Abenomics and Fiscal Consolidation*

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Abstract

In June 2013, the Japanese government set a fiscal consolidation target that aims to steadily decrease the debt balance as a percentage of GDP after 2020. This paper examines the achievability of this target using an OLG model calibrated to the Japanese economy. Our simulation yielded the following results. (i) It is severe to achieve the fiscal consolidation target even when assuming that Abenomics has the desired effects. (ii) Moreover, due to the accelerating population aging, further economic and fiscal reform is needed in the 2020s and 2030s. (iii) Regarding further reforms, pension reform is suitable for intergenerational equality.

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1 Introduction

Immediately after the Liberal Democratic Party's triumph in the House of Representatives election held at the end of the year 2012, Prime Minister Abe has implemented an aggressive monetary policy and a flexible fiscal policy as the "first and second arrows" of Abenomics. In January 2013, the Bank of Japan announced that it would continue to buy Japanese government bonds without limit until the deflation ends. In the next month, the government settled the supplementary budget of FY2012. Although these policies succeeded in changing market expectations in Japan,[1] the unlimited buying operation and expanding fiscal policy were associated with the "monetization" of fiscal deficits by the central bank. For maintaining the credibility of Japan's fiscal policy, the government undertook the formulation of basic directions for fiscal consolidation. As a result, "Basic Policies for Economic and Fiscal Management and Reform" (Basic Policy, hereafter) were decided at the Cabinet Meeting in June 2013. It stated that the government's fiscal consolidation target is to cut the ratio of primary balance against GDP in half between FY2010 and FY2015, to achieve a primary surplus by FY2020, and to steadily decrease the debt balance as a percentage of GDP.

Is it possible to achieve the government's fiscal targets by accomplishment of Abenomics? The first aim of this paper is to answer this question. To this end, we use a general equilibrium OLG model that is calibrated to the Japanese economy and that incorporates a drastic demographic shift. Because it enables us to quantify the impacts of population aging on government budget throughout the pension system and tax revenue, the model is suitable for long-run fiscal projection. In our simulation, we try to incorporate the effects of Abenomics; however, these effects are ambiguous because the impact of the Abenomics economic revitalization plan (i.e., the "third arrow" of Abenomics) is long-run policy reform. Then, we adopt assumptions imposed in government projection (Cabinet Office (2014)) as expected

[1] One clear evidence is briskness in the stock market. Although *Nikkei 225* was around 10,000 Yen at the end of November 2012, it exceeded 13,000 Yen at the end of April 2013.

effects of Abenomics. Cabinet Office (2014) provides long-term economic and fiscal projections in which technology growth rate and labor force participation rate are assumed to improve drastically as fruits of Abenomics. Given these assumptions, we calculate the tax rate or the pension replacement rate needed for achieving the government's fiscal consolidation target. The results show that the fiscal target is difficult to achieve only by the increases in technology growth and labor participation rate that the government expects. In the case of consumption tax, our simulation projects that its rate should be raised by about 15%, as compared to the current rate. Although the Japanese government plans to increase the tax rate on consumption by 5% (2% in 2014 and by 3% in 2015), our simulation implies that it is insufficient for achieving the fiscal target. Moreover, due to the accelerating population aging, its rate should be raised to more than 25% in 2030.

Given that we now know the difficulty of meeting the fiscal target and know the necessity of further reform, we would want to identify the policy changes preferable for further reform. Our second aim is to analyze the order of suitability of these policy changes. Using the utility of the representative household of each generation as criteria, we investigate preferable policies for generations.

Recent studies that investigate Japan's fiscal reconstruction and economic growth have insisted that drastic reform is needed for achieving fiscal consolidation. For example, 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. İmrohoroğlu and Sudo (2011) insist that even an annual growth rate of 3% in GDP over the next 20 years, combined with a new consumption tax rate of 15%, may be insufficient to achieve a consistent primary surplus. Hansen and İmrohoroğlu (2012) simulate the future Japanese fiscal situation using the standard growth model and report that a nearly permanent increase in consumption tax of about 30% is needed for fiscal consolidation.

Among previous studies, Braun and Joines (2011) and İmrohoroğlu et al. (2013) should be mentioned because they are related to this paper with regard to the use of the OLG model. Braun and Joines (2011) calculate the consumption tax rate sufficient for fiscal soundness, and report that it should be raised to 33%. While they focus on the consumption tax reform, taking this argument one step further, we consider other policy options: labor income tax and pension reform. İmrohoroğlu et al. (2013) construct a large-scale OLG model in which heterogeneity in generation is considered, and incorporate the Japanese pension system in detail. Although they describe Japan's fiscal and social security system very carefully, they do not model individual decision on consumption/savings and on labor/leisure choice. In contrast, our model is tractable, and as such, we can calculate the utility of each generation during the transition path and provide normative analysis.

The remainder of this 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 Model

This section describes our model that consists of three agents, a household, a firm, and the government. Time is discretized by year t ($t = T_s, \ldots, T_e$). After we provide the demographic structure of our model, the economic activity of each agent is explained.

2.1 Demographics

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

$$
\begin{bmatrix} \mu_{0,t+1} \\ \vdots \\ \vdots \\ \mu_{99,t+1} \end{bmatrix} = \begin{bmatrix} n_{0,t} & 0 & 0 & \dots & 0 & 0 \\ \psi_{0,t} & 0 & 0 & \dots & 0 & 0 \\ 0 & \psi_{1,t} & 0 & \dots & 0 & 0 \\ \dots & \dots & \dots & \dots & \dots & \dots \\ 0 & 0 & 0 & \dots & \psi_{98,t} & 0 \end{bmatrix} \begin{bmatrix} \mu_{0,t} \\ \vdots \\ \vdots \\ \mu_{99,t} \end{bmatrix}. \tag{1}
$$

Here $\mu_{s,t}$ is the population size of age s $(s = 0, \dots, 99)$ generation at year t. $\psi_{s,t}$ and $n_{0,t}$ stand for the conditional survival probability of age s generation and population growth rate of age 0 generation at year t, respectively. Given the population distribution at the initial year, survival probability, and population growth rate of age 0 generation exogenously, equation (1) creates Japan's demographic distribution.

2.2 Household

A household's problem is finite. In the model, the age of the representative household is represented by j $(j = 1, \dots, 80)$. Each household enters into the economy at age 20 $(j = 1)$ and works during age 65 $(j = 46)$. After retirement, she lives by dis-saving her assets and receiving pension payments until age 99 $(j = 80)$. In our calculation, we define the population size of age 20-99 at t as N and normalize the size of the total population at an initial year to unity. We define the country-wide population growth rate as n_t.

$$
N_t = \sum_{j=1}^{80} \mu_{j,t}, N_{T_s} = 1, n_t = \frac{N_{t+1}}{N_t} - 1. \tag{2}
$$

Throughout her lifetime, every household faces an uninsurable probability of death. The discounted sum of the lifetime utility of a representative household at age 1 at year $m(t = m + j - 1)$ is as follows:

$$
U_m = \sum_{j=1}^{80} \beta^{j-1} \pi_{j,t} u \left(c_{j,t}, l_{j,t} \right), \tag{3}
$$

where β is the discount factor and $\pi_{j,t}$ is the unconditional survival probability. $u(\cdot)$ is an instantaneous utility function. $c_{j,t}$ and $l_{j,t}$ are the consumption and labor input of an age j agent. The budget constraint at year t and age j is equation (4).

$$\begin{aligned}(1+\tau_{c,t})c_{j,t} + a_{j+1,t+1} = &\{1+(1-\tau_{r,t})r_t\}a_{j,t} \\ &+ (1-\tau_{w,t})w_t e_j l_{j,t}\Gamma(j < 46) + b_t\Gamma(j \geq 46) + \xi_t,\end{aligned} \tag{4}$$

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

$$a_{1,t} = a_{81,t} = 0. \tag{5}$$

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 factors e_j and ξ_t are the labor efficiency by age and distributed bequest, respectively. We assume that accidental bequest left by the household is equally distributed by the living household; as such, the following holds:

$$\sum_{j=1}^{80} \xi_t \mu_{j,t} = \sum_{j=1}^{80} (1-\psi_{j-1,t-1})(1+r_t)\mu^i_{j-1,t-1}a_{j,t}. \tag{6}$$

A household determines her profiles of consumption, asset, and labor input by maximizing the lifetime utility (3) under the constraint (4).

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. We define the growth rate of TFP as γ_t:

$$\gamma_t = \frac{Z_{t+1}}{Z_t} - 1. \tag{8}$$

Capital depreciates at rate δ_t, and hence, capital transition follows equation (9):

$$K_{t+1} = I_t + (1 - \delta_t)K_t, \tag{9}$$

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

$$\begin{aligned} w_t &= (1-\theta)Z_t \left(\frac{K_t}{L_t}\right)^{\theta}, \\ r_t &= \theta Z_t \left(\frac{K_t}{L_t}\right)^{\theta-1} - \delta_t, \end{aligned} \tag{10}$$

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

2.4 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.

$$T_t = \sum_{j=1}^{80} \tau_{c,t} c_{j,t} \mu_{j,t} + \sum_{j=2}^{80} \tau_{r,t} r_t a_{j,t} \mu_{j,t} + \sum_{j=1}^{45} \tau_{w,t} w_t l_{j,t} \mu_{j,t}. \tag{11}$$

Second, it runs the pay-as-you-go pension system. The pension payment for retired households is as follows:

$$b_t = \phi_t \frac{\sum_{j=1}^{45} (1-\tau_{w,t}) w_t l_{j,t} \mu_{j,t}}{\sum_{j=1}^{45} \mu_{j,t}}, \tag{12}$$

where ϕ_t is the pension replacement rate[2] at year t. The total pension expenditure of the government is described in the following equation:

$$P_t = \sum_{j=46}^{80} b_{j,t}\mu_{j,t}. \tag{13}$$

The final role is that of government spending. Incorporating the impact of population aging on health expenditure, we assume that it evolves depending on population structure.

$$G_t^h = \sum_{j=1}^{80} \sigma_j \mu_{j,t}, \tag{14}$$

where $\sigma_{j,}$ is individual health care consumption by age. The government expenditure excluding health care expenditure is defined as G_t. The government plays these roles under its budget constraint:

$$D_{t+1} + T_t = (1 + r_t)D_t + G_t + G_t^h + P_t. \tag{15}$$

The LHS of the above equation is the general government's revenue, and the RHS is its expenditure. D_t is the government debt outstanding at year t. We define government debt and expenditure per output at year t as g_t and d_t, respectively:

$$\begin{aligned} g_t &= \frac{G_t}{Y_t}, \\ d_t &= \frac{D_t}{Y_t}. \end{aligned} \tag{16}$$

2.5 Market clearing

Before describing the market clearing conditions, we 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

[2]It stands for the ratio of pension payments for retired households to the average after-tax labor income of workers.

consumption and asset are defined as follows:

$$\begin{aligned} C_t &= \sum_{j=1}^{80} c_{j,t}\mu_{j,t}, \\ A_t &= \sum_{j=2}^{80} a_{j,t}\mu_{j,t}. \end{aligned} \tag{17}$$

There exist three markets: good, capital, and labor. The clearing condition for each market is as follows. The good market clearing condition is

$$Y_t = C_t + I_t + G_t + G_t^h. \tag{18}$$

We assume that the government debt is held by households in Japan. Thus, the aggregate asset is equal to government debt plus the aggregate capital stock. The asset market clearing condition is (19).

$$A_t = K_t + D_t. \tag{19}$$

In the labor market, the sum of individual labor supply must be equal to aggregate labor demand in efficiency units:

$$L_t = \sum_{j=1}^{45} e_j l_{j,t}\mu_{j,t}. \tag{20}$$

3 Simulation Method

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

3.1 Settings and parameters

Functional form of instantaneous utility and parameters are invariant throughout simulations conducted in the next section.

We assume an instantaneous utility function in equation (3) as logarithmic:

$$u(c_t, l_t) = \epsilon \log(c_{j,t}) + (1-\epsilon) \log(\bar{l}_{j,t} - l_{j,t}), \tag{21}$$

where ϵ is a parameter that determines consumption–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 our settings.

The parameters are listed in Table 1. The discount factor (β) and is targeted to the value of the capital–output ratio in the terminal steady state to match the actual value on average between 1980 and 2000 (2.28 in data and 2.25 in the model, respectively). We calculate ratio of average hours worked per worker against average time endowment per worker then consumption–leisure share (ϵ) targets to match actual data of that ratio on between 1980 and 2000 (0.40 in data v.s. 0.48 in the model). Capital share (θ) are from Braun et al. (2009). Labor earning profile by age (e_j) is calculated from Ministry of Health, Labour and Welfare (2011a). Dividing "contractual cash earnings" by "actual number of scheduled hours worked", we obtain average earning per hours worked by age groups. The values include all industry, all employees and all sizes of enterprise. Because it only reports the values classified by age group, we interpolate them. Medical expenses by age (σ_j) is sourced from Ministry of Health, Labour and Welfare (2011b) which reports medical care expenditure by age groups.

3.2 Exogenous variables

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. The exogenous variables and their values are listed in Table 2.

We construct historical data (1980:2010) and impose assumptions on the future values (2011:2200) of exogenous variables. The former is used for calibration and to check the fitness of the model with actual data. The latter is necessary for future projection. As for the future values, in order to incorporate the government expected impacts of Abenomics, we follow the assumptions that are imposed on the government fiscal and economic projections (Cabinet Office (2014)). This projections considers two cases: (a) Economic Revitalization Case and (b) Reference Case. In case (a), it assumes that technology growth rate and labor force participation rate increase drastically given the success of Abenomics. Among the assumptions in Cabinet Office (2014), the major suppositions that our model incorporates are as follows.

- The TFP growth rate is around 0.6% until FY2014 in both cases. In case (a), it gradually recovers to around 1.8% during the period from FY2015 to the beginning of the 2020s. In case (b), it recovers to 1.0% (Panel (a) of Figure 1).
- In case (a), the labor force participation rate improves following the "good scenario" in the Japan Institute for Labour Policy (2014). For example, this rate among females aged 30–34 gradually rises from about 68% for FY2010 to 77% for FY2023. Case (b) supposes that the labor force replacement rate remains constant at the current level (Panel (b) of Figure 1).
- It is assumed that social security expenditure will increase due to the aging of population.
- The tax rate on consumption is raised by 3% in FY2014 and then by 2% in FY2015.

In the rest of this subsection, we explain the contraction of historical data and assumptions for the future values.

Demographics ($n_{0,t}, \mu_{s,T_s}, \psi_{s,t}$): Historical data concerning demographics are from the Human Mortality Database for 1980–2010. Estimation values between 2011 and 2050 are sourced from the World Population Prospects. For 2051 and beyond, we assume that the survival probability of each generation is constant at its 2050 value. To confirm convergence to a stationary distribution, the population growth rate of age 0 generation is assumed to gradually recover to 0% in 2100.

Technology growth rate (γ_t): We applied the dataset from Miyazawa and Yamada (2013) to produce the TFP growth between 1980 and 2010. It is calculated as a Solow residual depending on the Cobb–Douglas production function (Equation (7)). Miyazawa and Yamada (2013) provided the details for the construction of TFP. The future growth rate of TFP is set in the same way as the assumption of government projection.

Depreciation rate (δ_t): The depreciation rate of capital is sourced from Braun et al. (2009). Since their data set ends at 2001, we assume that it is constant at that value thereafter.

Time endowment ($\bar{l}_{j,t}$): Time endowment per capita is calculated from below equation:

$$\begin{aligned}\bar{l}_{j,t} &= (\text{Participation Rates of age } j) \times (16 \text{ hours}) \\ &\quad \times (\text{days per week}) \times (4 \text{ weeks}) \times (12\text{months}).\end{aligned}$$

In order to take into account the effect of the government's policy of labor force participation, we reflect the participation rates for time endowment. "Participation Rates" from 1980 to 2013 are sourced from the Labor Source Survey. Those in 2020 and 2030 are from Japan Institute for Labour Policy and Training (2014), and for in-between years are linearly interpolated. "Days per week" are based on Yamada (2012), so as to consider a reduction in workweek length introduced by the Labor Standards Law in the late 1980s.

Tax rates ($\tau_{c,t}, \tau_{r,t}, \tau_{w,t}$): Tax rates between 1980 and 2009 are calculated with the methodology of Mendoza et. al. (1994) and the data of the National Accounts of Japan. We assume that the tax rate on consumption is hiked by 2% in 2014 and then by 3% in 2015, following the government projection. For 2010 and beyond, we assume that the other tax rates are assumed to be constant at the 2009 values.

Government spending–output ratio (g_t): The government spending–output ratios between 1980 and 2009 are sourced from National Accounts of Japan. Since we consider the government spending excluding medical expenditure, we subtract "Social security benefits" from "Government final consumption expenditure". For 2010 and beyond, we assume that the ratio is constant at the 2009 value.

Pension replacement rate (ϕ_t): The pension replacement rates for 2000 and 2004 are from Ministry of Health, Labour and Welfare (2004). Since it reports the ratio of pension benefit against before tax income prior to 2000, we adjusted it using labor income tax described below. The future values are from Ministry of Health, Labour and Welfare (2009). It reports estimated values of replacement rate from 2009 to 2050. We assume that it is constant at the value in 2050 thereafter.

Government debt–output ratio (d_t): The historical data for the debt–output ratio are from OECD "Economic Outlook No. 93". Estimation values from 2011 to 2014 are also from OECD. We assume that the estimated values from 2015 are along with the government fiscal consolidation plan under Basic Policy. Following this plan, the estimated debt–output ratio is assumed to stop increasing from 2020.

3.3 Calculations

Given the path of exogenous variables $\{n_{0,t}, \mu_{s,T_s}, \psi_{s,t}, \bar{l}_{j,t}, \gamma_t, \delta_t, g_t, d_t, \tau_{c,t}, \tau_{r,t}, \tau_{w,t}, \phi_t\}$ and time-invariant parameters $\{\beta, \eta, \theta, e_j, \sigma_j\}$, we 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 $\{K_t, L_t, x_t\}$.[3]

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

5. Aggregate the individual variables obtained at step 4 and check the asset market clearing condition (19), labor market clearing condition (20), and government budget constraint (15).

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

x_t in step 2 is the arbitrary exogenous variable. Since our motivation is to quantify the reform that is needed for sounding Japan's fiscal condition, we set the government debt–output ratio (d_t) exogenously. In order to satisfy the government budget constraint, some exogenous variable x_t has to be adjusted.

4 Simulation Results

4.1 Model's performance

In this subsection, to confirm the explanatory power of our model, we check the fitness of model-generated variables with actual data. In this regard, the simulation conducted here starts from the year 1980 and includes a lump-sum tax (transfer). Therefore, the government budget constraint is satisfied by adjusting it. We impose assumptions on the values of exogenous variables beyond 2011 as described in the previous section. For productivity growth rate and labor force participation rate, we adopt assumptions in case (a) of Cabinet Office (2014)[4]; that is, TFP and labor force participation rate are expected to increase drastically.

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

[4]See the first and second assumptions in subsection 3.2.

Figure 2 shows the actual and simulated demographic variables. The model captures the rapid aging and shrinking population in Japan very well. Figure 3 plots model-generated macro variables along with actual data. While our model can track fluctuation of real GDP very well, it underestimates capital–output ratio. This is because our model includes government debt and assumes it is held by domestic household. Since government debt crowds out capital, the gap between data and model gradually expands as debt increases. The model can capture an increasing trend of pension and medical care expenditure ratio against output. We overestimates pension expenditure against GDP during the 1980s and 1990s. This is because we calculated pension replacement rate prior to 2000 by converting before tax income to after tax income as described above.

4.2 Settings for future projections

In the future projections conducted below, we set the year 2011 as the initial period of simulation. To pin down the initial condition, the asset distribution of the household at the initial year is needed. We adopt the asset holdings by age at 2011—that is calculated in the simulation conducted in the previous section—as the initial asset distribution. For the future path of exogenous variables, we consider two cases: (a) and (b) along with Cabinet Office (2014). As described above, the differences between the two cases is that in one, we incorporate the TFP growth rate, and in the other, the labor force participation rate. As policy options, we consider the following three scenarios.

(i) Increasing the tax rate on consumption (τ_c)

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

(iii) Decreasing the pension replacement rate (ϕ)

Under these scenarios, we calculate the tax rates or replacement rates to smooth the debt–output ratio.

4.3 Achieving fiscal target

Figure 4 shows the results of quantitative analysis. It depicts the consumption tax rate, labor income tax and pension replacement rate that needed for stopping increase in debt–output ratio at 2020. It also depicts the current or expected rates of them as a reference. For example, the dotted line in Panel (i) depicts the consumption rates that is assumed in the simulation with scenario (ii) and (iii). If the solid line matched with the dotted line, the targeted government-output ratio would be achieved without extra fiscal reform.

Before considering each scenario, we mention about differences between the two case; (a) and (b). Under any scenario, gap between case (a) and (b) arises after around 2015. This is because we set the TFP growth rates as the same level in two case between 2011 and 2014, following the government projection (Figure 1). Moreover, difference in labor participation rates in two case is assumed not to be large during the 2010s. After around 2020, we can see a clear gap between (a) and (b), however, the gap is not so large in each scenario.

(i) consumption tax: Panel (i) of Figure 4 shows the results of scenario (i). Tax rate on consumption should be increased to 20% (22% in case (b)) in 2020. Although the government plans to increase the rate by 5%, our simulation shows that it should be raised by 10% more in order to stop the increase in debt–output ratio in 2020. Note that the rate increases drastically between 2018 and 2019. Since we assume that the increase in exogenous debt–output ratio stops suddenly in 2020, the tax rate in 2019 should be large in order to restrain the debt issue.

(ii) labor income tax: The labor income tax rate should be nearly 40% in 2030. 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) replacement rate: Under scenario (iii), we consider the case that the government changes the pension system by decreasing the replacement rate of pension payments (ϕ_t in equation (12)). 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, we remove this government-decided rate. Panel (iii) of Figure 4 shows the result of scenario (iii) that reports the replacement rate to be around 30% in 2030. Seeing that its value in 2011 was more than 60%, the rate may need to be cut by more than half in the future.

In any case, the tax or replacement rate between 2011 and 2020 is sufficiently different from the current rate. This implies that the fiscal target is difficult to achieve in spite of the success of Abenomics. In addition, our simulation showed that a drastic policy shift is needed in the future since population aging is projected to become severe.

4.4 Policy comparison

In the previous subsection, we provided quantitative results showing 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, we calculate the discounted sum of lifetime utility (Equation (3)) of the household that represents each generation. Using it as an evaluation standard, we compare the impacts of policy changes.

Figure 5 plots the level of lifetime utilities of generations under three scenarios with case (a). 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 1912 under scenario (i) is normalized to unity. For example, the utility of the generation born in 1980 is around 0.8 in scenario (i). This means that the lifetime utility of the 1980 generation is 20% lower than that of the 1912 generation when the fiscal consolidation is achieved by increasing the consumption tax rate. Note that the simulation starts from 2011. Therefore, the individual variables (consumption, labor input, and asset holding) before 2011 are fixed to the values at the initial steady state, and the difference in the utilities of households is derived from their utility maximization problems after 2011.

As Figure 5 shows, the three policy changes, namely, in relation to the consumption tax, labor income tax, and replacement rate, have different impacts on each generation's utility. For the generations born before around 1975, scenario (ii) is the most preferable and scenario (iii) is the worst. In contrast, for the generations born after around 1975, the order of preference is scenario (iii), (i), and (ii).

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 2011 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 2011, a drop in pension payment distorts the consumption smoothing of the retired generation.

For the generations employed in 2011 and for the future generations, the reform by cutting pension payments brings the highest utility in the three scenarios. Since 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.

As for the increase in labor income tax (scenario (ii)), the future generations suffer from a serious utility loss under this scenario. For example, the lifetime utility of the generation to be born in 2020 would only be 70% of that of the generation born in 1912 if scenario (ii) were to be selected. As Figure 2 shows, the aging of the population structure is estimated to become increasingly severe. The working population in the 2020s will be about 13% lesser than that in 2011. Taxing labor income is not a preferable policy for future generations in a reducing-population economy.

Note that there exists a severe preference gap between the retired generations 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 (iii). When we calculate the size of the population agreeing to an increase in the labor income tax and that agreeing with the policy that decreases the replacement rate in 2011 [5], 73 million prefer scenario (ii) and 28 million prefer scenario (iii). 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 (iii)) may not be chosen through a democratic policy decision based on the current population distribution.

4.5 Policy implications

As indicated by the simulation results, pension reform is the preferable policy shift for the future generations. However, the results also imply that it is difficult to achieve consensus over drastic pension reforms. It is likely that without these results, we may tend to believe that it is hard to realize a policy that cuts the pension payments of the current retired generation. Thus, the current government policy, of combining pension system reform with increasing consumption tax, may be the preferable way.

5 Conclusions

This study examined two questions concerning Japan's fiscal reconstruction. First, we calculated the quantity needed to redress the fiscal condition using an OLG model that considers multiple generations. The results show 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

[5] They coincide with the size of households who are 37–99 years old (were born in 1912–1973) and 20–36 years old (were born in 1974–1990) in 2011, respectively.

in the consumption tax rate, its rate is estimated to increase to 20% in 2020 and more than 25% in 2030. These results imply that the government fiscal consolidation target, to stop increasing the debt–GDP ratio after 2020, is difficult to achieve even when assuming that Abenomics has the desired effects. The second question was identifying the most feasible policy, out of all the options, for each generation. This study clarified the serious gap between older and future generations in their preferences. We also pointed out that the pension system reform is the more preferable option when considering intergenerational equality.

This research could be improved by elaborating description of the model. In this study, we used the discounted sum of lifetime utility; however, using discounted utility underestimates the instantaneous utility of older generations. Further, although we incorporate a simple pension system in order to make the model tractable, a more complex pension system can yield a change in the utility of elders.

Appendix.1 Household equilibrium conditions

Households maximize their discounted sum of lifetime utility (3) subject to their budget constraints (4), given the sequences of factor prices $\{w_t, r_t\}$ and fiscal policies $\{\tau_{r,t}, \tau_{w,t}, \tau_{c,t}, b_{j,t}, \xi_{j,t}\}$ for all t. These conditions for workers $(1 \leq j \leq J_r)$ yield the following:

$$\begin{aligned}
\frac{1}{1+\tau_{c,t}}\frac{1}{c_{j,t}} &= \beta\psi^i_{j,t}\frac{1}{1+\tau_{c,t+1}}\frac{1}{c_{j+1,t+1}}[1+(1-\tau_{r,t+1})r_{t+1}],\\
(1-\epsilon)\frac{1}{\bar{l}_t - l_{j,t}} &= \epsilon\frac{1}{1+\tau_{c,t}}\frac{1}{c_{j,t}}(1-\tau_{w,t})w_t e_{j,t},\\
(1+\tau^i_{c,t})c_{j,t} + a_{j+1,t+1} &= [1+(1-\tau_{r,t})r_t]a_{j,t} + (1-\tau_{w,t})w_t e_j l_{j,t} + \xi_t,
\end{aligned}$$

and for retirees $(J_r + 1 \leq j \leq J)$,

$$\begin{aligned}
\frac{1}{1+\tau_{c,t}}\frac{1}{c_{j,t}} &= \beta\psi_{j,t}\frac{1}{1+\tau_{c,t+1}}\frac{1}{c_{j+1,t+1}}[1+(1-\tau_{r,t+1})r_{t+1}],\\
(1+\tau_{c,t})c_{j,t} + a_{j+1,t+1} &= [1+(1-\tau_{r,t})r_t]a_{j,t} + b_{j,t} + \xi_t,
\end{aligned}$$

for any t. Combining them, they yield the difference equations for transition of individual asset holdings. By imposing $a_{1,t} = a_{J+1,t} = 0$ and solving them, we obtain the lifetime profile of asset of each individual. Taking the asset transition as given and using the equilibrium conditions again, profiles of consumption and labor input are derived.

Appendix.2 Detrending

We can detrend the model by defining

$$\tilde{X}_t \equiv \frac{X_t}{Z_t^{\frac{1}{1-\theta}} N_t},\ \tilde{x}_{j,t} \equiv \frac{x_{j,t}}{Z_t^{\frac{1}{1-\theta}}},\ q_t \equiv \left(\frac{Z_{t+1}}{Z_t}\right)^{\frac{1}{1-\theta}},\ \left(\tilde{L}_t \equiv \frac{L_t}{N_t}, \tilde{w}_t \equiv \frac{w_t}{Z_t^{\frac{1}{1-\theta}}}\right)$$

where X_t is the arbitrary aggregate variable other than labor input, and $x_{j,t}$ are individual variables such as $a_{j,t}$ and $c_{j,t}$. This allows us to convert the growth economy into a stationary economy.

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Table 1: Value, target and source of parameters

	Parameters	Value	Target or source
β	discount factor	0.988	avg. capital output ratio 1980–2000
ϵ	leisure share	0.372	avg hours worked per worker 1980–2000
θ	capital share	0.363	Braun et al. (2009)
e_j	labor efficiency by age	–	Ministry Health, Labor and Welfare (2010)
σ_j	medical care expenditure by age	–	Ministry Health, Labor and Welfare (2013)

Table 2: Settings of exogenous variables

Exogenous variables		Values in 2011	Values in 2200
Demographics			
$n_{0,t}$	growth rate of age 0 generation	0.973	1.000
μ_{s,T_s}	initial pop. dist.	–	–
$\psi_{s,t}$	survival prob.	–	–
Labor			
$\bar{l}_{j,t}$	time endowment	–	–
Production			
γ_t	growth rate of productivity	0.006	0.018
δ_t	depreciation rate	0.076	0.076
Government			
g_t	government spending output ratio	0.125	0.125
d_t	government debt output ratio	1.178	1.550
$\tau_{c,t}$	tax rate on consumption	0.057	0.107
$\tau_{r,t}$	tax rate on capital income	0.412	0.412
$\tau_{w,t}$	tax rate on labor income	0.278	0.278
ϕ_t	replacement rate	0.623	0.501

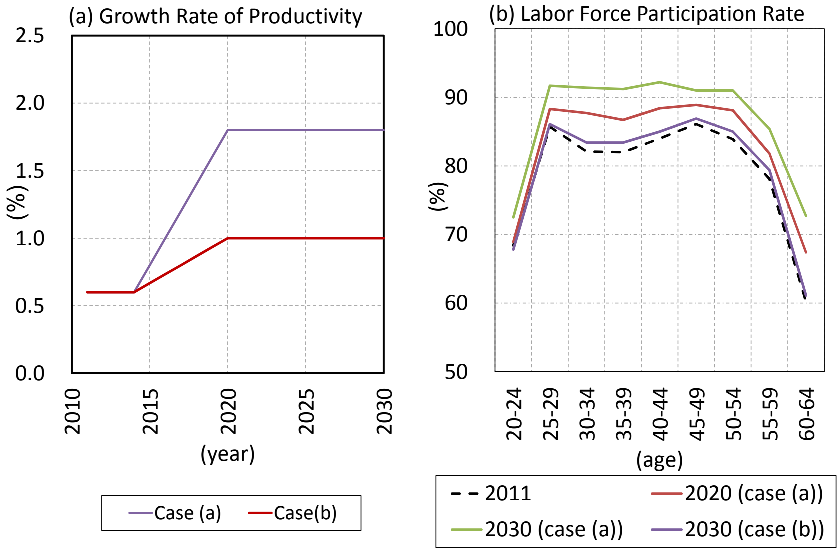

Figure 1: TFP growth rate and labor force participation rate

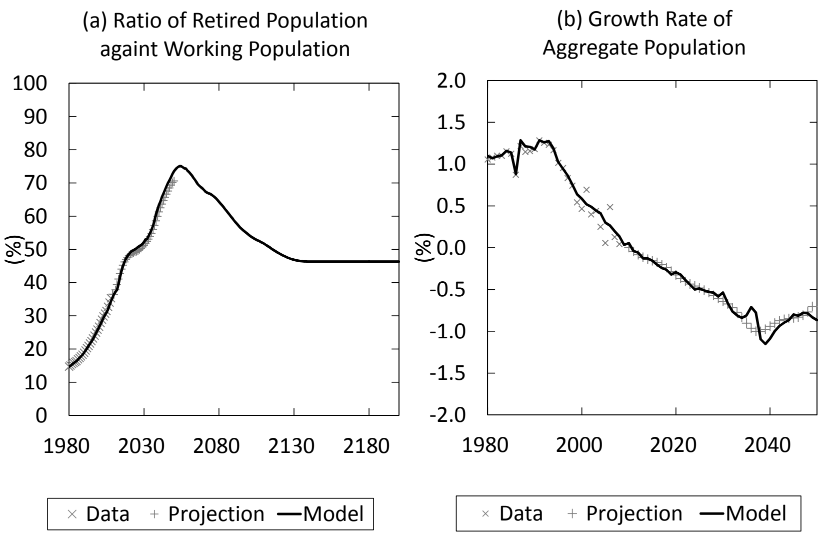

Figure 2: Actual and simulated demographic variables in Japan

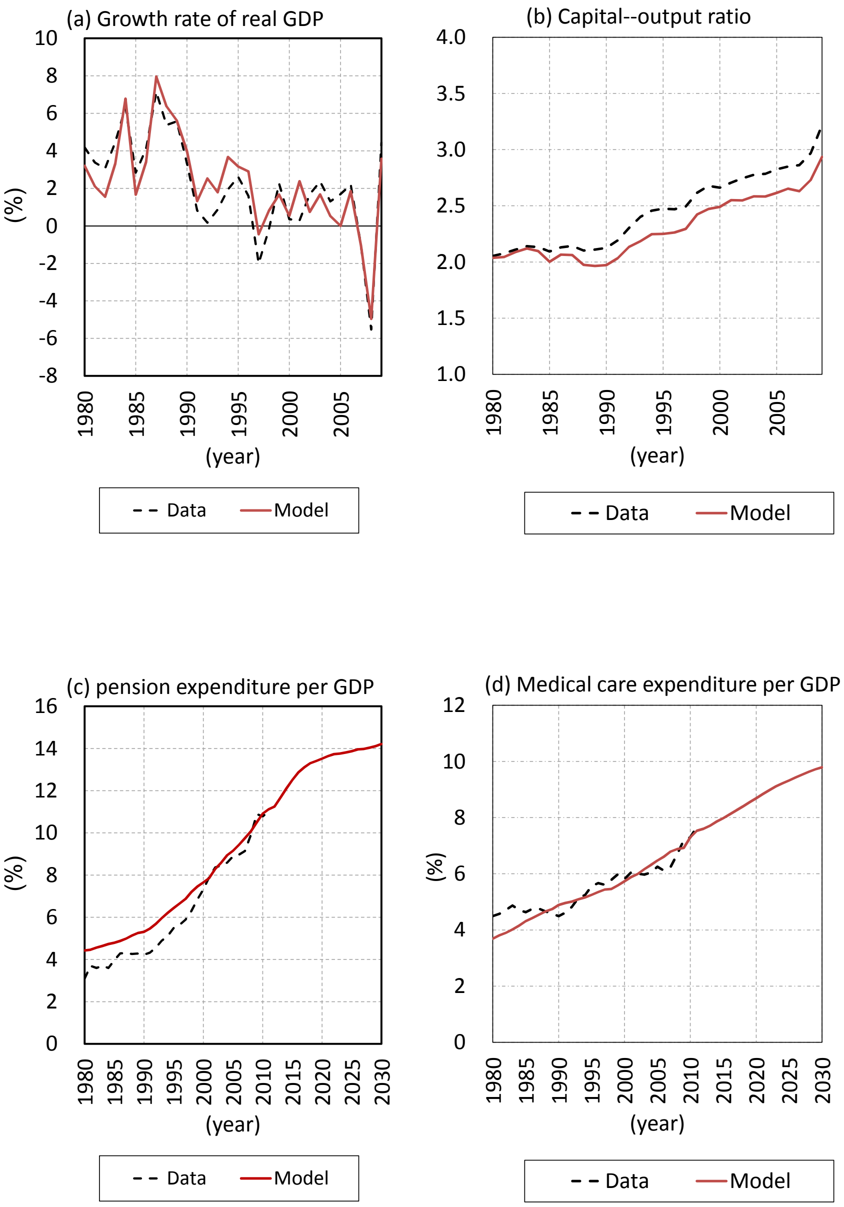

Figure 3: Actual and simulated macro variables in Japan

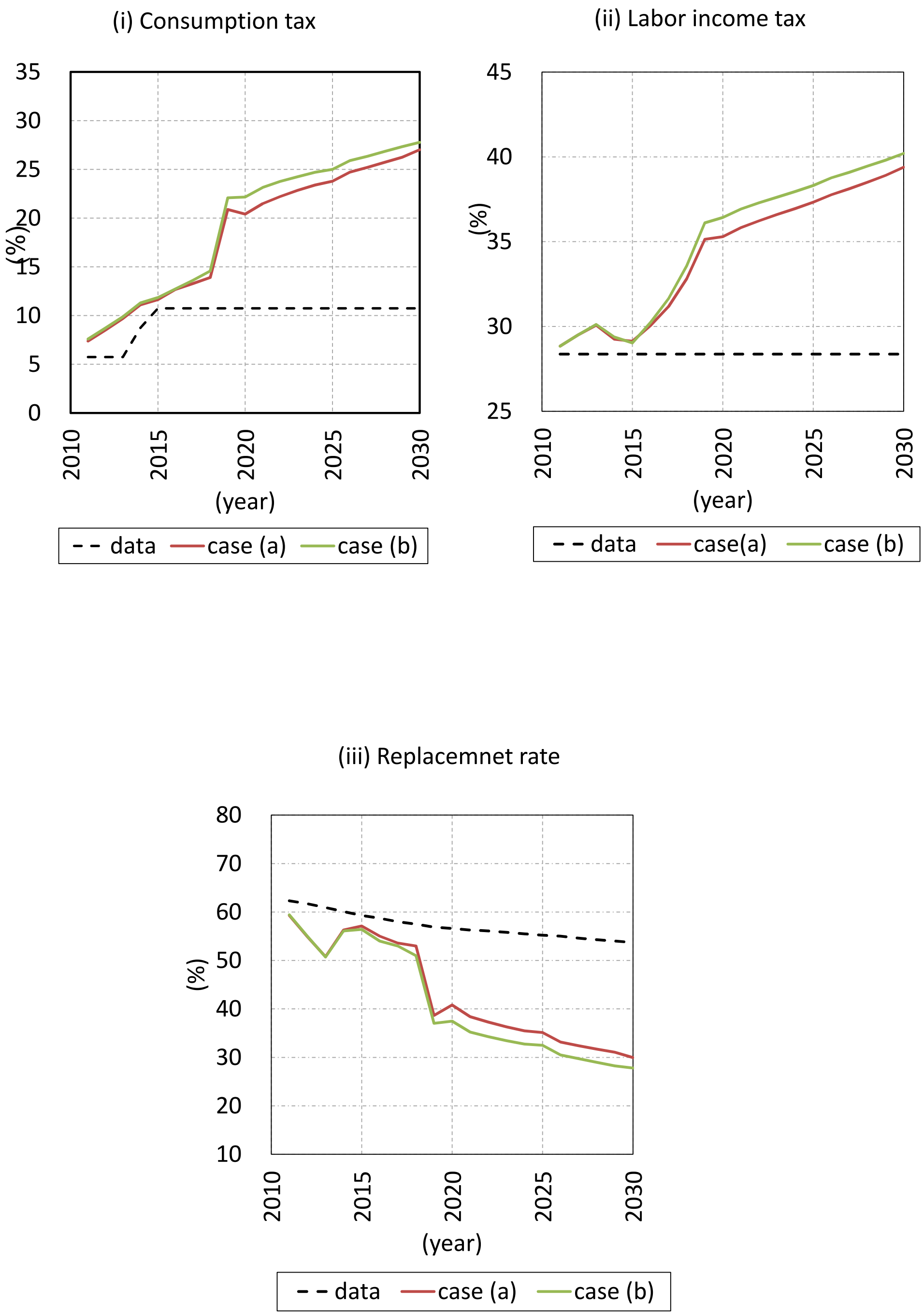

Figure 4: Tax rates and replacement rate sufficient for fiscal soundness

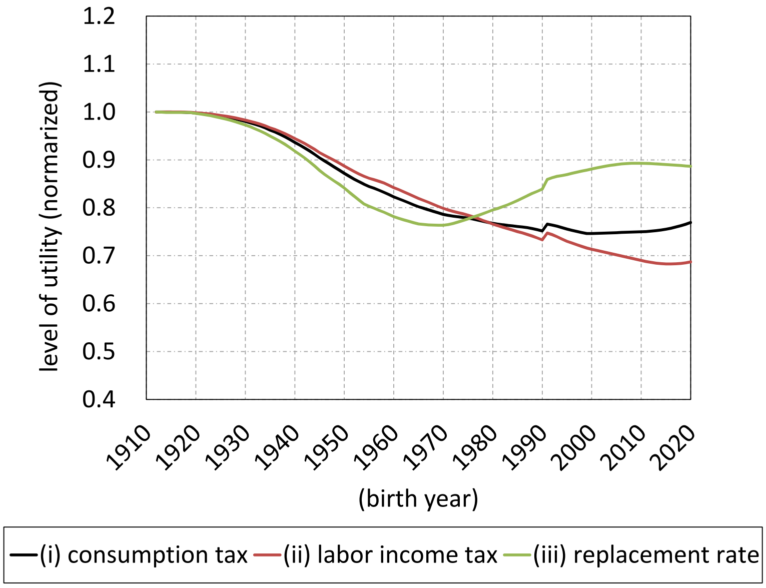

Figure 5: Level of utility