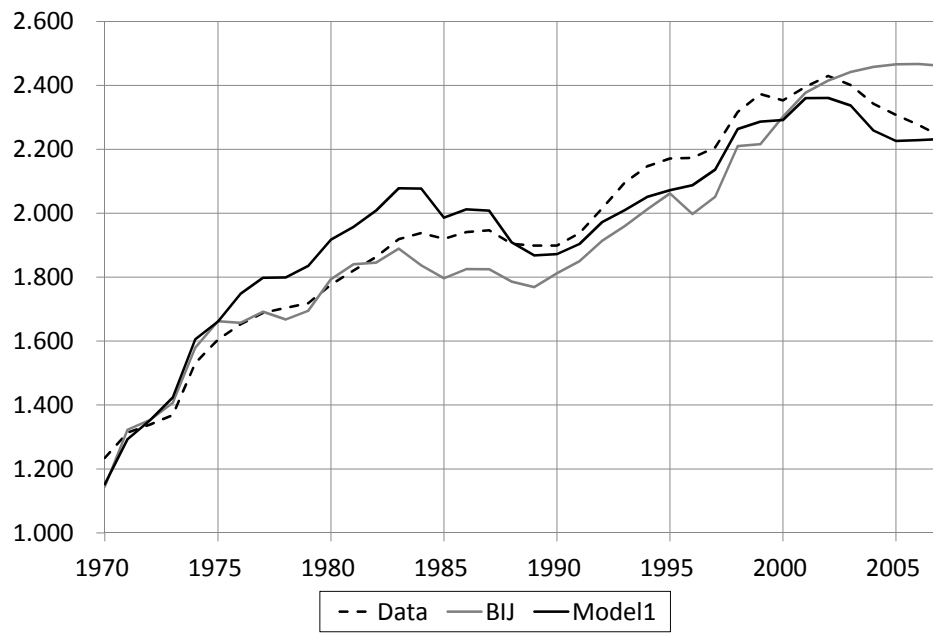
Figure 6: Capital output ratio

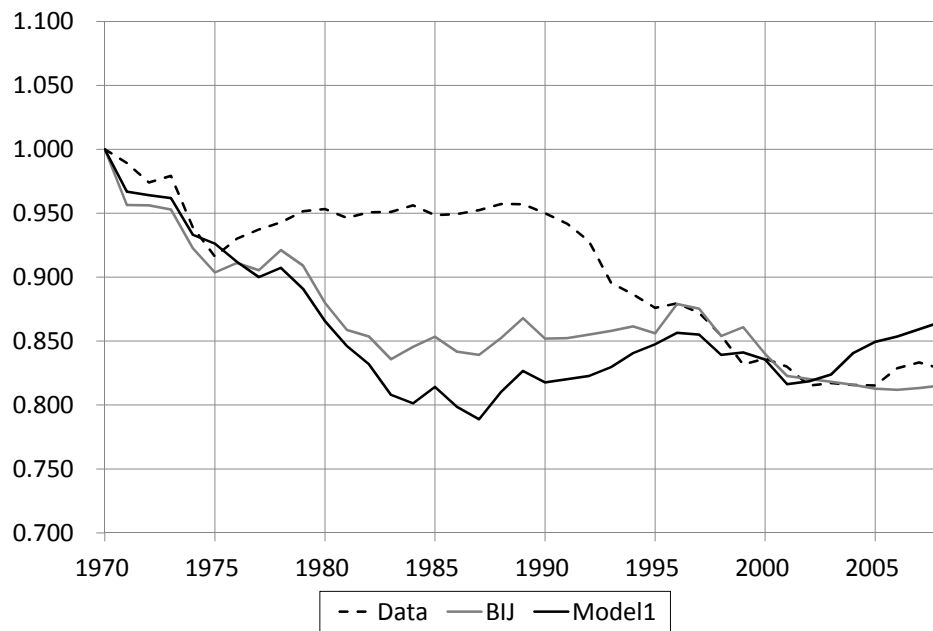**Note**: 'BIJ' denotes the result of Braun et al. (2009).

Figure 7: Annual hours worked per working population (1970=1)

Note: 'BIJ' denotes the result of Braun et al. (2009).
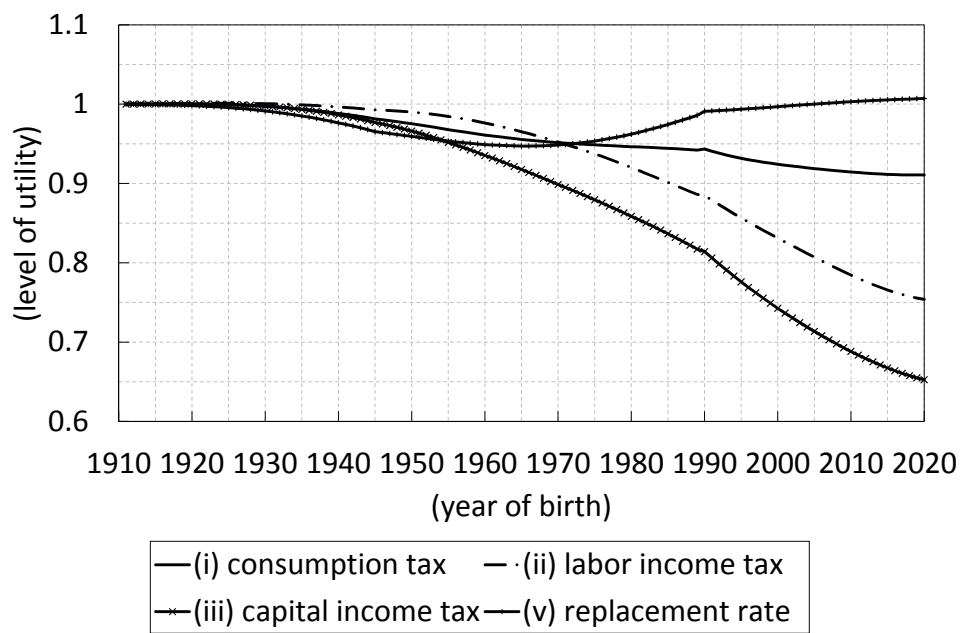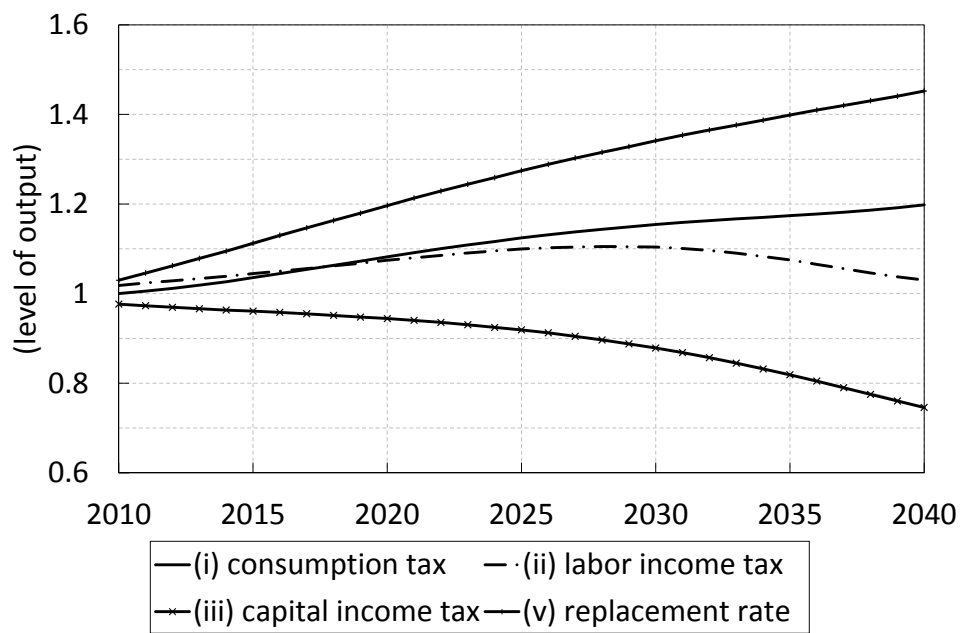
Figure 8: Level of utility (Type 1, born in 1911 & scenario (i) = 1)

Figure 9: Level of output (scenario (i) = 1)