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The growth strategy of Abenomics and fiscal consolidation ☆

Kensuke Miyazawa [a], Junji Yamada [b,*]

[a] Faculty of Economics, Kyushu University, 6-10-1 Hakosaki, Higashi-ku, Fukuoka 812-8581, Japan
[b] Faculty of Economics, University of Toyama, 3190 Gofuku, Toyama 930-0055, Japan

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ABSTRACT

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Using a general equilibrium model with an overlapping generation structure, this study examines the impacts of a new Abenomics growth strategy on fiscal consolidation in Japan. Our simulation yielded the following results. (i) It is difficult to achieve the government target of fiscal consolidation by the year 2020 even when assuming that the growth strategy has the desired effects. (ii) Moreover, further economic and fiscal reforms are required from 2030 to 2070 because of accelerated population aging. (iii) However, population policy and an extended retirement age contribute to significant improvements in Japan's fiscal condition after 2070. (iv) In contrast, the promotion of productivity and the labor force participation rate have a lesser impact on fiscal reconstruction. *J. Japanese Int. Economies* **xxx** (xx) (2015) xxx–xxx. Faculty of Economics, Kyushu University, 6-10-1 Hakosaki, Higashi-ku, Fukuoka 812-8581, Japan; Faculty of Economics, University of Toyama, 3190 Gofuku, Toyama 930-0055, Japan.

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* Corresponding author.
E-mail addresses: kensuke.miyazawa@gmail.com (K. Miyazawa), jyamada@eco.u-toyama.ac.jp (J. Yamada).

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1. Introduction

As the ''third arrow'' of Abenomics, a new growth strategy was announced publicly in June 2013. The Basic Policies for the Economic and Fiscal Management and Reform presented basic plans for Abenomics and outlined the growth strategy. Additionally, the Japan Revitalization Strategy provided detailed contents of the growth strategy and targets, such as the promotion of productivity. In June 2014, these two plans were revised. The revised plans targeted a stable demographic structure, maintenance of the population at approximately 100 million people in 50 years' time,[1] and promotion of women's labor force participation.

On the other hand, to maintain credibility in Japan's fiscal policy, the Cabinet approved basic directions for fiscal consolidation, the Basic Framework for Fiscal Consolidation: Medium-term Fiscal Plan, in August 2013. The plan states that the government's fiscal consolidation target is to halve the ratio of the primary balance against Gross Domestic Product (GDP) between FY2010 and FY2015, achieve a primary surplus by FY2020, and steadily decrease the debt balance as a percentage of GDP after FY2020.

This study addresses the following two questions. First, is it possible to achieve the government's medium-term fiscal targets by adopting the growth strategy of Abenomics? Second, what is the impact of the growth strategy on fiscal conditions in the long-run?

The government provided responses to questions in Economic and Fiscal Projections for Medium to Long Term Analysis (July 2014) (EFP). EFP conducted projections using a large scale macro econometric model and concluded that, under optimistic assumptions, the target of halving the ratio of the primary deficit to GDP from the FY2010 rate by FY2015 is achievable by Abenomics. However, it insisted that further efforts are necessary to steadily reduce the ratio of debt to GDP. The ratio of debt to GDP is projected to be approximately 185.5% in FY2020 and to remain at that level thereafter.

In contrast to the government projections, we provide economic projections based on a general equilibrium model. It is desirable to conduct economic and fiscal projections based on a model where consumers maximize their utility and firms maximize their profit. A macro econometric model without such a micro foundation may fail to quantify the impact of future policy reform precisely. Lucas (1976) criticizes that the use of estimated statistical relationships may lead to a wrong policy implication because the estimated regression coefficient will change along with agents' behaviors in response to a new policy. Therefore, unlike EFP, this study provides long-run projections for the Japanese economy using a model with a profound micro foundation. Specifically, we use the general equilibrium overlapping generations (OLG) model calibrated to the Japanese economy, which contains optimal and forward-looking behaviors of households and firms.

For exogenous policy shocks, our simulation adopts the same assumptions as what were used by EFP and Choice for the Future (CFF).[2] EFP assumed that the technology growth rate and labor force participation rate (LFPR) would improve drastically as a result of Abenomics. CFF which is an interim report by the Committee for Japan's Future analyzed the conditions required to maintain the population target as stated in the Basic Policies. CFF also proposed increasing the retirement age to 70 years. Given these assumptions, we calculate the tax rate required to achieve the government's fiscal consolidation target. If the calculated rate is higher than the current rate, this implies difficulty in achieving fiscal consolidation.

We obtained the following results. First, the government's mid-term fiscal target is difficult to achieve even when policy reforms are assumed to have been executed completely. Our simulation projects that consumption tax should be raised more than 10% between the years 2010 and 2030 compared to the average rate in the 2000s. Although the Japanese government increased the tax rate on consumption by 3% in 2014, our simulation implies that this increase is insufficient to achieve the fiscal target. Moreover, because of accelerated population aging, the tax rate on consumption should

[1] The population target was stated in the revised Basic Policies. We consider a policy that aims at this target as a part of the growth strategy of Abenomics.

[2] While the Basic Policies and the Japan Revitalization Strategy outlined a growth strategy, EFP and CFF provided quantitative targets and effects of the growth strategy. We, therefore, assume the targets and effects of the latter as a consequence of the Abenomics growth strategy.

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be raised to more than 20% for the 2030 decade. Finally, among the policy reforms, improvements in birth rates and the extension of the retirement age improve fiscal conditions in the long-run, particularly after 2070. In contrast, the promotion of the productivity growth rate has no significant impact on fiscal consolidation. This is because the growth rate stimulates economic growth and increases the interest payment burden of government debt through a raised interest rate. Additionally, the growth rate increases the level of individual pension payments related to the average labor income of the working population.

A number of previous studies have investigated Japan's current fiscal problems. We classify them into two categories based on the methodology they employ. The studies in the first category use a non-behavioral approach, which is different to the method used here. Doi et al. (2011) calculate a required government revenue to stabilize the debt-to-GDP ratio and find that it must rise permanently to 40–47% of GDP in the future from 33% in 2010. Kameda (2014) employs an event study methodology and analyzes the relationship between budget deficits, government debt, and interest rates. İmrohoroğlu et al. (2013) construct a micro data based OLG model and analyze the impacts of improvement in LFPR and the retirement age extension on paths for the ratio of government debt. İmrohoroğlu et al. (2013) have a similar motivation to ours, however, they do not consider optimal behavior of agents.

The second category are studies that use a micro-foundation model. İmrohoroğlu and Sudo (2011a) use a representative agent model and insist that even an annual GDP growth rate of 3% over the next 20 years combined with a new consumption tax rate of 15% may be insufficient to achieve a consistent primary surplus. Using a similar model, Hansen and İmrohoroğlu (2013) simulate the future Japanese fiscal situation and report that a nearly permanent increase in consumption tax of about 30% is required for fiscal consolidation. Sakuragawa and Hosono (2011) investigate the fiscal sustainability of Japanese economy using a dynamic stochastic equilibrium model that features the low interest rate of the government debt relative to the economic growth rate. They find that if the government does not react to the current fiscal situation, the debt-to-GDP ratio will increase indefinitely. Using an OLG model, Arai and Ueda (2013) numerically show that the primary deficit cannot be sustained unless the rate of economic growth is unrealistically high. Braun and Joines (2014) construct a general equilibrium OLG model and calculate the consumption tax rate sufficient for fiscal soundness to be 36% and find that it should be kept at this level forever. These studies report pessimistic results on Japan's fiscal situation if the government policy is maintained at the status quo.

However, few previous studies have explored how the growth strategy of Abenomics will contribute to fiscal consolidation. This study imposes optimistic assumptions as much as possible on the impacts of future policy reforms consistent with the government projections and analyzes the effects of reforms on Japan's fiscal condition. Because the growth strategy has a positive effect on the fiscal condition, it is essential to quantify it. By analyzing the effects of the growth strategy, we suggest desirable government policies for fiscal consolidation.

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

2. Model

This section describes our model, which 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, we explain the economic activity of each agent.

2.1. Demographics

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

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$$\begin{bmatrix} \rho_{0,t+1} \\ \vdots \\ \vdots \\ \rho_{104,t+1} \end{bmatrix} = \begin{bmatrix} 1+n_{0,t} & 0 & 0 & \cdots & 0 & 0 \\ \psi_{0,t} & 0 & 0 & \cdots & 0 & 0 \\ 0 & \psi_{1,t} & 0 & \cdots & 0 & 0 \\ \cdots & \cdots & \cdots & \cdots & \cdots & \cdots \\ 0 & 0 & 0 & \cdots & \psi_{103,t} & 0 \end{bmatrix} \begin{bmatrix} \rho_{0,t} \\ \vdots \\ \vdots \\ \rho_{104,t} \end{bmatrix}. \tag{1}$$

Here, $\rho_{s,t}$ is the population size of age s ($s = 0, \ldots, 104$) generation at year t. $\psi_{s,t}$ and $n_{0,t}$ represent 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, Eq. (1) creates Japan's demographic distribution.

2.2. Household

A household problem is finite. In the model, the age of the representative household is represented by j ($j = 1, \ldots, 85$). Each household enters into the economy aged 20 years ($j = 1$) and works to retirement age ($j = Jr$). After retirement, the individual lives by dissaving assets and receiving pension payments until the age of 104 years ($j = 85$). We define the population size of age j and the population size of age range 20–104 at year t as $\mu_{j,t}$ and N_t.

$$\mu_{j,t} = \rho_{j+19,t}, \quad N_t = \sum_{j=1}^{85} \mu_{j,t}. \tag{2}$$

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

$$U_m = \sum_{j=1}^{85} \beta^{j-1} \pi_{j,t} u(c_{j,t}, l_{j,t}), \tag{3}$$

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 inputs of an age j agent. The budget constraint at year t and age j is Eq. (4).

$$(1+\tau_{c,t})c_{j,t} + a_{j+1,t+1} = \{1 + (1-\tau_{r,t})r_t\}a_{j,t} + (1-\tau_{w,t})w_t e_j l_{j,t} \Gamma(j \leqslant Jr) + b_t \Gamma(j > Jr) + \xi_t, \tag{4}$$

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

$$a_{1,t} = a_{86,t} = 0. \tag{5}$$

r_t is the rental rate on capital, and w_t represents the wage rate. $\tau_{c,t}, \tau_{r,t}$, 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 one if the condition in parentheses is satisfied and zero otherwise. The remaining factors e_j and ξ_t are labor efficiency by age and distributed bequests, respectively. We assume that accidental bequests left by households are distributed equally by the remaining households. As such, the following holds:

$$\sum_{j=1}^{85} \xi_t \mu_{j,t} = \sum_{j=1}^{85} (1-\psi_{j-1,t-1})(1+r_t)a_{j,t}\mu_{j-1,t-1}. \tag{6}$$

A household determines its profiles of consumption, assets, and labor inputs by maximizing the lifetime utility (3) under constraint (4).

2.3. Firm

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

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

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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, hence, capital transition follows Eq. (9):

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

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

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

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

$$T_t = \sum_{j=1}^{85} \tau_{c,t} c_{j,t} \mu_{j,t} + \sum_{j=2}^{85} \tau_{r,t} r_t a_{j,t} \mu_{j,t} + \sum_{j=1}^{Jr} \tau_{w,t} w_t e_j l_{j,t} \mu_{j,t}. \tag{11}$$

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

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

where ϕ_t is the pension replacement rate[3] at year t. The total pension expenditure of the government is described in the following equation:

$$P_t = \sum_{j=Jr+1}^{85} b_{j,t} \mu_{j,t}. \tag{13}$$

The final government role is government spending. Incorporating the impact of population aging on health care expenditure, we assume that health care expenditure (G_t^h) evolves depending on the population structure.

$$G_t^h = \sum_{j=1}^{85} \sigma_{j,t} \mu_{j,t}, \tag{14}$$

where $\sigma_{j,t}$ is individual health care consumption by age. Government expenditure excluding health care expenditure is defined as G_t. The government fulfills 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 government's general revenue, and the RHS is its expenditure. D_t is government debt outstanding at year t. We define government debt and expenditure per output at year t as g_t and d_t, respectively:

[3] This represents the ratio of pension payments for retired households to the average after-tax labor income of workers.

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$$g_t = \frac{G_t}{Y_t}, \quad d_t = \frac{D_t}{Y_t}. \tag{16}$$

2.5. Market clearing

Before describing the market clearing conditions, we define the relationships between aggregate and individual variables. For an arbitrary individual variable $x_{j,t}$, the aggregated variable is described as X_t. For example, aggregate consumption and assets are defined as follows:

$$C_t = \sum_{j=1}^{85} c_{j,t}\mu_{j,t}, \quad A_t = \sum_{j=2}^{85} a_{j,t}\mu_{j,t}. \tag{17}$$

Three markets exist: goods, asset, and labor. The goods market clearing condition is

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

We assume that government debt is held by households in Japan. Thus, the aggregate assets are 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 the aggregate labor demand in efficiency units:

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

3. Simulation method

This section explains the method used to solve the model. After providing the targets or sources of parameters and exogenous variables, we briefly illustrate the process for solving the model.

3.1. Settings and parameters

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

We assume an instantaneous utility function in Eq. (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) is targeted to the value of the capital-output ratio in the terminal steady state to match the actual value on average between the years 1980 and 2000 (2.28 in the data and 2.25 in the model). We calculate the ratio of average hours worked per worker against average time endowment per worker; then, the consumption–leisure share (ϵ) targets match the actual data of the ratio between the years 1980 and 2000 (0.40 in the data and 0.48 in the model). Capital share (θ) is from Braun et al. (2009). The labor-earning profile by age (e_j) is calculated from Basic Survey on Wage Structure by the Ministry of Health, Labour, and Welfare. Dividing contractual cash earnings by the actual number of scheduled hours worked, we obtain average earnings per hour worked by age group. The values include all industries, all employees, and all enterprise sizes. We interpolate the values in between-ages because Basic Survey on Wage Structure reports the values categorized by age group.

Table 1
Value, target, and source of parameters.

	Parameter	Value	Target or source
β	Discount factor	0.988	Avg. capital output ratio 1980–2000
ϵ	Consumption-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	–	Basic Survey on Wage Structure

3.2. Exogenous variables

The exogenous variables and their values are listed in Table 2. We construct historical data and impose assumptions on the future values of exogenous variables. The former number 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, we consider two scenarios, (a) and (b). To incorporate the impacts of the growth strategy, we follow the assumptions imposed by EFP and CFF. EFP provided two estimation results: the economic revitalization case and the reference case. The government imposed optimistic assumptions in the economic revitalization case. We adopt the optimistic assumptions in the former case for scenario (a) and the assumptions in the latter case for scenario (b). CFF set targets for population policy and the extension of the retirement age. Scenario (a) assumes that these two targets are achieved precisely.

Among the assumptions by EFP, the major suppositions that our model incorporates are as follows.

- The TFP growth rate is approximately 0.6% until FY2015 in both cases. In scenario (a), the growth rate gradually recovers to approximately 1.8% from FY2016 to the beginning of the 2020 decade. In scenario (b), the growth rate recovers to around 1% (Panel (i) of Fig. 1).
- In scenario (a), the LFPR improves consistently with the “good scenario” in the Estimation of Labour Force Supply and Demand by the Japan Institute for Labour Policy and Training. For example, the LFPR among females aged 30–34 years gradually rises from approximately 70% for FY2013 to 81% for FY2023. Scenario (b) supposes that the LFPR remains constant at the current level (Panel (ii) of Fig. 1).
- Social security expenditure is assumed to increase because of the aging population.

Table 2
Settings of exogenous variables.

Exogenous variables		Values in 2013	Values in 2200
Demographics			
$n_{0,t}$	Growth rate of age 0 generation	−0.027	0.000
ρ_{s,T_s}	Initial population distribution	–	–
$\psi_{s,t}$	Survival probability	–	–
Labor			
$\bar{l}_{j,t}$	Time endowment	–	–
Production			
γ_t	Growth rate of productivity	0.006	0.018 (0.010)
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	1.923	0.000
$\tau_{c,t}$	Tax rate on consumption	0.057	0.087
$\tau_{r,t}$	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
$\sigma_{j,t}$	Medical expenses by age	–	–

Note: (1) The value in parentheses are those of scenario (b).

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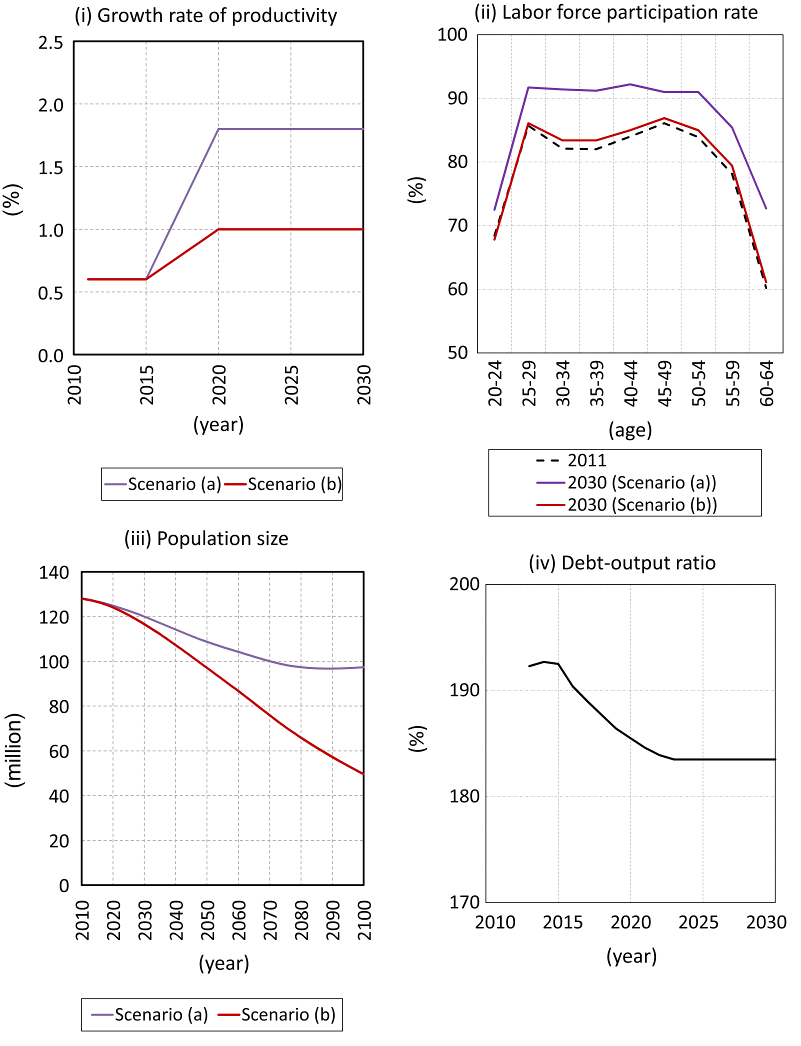

Fig. 1. TFP growth rate, labor force participation rate, population size, and debt-output ratio.

We incorporate the following assumptions imposed by CFF.

- CFF set a population target aimed at maintaining the population at 100 million people in 2060 (Panel (iii) of Fig. 1). To achieve this target, the birth rate increases drastically.
- Additionally, CFF promoted a retirement age of 70 years.

The remainder of this subsection explains the construction of the historical data and assumptions for the future values.

Demographics ($n_{0,t}, \rho_{s,T_s}, \psi_{s,t}$): Historical data concerning demographics are from Population Estimates for 1980 to 2012. We consider two scenarios for estimation values between 2013 and 2110. In scenario (b), we calculate population growth rates of the age zero generation and survival probabilities from the "medium-fertility" and "medium-death" estimations in Population Projections for Japan (January 2012) which is provided by the National Institute of Population and Social Security Research. In scenario (a), we use the same survival probabilities as scenario (b); however, we assume that the population growth rates of the age zero generation ($n_{0,t}$) increase drastically consistent with CFF. For 2111 and beyond, in any scenario, we assume that the survival probabilities are constant at the 2110 value. The population growth rates of the age zero generation are assumed to gradually converge to 0% in 2150.

Time endowment ($\bar{l}_{j,t}$)*:* Time endowment per capita is calculated from Eq. (22).

$$\bar{l}_{j,t} = (\text{Participation rates of age } j) \times (16 \text{ hours}) \times (\text{days per week}) \times (4 \text{ weeks}) \times (12 \text{ months}). \quad (22)$$

To consider the effect of the government's policy on labor force participation, we reflect the participation rates for time endowment. Participation rates from 1980 to 2013 are sourced from Labour Force Survey. Participation rates for the years 2020 and 2030 are from the Estimations of Labour Force Supply and Demand. We apply the same assumptions as what were used by EFP. That is, LFPR improves drastically in scenario (a). It remains constant at the current level in scenario (b). The in-between years are linearly interpolated. Days per week are based on Yamada (2012) to consider a reduction in the length of the work week introduced by the Labour Standards Law in the late 1980s.

Technology growth rate (γ_t)*:* We apply 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 (Eq. (7)). Miyazawa and Yamada (2013) provide details of the construction of TFP. The future growth rate of TFP is set in the same way as the assumption of EFP.

Depreciation rate (δ_t)*:* The depreciation rate of capital is sourced from Braun et al. (2009). Because the dataset ends in 2001, we assume that the rate is constant thereafter.

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

Government debt-output ratio (d_t)*:* The historical data for the debt-output ratio are from the OECD's Economic Outlook No. 93. Estimation values from 2012 to 2023 are from EFP. The estimated values from 2024 to the year 2100 are assumed to remain at the same level as in 2023 (Panel (iv) of Fig. 1). The ratio gradually decreases to zero during the next 50 years and remains zero after 2150.

Tax rates ($\tau_{c,t}, \tau_{r,t}, \tau_{w,t}$)*:* Tax rates between the year 1980 and the year 2009 are calculated using the methodology of Mendoza et al. (1994) and data from the National Accounts of Japan. The tax rate on consumption is increased by 3% in 2014 and is constant thereafter. The tax rate on labor income is assumed to increase from the year 2010 to the year 2017 consistent with the increase in the legislated future pension tax rate[4] and remains at the level of year 2017 thereafter. We assume that the capital income tax rate is constant at the 2009 rate for the year 2010 and beyond.

Pension replacement rate (ϕ_t)*:* The pension replacement rates for the years 2000 and 2004 are from Point of the Pension Revision by the Ministry of Health, Labour and Welfare. We adjust the data using labor income tax because the rates are the ratio of pension benefits to before-tax income prior to the year 2000. The future values are from the Review of the 2009 Actuarial Valuation of Public Pension Plans by the Ministry of Health, Labour and Welfare. The report provides the estimated values of the replacement rate from the years 2009 to 2050. We assume that the rate is constant at the 2050 value thereafter.

Medical expenses by age ($\sigma_{j,t}$)*:* The historical data for the medical expenses by age are sourced from the Basic Document on Health Insurance,[5] For the future values, we assume that it grows in proportion to the growth rate of output per capita.

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[4] İmrohoroğlu and Sudo (2011a) do not consider the legislated future increase in the pension tax rate. Because their simulation imposes different assumptions from our simulation, it is impossible to compare the two estimation results.

[5] Data is available at http://www.mhlw.go.jp/stf/seisakunitsuite/bunya/iryouhoken/database/zenpan/kiso.html (accessed on 5 October, 2014) (in Japanese).

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Retirement age (Jr): For the years 1980 to 2012, we assume that the agent retires at age 64 ($Jr = 45$). For the future value, we set the retirement age as 69 years ($Jr = 50$) in scenario (a), assuming that the suggestions in CFF are adopted immediately. In this case, agents begin to receive pensions at age 70, that is, they do not receive pensions from 65 to 69 years of age. In scenario (b), we suppose that the retirement age is maintained as the status quo ($Jr = 45$).

3.3. Calculations

Given the path of exogenous variables $\{n_{0,t}, \rho_{s,T_s}, \psi_{s,t}, \bar{l}_{j,t}, \gamma_t, \delta_t, g_t, d_t, \tau_{c,t}, \tau_{r,t}, \tau_{w,t}, \phi_t, \sigma_{j,t}\}$ and time-invariant parameters $\{\beta, \epsilon, \theta, e_j\}$, we calculate the path of endogenous variables. The procedure is as follows.

1. Calculate the population distribution using Eq. (1).
2. Calculate the initial and terminal stationary equilibrium.
3. Guess the transition path of $\{K_t, L_t, \chi_t\}$. [6]
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 in step 4 and check the asset market clearing condition (19), labor market clearing condition (20), and government budget constraints (15).
6. If these constraints are satisfied, the solution is achieved. Otherwise, update the initial guess in step 3, and repeat steps 3–6.

χ_t in step 3 is the arbitrary exogenous variable. Because our motivation is to quantify the reform required for sound Japanese fiscal conditions, we set the government debt-output ratio (d_t) exogenously. To satisfy the government budget constraint, some exogenous variables χ_t must be adjusted.

4. Simulation results

4.1. Model performance

To confirm the explanatory power of our model, this subsection verifies the fitness of variables generated by the model with actual data. The simulation begins from the year 1980 and includes a lump-sum tax (transfer). Therefore, the government budget constraint is satisfied by adjusting this tax. We impose assumptions on the future values of exogenous variables as described in Section 3. For the productivity growth rate and labor force participation rate, we adopt assumptions in scenario (a); that is, the TFP and LFPR are expected to increase drastically. Retirement age is maintained at age 64. Fig. 2 shows the actual and simulated demographic variables. The model effectively captures the rapid aging in Japan. Panel (i) plots the actual and simulated dependency ratio. When demographic reforms are not accomplished, the ratio reaches 90%; however, if the demographic structure changes as CFF expects, the ratio gradually decreases after 2050. Panels (ii) and (iii) show estimated population distributions in the year 2060. In the optimistic scenario (a) (Panel (ii)), the population distribution between age 20–90 becomes flat because of increases in newborns after the year 2013. Compared with Panel (iii), an imbalance in population size between working and retired generations is removed by the increase in the birth rate. Fig. 3 plots macro variables generated by the model with actual data. While our model can accurately track fluctuations in real GDP, it underestimates the capital-output ratio. This is because our model includes government debt and assumes it is held by domestic households. Because government debt crowds out capital, the gap between actual data and the model gradually expands as debt increases. The model can capture the increasing trend of the pension-medical care expenditure ratio against output. We overestimate pension expenditure against GDP during

[6] After obtaining the values of aggregate capital and labor, we calculate the factor prices required to solve the household problem. Household equilibrium conditions are shown in Appendix A.

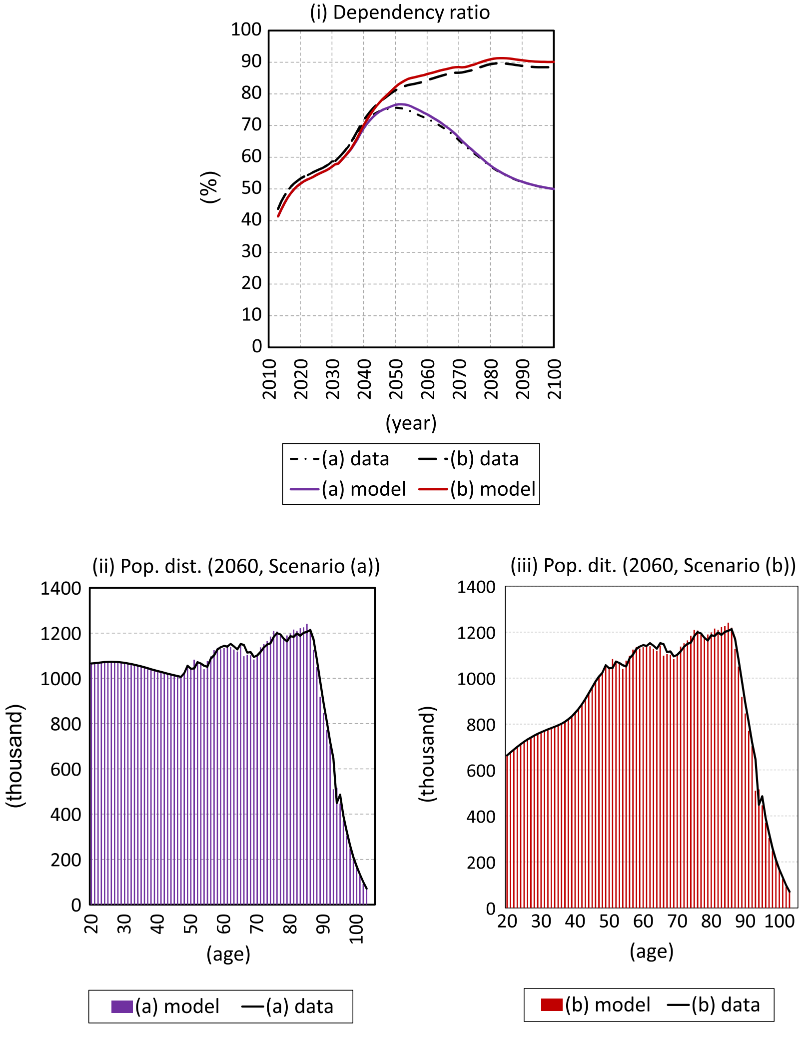

Fig. 2. Actual and simulated demographic variables in Japan.

the 1980s and 1990s. This is because we calculated the pension replacement rate prior to the year 2000 by converting before-tax income to after-tax income.

4.2. Settings for future projections

In the future projections conducted below, we set the year 2013 as the initial period of simulation. To identify the initial condition, the asset distribution of the household in the initial year is required. We use the asset holdings by age in 2013, which was calculated in the simulation conducted in the previous subsection as the initial asset distribution. For the future path of exogenous variables, we consider two scenarios: (a) and (b). The scenarios differ according to the TFP growth rate, the LFPR, the birth rate, and retirement age. In the main simulation, the government budget constraint is satisfied by adjusting the tax rate on consumption. We calculate the tax rate required to smooth the debt-output ratio.

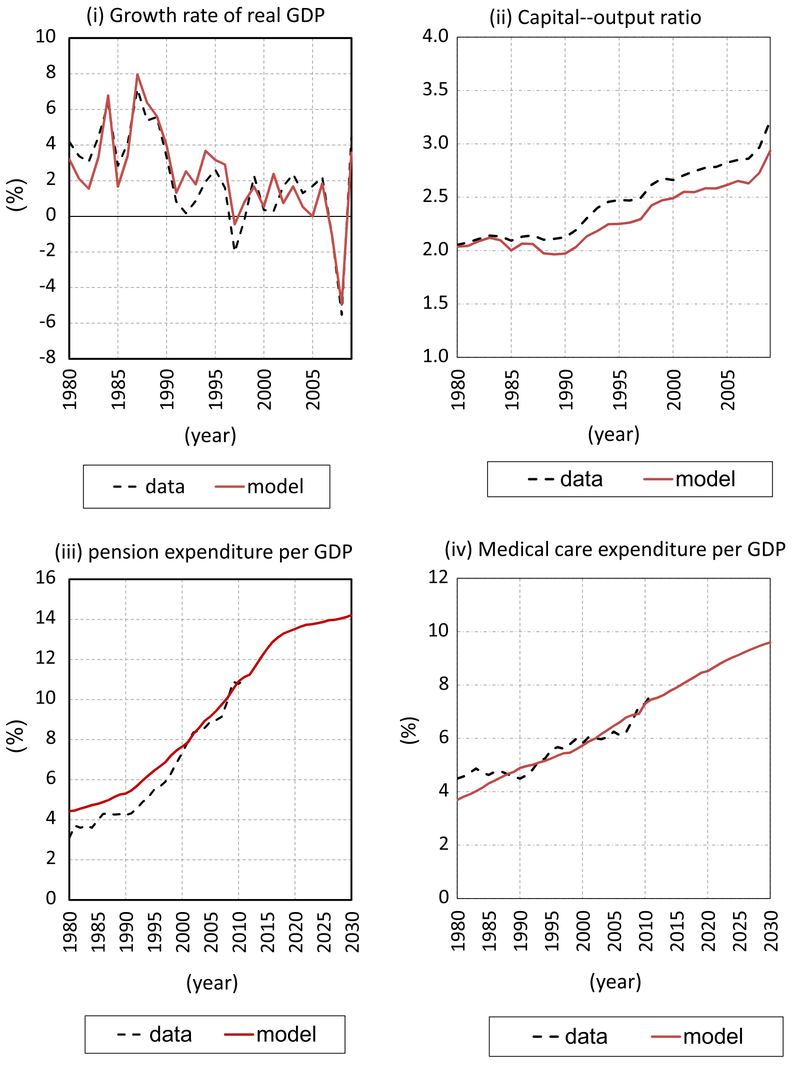

Fig. 3. Actual and simulated macro variables in Japan.

4.3. Achieving fiscal targets

Table 3 shows the results of the quantitative analysis. The table depicts the average consumption tax rate during each decade. The values in the table represent the tax rates required to stop the increase in the debt-output ratio in the year 2020. Additionally Table 3 depicts the rate during the 2000s as a reference.

With respect to the achievability of the government mid-term fiscal target, our simulation provides pessimistic results. In scenario (a), the tax rates should be raised to 16% from the 2010 decade to the 2020 decade. Compared with the rate in the 2000s (6%), the tax rates should be increased by 10% to achieve the government fiscal consolidation target. Although the tax rate on consumption was increased by 3% in 2014, our simulation suggests that a 3% increase in consumption tax is insufficient. Even when the four policy reforms have the desired effect, the fiscal consolidation target is not

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Table 3
Consumption tax rate to achieve the fiscal consolidation target (%).

	Scenario (a)	Scenario (b)
2000s	(6.3)	
2010s	16.6	24.4
2020s	16.8	26.4
2030s	20.6	30.3
2040s	23.1	36.8
2050s	26.0	42.1
2060s	25.7	45.9
2070s	18.6	46.3
2080s	12.2	44.4
2090s	9.8	43.3

Notes:
(1) The values are average rates during decades.
(2) The average actual tax rate during the 2000s is in parentheses.
(3) Scenario (a) is the optimistic scenario. LFPR and the birth rate are assumed to increase drastically. Productivity growth rate reaches 1.8%. Retirement age is extended to the age of 70 years.
(4) In Scenario (b), LFPR and the birth rate are assumed to be maintained at the level of the early 2010s. The productivity growth rate reaches 1%. Retirement age is 65 years.

achieved. This result is pessimistic compared with the government projections. EFP projected that the debt-output ratio is approximately 185.5% in FY2020 and to remain at that level thereafter under the optimistic assumptions. In contrast, our simulation result implies that it is difficult to keep the debt-output ratio under the current tax rate even when the policy reforms are accomplished. In scenario (b), the tax rate should be more than 20% during the 2010s. When the four policy reforms are not accomplished, the fiscal condition in Japan deteriorates.

Moreover, in any scenario, the tax rates after 2030 should be substantially higher than the rate during the 2000 decade. The tax rates are projected to exceed 20% from the 2030s to the 2060s in scenario (a) and 30% after 2030 in scenario (b) to ensure sound Japanese fiscal conditions. This is because the accelerating aging population increases the government pension and health care burden. Further economic and fiscal reforms are required after 2030.

However, in scenario (a), the tax rate begins to decrease after 2060. In this scenario, the dependency ratio starts to decline in 2050 (Panel (i) of Fig. 2), then, population size ceases to shrink around the year 2090 (Panel (iii) of Fig. 1). Along with the demographic shift, fiscal conditions in Japan improve. This implies that the government population target—to maintain the population at 100 million people in 2060—contributes to the sustainability of Japan's fiscal conditions in the long-run if the target is achieved.

Table 4 shows the growth rate of real GDP and the contribution rate of each factor. GDP growth rates are projected at more than 2% after 2050 in scenario (a). This is because high productivity growth and capital accumulation drive a robust economy. Additionally, improvements in labor contribution support economic growth. Implementation of the growth strategy and policy reforms contributes to long-run fiscal conditions and vital economic growth. In contrast, our projection forecasts that Japan will suffer nearly zero economic growth after 2030 in scenario (b). Even when the TFP growth rate recovers to 1%, its contribution is canceled out by the negative contribution of labor input.

4.4. The contribution of each policy reform

Table 5 reports the contribution of policy reforms to fiscal consolidation. Because we consider four policy reforms in the growth strategy—change in retirement age, population policy, TFP promotion, and improvements in the LFPR—we compute the contribution of each reform by conducting simulations under the assumption that only one of the four policy reforms is executed. For example, to

Table 4
Growth rate of real GDP and the contribution of each factor (%).

	Real GDP growth rate	Contribution		
		TFP	Capital	Labor
Scenario (a)				
2010s	1.24	0.97	0.44	−0.17
2020s	1.74	1.73	0.44	−0.32
2030s	1.48	1.80	0.57	−0.79
2040s	1.81	1.80	0.59	−0.40
2050s	2.17	1.80	0.86	−0.17
2060s	2.67	1.80	1.09	−0.04
2070s	3.37	1.80	1.17	0.19
2080s	3.43	1.80	1.09	0.12
2090s	2.87	1.80	0.96	−0.03
Scenario (b)				
2010s	1.06	0.68	0.53	−0.16
2020s	0.69	0.97	0.29	−0.56
2030s	0.01	1.00	0.01	−0.98
2040s	0.19	1.00	0.04	−0.84
2050s	0.13	1.00	0.07	−0.92
2060s	0.14	1.00	0.12	−0.96
2070s	0.31	1.00	0.15	−0.83
2080s	0.18	1.00	0.06	−0.87
2090s	−0.23	1.00	−0.11	−1.10

Note: (1) The values are average rates during decades.

Table 5
The contribution of each policy (%).

	Scenario (a)	Contribution				Scenario (b)
		Retirement age	Population	LFPR	TFP	
2010s	16.6	7.3	0.0	0.0	0.6	24.4
2020s	16.8	7.0	0.0	0.3	0.8	26.4
2030s	20.6	7.3	0.3	0.6	0.6	30.3
2040s	23.1	9.6	2.5	0.8	0.3	36.8
2050s	26.0	9.1	6.5	1.4	0.3	42.1
2060s	25.7	9.4	12.5	1.4	0.3	45.9
2070s	18.6	10.2	19.2	1.3	0.2	46.3
2080s	12.2	9.7	23.5	1.2	0.2	44.4
2090s	9.8	8.8	25.1	1.5	0.1	43.3

Notes:
(1) The values are average rates during decades.
(2) The values in the columns scenario (a) and scenario (b) are the same rates as in Table 3.
(3) The contribution of each policy is calculated as the consumption tax rate.
(4) If we sum the contribution of the four policy reforms, the result does not coincide with the difference between scenarios (a) and (b). This is because the policies have mixed effects.

quantify the contribution of an extended retirement age (third column in Table 5), we conduct a simulation in which we impose the assumption of scenario (a) only on retirement age and the assumptions of scenario (b) for the remaining three reforms. By comparing the results of such an exercise with those of scenario (b), we calculate the impacts of change in retirement age. The contribution is represented as the consumption tax rate. The contribution of retirement age during the 2010 decade is 7.3%. This implies that if the government extends the retirement age from 65 to 70 years of age, fiscal conditions improve. The improvement corresponds with a 7.3% increase in consumption tax. When we add up the contribution of the four policy reforms, the result does not coincide with the difference between scenarios (a) and (b). This is because the policies have mixed effects.

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As Table 5 shows, two long-run policies—the extension of retirement age and population policy—improve the government's fiscal condition. The former contributes to increased tax revenue through increased labor input and a decrease in the amount of pension expenditure through a decline in retired generations. This contribution corresponds to a consumption tax of more than 7% throughout periods. The latter improves the long-run fiscal status in Japan because of a decreasing dependency ratio. Consequently, the share of households that receive pension and medical care payments decreases. The contribution corresponds to a consumption tax of over 10% after 2060.

To clarify the mechanisms of the two policies for fiscal conditions, components of government expenditure against GDP are depicted in Table 6. The values in the third and sixth columns are the ratios under scenarios (a) and (b) in the year 2090. The policy reforms cause the ratio of pension expenditure against GDP to decrease from 20.9% to 8.7% and the share of total expenditure to drop by 15.6%. The key variable is the dependency ratio. While the ratio is 37.5% in scenario (a), it is more than 90% in scenario (b). Drastic changes in the population structure directly improve fiscal conditions throughout compression of pension expenditure-GDP ratio. The contribution of the two policies is summarized in the fourth and fifth columns.[7] For instance, the contribution of population policy to pension expenditure ratio is 9.1%. If the population target is accomplished as the government desires, the pension expenditure-GDP ratio is estimated to decrease by 9.1% in the 2090s, compared with scenario (b). As part of the total decrease in government expenditure by the policy reforms, the contribution of population policy accounts for 73%. The substantial impact of population policy on government expenditure is a result of the policy's effect on the changing population distribution. Population policy decreases the dependency ratio by 34.5%. The contribution of population policy accounts for approximately 60% of the improvement in the dependency ratio. Identifying the necessary measures to address population aging is one of the most important policies for Japan's future.

Improvements in the LFPR and TFP have a lesser impact on fiscal conditions (fifth and sixth columns in Table 5) than those of retirement age extension and population policy. The contribution of LFPR is nearly zero during the 2010 decade because there is little improvement in LFPR during that period. After the 2020 decade, there are differences in the LFPR between scenarios (a) and (b) (Panel (ii) of Fig. 1). This impact corresponds with more than 1% consumption tax increase after 2050. The contribution of TFP is only 0.1–0.8% throughout the periods. Although the LFPR and TFP have positive impacts on fiscal conditions through the expansion of GDP growth, they also have negative impacts. They increase government expenditure and pension payments. First, the increase in GDP by TFP and the LFPR promotion expands government expenditure because we assume that government spending is computed as a share of GDP. Second, improvements in productivity and the LFPR raise the level of individual pensions because pensions are related to average labor income. Policies that do not affect population structure but expand the economy have little effect on fiscal conditions. In addition, TFP promotion leads to increased interest rates. A rise in the interest rate directly increases interest payments on government debt. Overall, the positive impacts of TFP growth are canceled out by the negative impacts of interest rates, government spending, and individual pensions. Therefore, the contribution of TFP is almost zero in the long-run. These negative impacts of productivity growth create clear differences between our results and those of the government projection.

4.5. Other settings

In this subsection, we conduct simulations with other settings to confirm the robustness of our results. We consider two other policy options for fiscal consolidation that are not considered in the main simulations. That is, we assume that the government aims to encourage fiscal consolidation by increasing the labor income tax ($\tau_{w,t}$) or decreasing the replacement rate of pension payments (ϕ_t). In these settings, the tax rate on consumption is raised by 3% in the year 2014 and to remain constant thereafter. The results of simulations are summarized in Table 7. The labor income tax rates

[7] The contribution of the other two factors is not listed in the table because it is nearly zero in 2090.

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Table 6
The components of government expenditure (%).

	2000s	2090s			
		Scenario (a)	Contribution		Scenario (b)
			Retirement age	Population	
Pension ex./GDP	8.8	8.7	5.6	9.1	20.9
Health ex./GDP	6.2	7.9	0.0	3.3	11.2
Total gov. ex./GDP	27.5	29.1	5.6	12.4	44.7
Dependency ratio	38.9	37.5	21.4	34.5	90.3

Note: (1) If we sum the contribution of the two policy reforms, the result does not coincide with the difference between scenarios (a) and (b). This is because the policies have mixed effects.

Table 7
Labor income tax rate and pension replacement rate to achieve the fiscal consolidation target (%).

	Scenario (a)	Scenario (b)
Labor income tax rate		
2000s	(26.1)	
2010s	32.6	37.8
2020s	33.2	38.9
2030s	35.4	41.4
2040s	37.3	45.0
2050s	38.9	47.6
2060s	38.1	49.2
2070s	34.3	49.0
2080s	30.5	48.2
2090s	29.2	48.5
Pension replacement rate		
2000s	(60.5)	
2010s	52.1	33.5
2020s	46.0	29.4
2030s	33.3	23.7
2040s	27.7	18.3
2050s	23.9	15.4
2060s	24.8	13.6
2070s	28.6	14.7
2080s	42.2	17.4
2090s	50.6	19.1

Notes:
(1) The values are average rates during decades.
(2) The average actual rates during the 2000s are in parentheses.

should be 32.6% and 33.2% for the 2010 and the 2020 decade in scenario (a). These rates are higher than the average rate in the 2010 decade. Additionally, the replacement rate during the 2010 decade should be lower than the replacement rate in the 2000s. The simulations confirm the robustness of the finding that it is difficult to achieve the fiscal consolidation targets using the growth strategy. The result does not depend on the policy options. After 2020, the two rates have the same tendency as the consumption tax. The replacement rate should be cut by less than half from the 2040 decade to the 2070 decade in scenario (a) because of further population aging. However, the replacement rate recovers gradually thereafter as population policy achieves results.

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5. Concluding remarks

This study examined the impacts of a new Abenomics growth strategy on Japan's fiscal reconstruction. We calculated the quantity required to redress the fiscal condition using a general equilibrium OLG model that considers multiple generations. The results show that for mid-term fiscal consolidation, it is necessary to change the tax or pension systems drastically. When the consolidation fund is entirely dependent on an increase in the consumption tax rate, to stop increasing the debt-to-GDP ratio after 2020, the rate is estimated to increase to more than 15% in the 2010 decade and more than 20% in the 2030 decade. These results imply that the government mid-term fiscal consolidation target is difficult to achieve, even when assuming that the growth strategy of Abenomics has the desired effect. In contrast, an extension in the retirement age and population maintenance have significant positive impacts on fiscal consolidation especially after the 2070 decade.

The assumptions imposed in the simulation are optimistic and may not be capable of being realized. The birth rate must increase significantly to maintain the population at 100 million people in 2060. The retirement age is assumed to be extended immediately in 2013. Further, the cost of policy reform is not considered in our simulation. It may be difficult to assume that promoting TFP can be attained without any cost. However, even when optimistic assumptions are imposed, the fiscal conditions from the 2020s to the 2060s in Japan cannot be considered optimistic. Moreover, although the results show that the combination of population policy and retirement age extension contributes to fiscal soundness in the long-run, to achieve it, it is important to tackle fundamental labor system reforms and drastic population policy reform.

Appendix A. Household equilibrium conditions

Households maximize their discounted sum of lifetime utility (3) subject to their budget constraints (4), given the parameters, sequences of factor prices $\{w_t, r_t\}$ and exogenous variables for all t. These conditions for workers ($1 \leqslant j \leqslant J_r$) yield the following:

$$\frac{1}{1+\tau_{c,t}}\frac{1}{c_{j,t}} = \beta\psi_{j,t}\frac{1}{1+\tau_{c,t+1}}\frac{1}{c_{j+1,t+1}}[1+(1-\tau_{r,t+1})r_{t+1}],$$

$$(1-\epsilon)\frac{1}{\bar{l}_{j,t}-l_{j,t}} = \epsilon\frac{1}{1+\tau_{c,t}}\frac{1}{c_{j,t}}(1-\tau_{w,t})w_t e_j,$$

$$(1+\tau_{c,t})c_{j,t} + a_{j+1,t+1} = [1+(1-\tau_{r,t})r_t]a_{j,t} + (1-\tau_{w,t})w_t e_j l_{j,t} + \xi_t,$$

and for retirees ($J_r + 1 \leqslant j \leqslant 85$),

$$\frac{1}{1+\tau_{c,t}}\frac{1}{c_{j,t}} = \beta\psi_{j,t}\frac{1}{1+\tau_{c,t+1}}\frac{1}{c_{j+1,t+1}}[1+(1-\tau_{r,t+1})r_{t+1}],$$

$$(1+\tau_{c,t})c_{j,t} + a_{j+1,t+1} = [1+(1-\tau_{r,t})r_t]a_{j,t} + b_{j,t} + \xi_t,$$

for any t. Combining them, difference equations are yielded for the transition of individual asset holdings. By imposing Eq. (5) and solving them, we obtain the lifetime asset profile of each individual. Taking the asset transition as given, and using the equilibrium conditions again, the profiles of consumption and labor input are derived.

Appendix B. Detrending

We can detrend the model by defining

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

where X_t is an 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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