Achieving Fiscal Balance in Japan*

Selahattin İmrohoroğlu[†], Sagiri Kitao[‡], and Tomoaki Yamada[§]

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Abstract

Japan's population is aging fast and the ratio of Japanese Government Bonds (JGBs) to GDP is highest among advanced economies. In addition, further government spending is expected, causing concerns about the potential for JGBs to become a significant global issue. In this paper we build a micro-data based, large-scale overlapping generations model for Japan in which individuals differ in age, gender, employment type, income, and asset holdings, and incorporate the Japanese pension rules in detail. We estimate age-consumption and age-earnings profiles from micro data, assume complete markets and use these to generate tax revenues and transfer payments for government accounts. We calibrate the model so that it replicates the main macroeconomic and fiscal indicators for 2010. Using existing pension law and fiscal parameters and the medium variants of fertility and survival probability projections, we produce future time paths for JGBs and the pension fund.

Keywords: Fiscal balance, Social security, Demographic trends
JEL Classification: H60, H55, J11

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† University of Southern California, Marshall School of Business, simrohor@marshall.usc.edu.

‡ Hunter College, City University of New York, sagiri.kitao@gmail.com.

§ Meiji University, tyamada@meiji.ac.jp.

1 Introduction

Japan has the highest debt to GDP ratio among advanced economies and faces a fast and large demographic transition to an older society. In addition, recent political developments suggest that the Japanese government may start a new round of government spending, renewing concerns over whether or not the Japanese sovereign debt may become a global problem. In the absence of a robust theory of government debt, it is difficult to evaluate statements regarding the massive quantity of the JGBs, their prices, and, if and when bond market participants will stop buying them. One can, however, develop a model to measure what will contribute to the magnitude of the JGBs and the underlying reasons and that is what we do in this paper.

We build a micro-data based, large-scale overlapping generations model for Japan in which individuals differ in age, gender, employment status, income, and asset holdings, and incorporate the Japanese pension rules in detail. We estimate age-consumption and age-earnings profiles from micro data, assume complete markets and use these to generate the paths of tax revenues and transfer payments for government accounts. We calibrate the model so that it produces the main macroeconomic and fiscal indicators for 2010. Using existing pension law and fiscal parameters and the medium variants of fertility and survival probability projections, we produce predicted time paths for the JGBs and the pension fund. In addition, we decompose annual net borrowing requirements that integrate to the JGBs into non-pension primary deficit, pension deficit, and net interest payments on JGBs net of the pension fund.

Our analysis highlights the following key quantitative findings.

1. Under current policies and absent any further reforms or changes, large pension and non-pension deficits will persist, with growing interest payments on government debt becoming a serious burden. The ratio of debt to GDP exceeds 210% in 2030 and 375% in 2050.

   (a) Pension and non-pension deficits contribute about the same, just about 4% of GDP each, to new borrowing requirements over the next few years, with net interest on debt playing a much smaller role, thanks to the low real interest rate on JGBs in the current economic environment.

   (b) With the consumption tax rate scheduled to rise from 5% to 10% in 2014-2015, there is a significant improvement in the non-pension deficit and then a gradual rise of the deficit over time as the ratios of non-pension transfers and government expenditures to GDP start to rise.

   (c) There is an initial, significant decline, and later, a smooth decline in the pension deficit due to the pension reforms under way. However, in about 25 years the pension deficit starts to rise again, eventually stabilizing at about 5% of GDP annually.

   (d) Net interest payments on JGBs eventually dominate net borrowing requirements despite the low 1% interest rate assumed in the baseline scenario; the stock of debt becomes just too large.

2. Among the outcomes and policies considered, three seem to have a large impact, although none of them by itself is able to restore fiscal balance.
   (a) Raising the retirement age to 70 and cutting benefits by 10% significantly reduces the pension deficit.
   (b) Raising the consumption tax to 20% produces a surplus in the non-pension balance.
   (c) Raising the female labor force participation rates to those of males and having the distribution of employment types converge to that of males impact the budget more significantly; both pension and non-pension deficits are reduced.

In addition to the policy simulations, we present a number of sensitivity analysis on variables that bring about changes in the deficit projections, including alternative assumptions on the productivity growth, the interest rate on the government debt and the returns on the asset held in the pension fund. We also note that outcomes and policies that are not considered in this paper, such as comprehensive tax reform, immigration and health insurance reform, may contribute to the solution of the fiscal problems and these are left for future research.

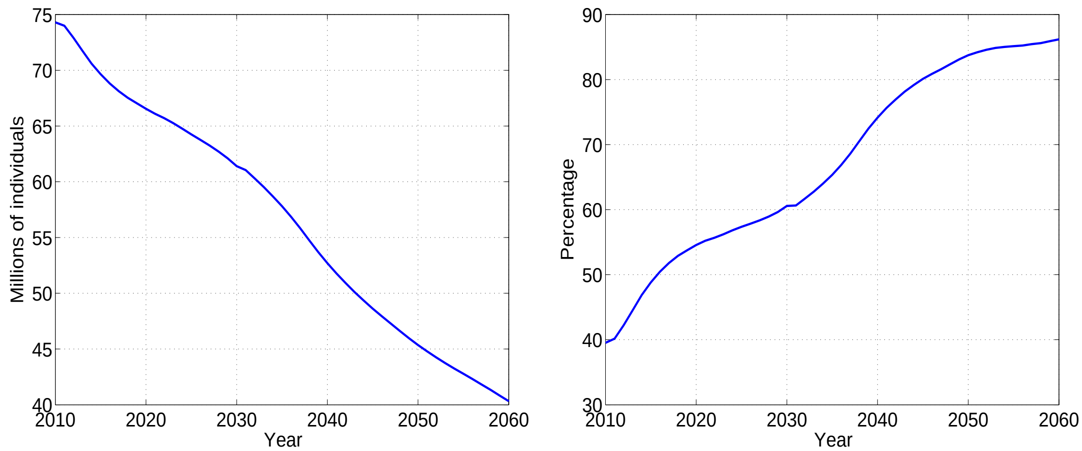
The remainder of the paper is organized as follows. We review the literature in section 2 and present the model in section 3. Details of the calibrated parameters are given in section 4. The benchmark results are discussed in 5 and section 6 conducts a sensitivity analysis. Policy experiments are presented in section 7 and section 8 concludes.

2 Overview of the literature

Our paper contributes to a growing literature that relies on workhorse macro models to shed light on the severity of fiscal adjustment Japan needs to make, the policy options that are available, and the economic consequences of these alternative policy actions. We use Japan as our economic laboratory because aging and fiscal imbalance are arguably most severe in Japan among advanced economies. Therefore, a careful quantitative analysis of the impact of outcomes and policies on the Japanese economy will allow us to discuss similar events for other advanced economies.

The backdrop for this effort can be described as follows. The Japanese economy has essentially been stagnant since 1990. The policy rate has been lowered to essentially zero for more than a decade. Several rounds of fiscal stimulus packages since early 1990s have resulted in the highest debt to GDP ratio in the developed world. According to the OECD, Japan's net debt to GDP is about 116% and its gross debt to GDP is above 200% by the end of 2010.

In addition, Japan has the fastest aging population among the developed economies. Therefore, Japan serves as a laboratory for i) how severe demographic and fiscal challenges are, and ii) how various government policies and changes in economic environment may affect fiscal sustainability. The expected aging of the population will raise pension payments as more and more retirees will receive old age pensions, raising the transfers to output ratio.



(a) Working age population

(b) Old-age dependency ratio

Figure 1: Projected Demographics: 2010-2060

Figure 1 shows the projected population in Japan at the working ages of 20 to 64 and the old-age dependency ratio defined as the ratio between the population above age 65 and 20-64.[1] With the increase in the fraction of 65 and older, the working age individuals will have to increasingly support the elderly through some combination of higher taxes, lower leisure, lower consumption, or lower future benefits for themselves, if current projections of future benefits to current cohorts are to be maintained.

Using a neoclassical growth model, İmrohoroğlu and Sudo (2010) examine the impact of a rise in the consumption tax rate from 5% to 15% on the primary deficit to GDP ratio. Despite a temporary improvement in the primary balance, their quantitative results indicate that a much larger fiscal adjustment is needed to achieve fiscal sustainability. İmrohoroğlu and Sudo (2011) explore whether faster productivity growth can increase the tax base sufficiently to reduce debt to GDP to manageable levels. They find that only a growth miracle, such as a 6% real growth rate over 10 years, could achieve a fiscal adjustment of the size that Japan is facing.

Braun and Joines (2011) build an overlapping generations model that incorporates the demographic transition and calculate economic projections for Japan. Their findings suggest that in the absence of any reform, the consumption tax rate will have to rise to about 37% in order to achieve fiscal sustainability.

Hoshi and Kashyap (2012) use a narrative to argue that zombie financing and very large spending programs have significantly contributed to the already large projected fiscal burden of the demographic transition. In addition to suggesting fiscal consolidation and major regulatory and microeconomic reforms, they also recommend opening up the Japanese economy. In particular, they suggest a stronger push to become a member of the Trans Pacific Partnership (TPP) and to take immigration seriously.

[1] Projections are based on the estimates of the survival rates and fertility rates by the National Institute of Population and Social Security Research. For details, see the following website: `http://www.ipss.go.jp/site-ad/index_english/esuikei/gh2401e.asp`

Hoshi and Ito (2012) use back-of-the-envelope calculations for sustainability. Emphasizing the seemingly unending appetite of Japanese private sector for JGBs in the face of extremely high prices for such bonds, they argue that there is an upper bound on the private sector's ability to finance further new borrowing by the government. They predict that under certain assumptions this threshold will be reached in around 2022 and the yields on JGBs will start to rise, even before 2022. This would then be followed by Greece-like events of fiscal austerity, financial instability and even inflation.

Japan's high government debt is the result of several fiscal stimulus packages. Doi et al. (2011) pursue sustainability of fiscal policy using three complementary approaches. Broda and Weinstein (2005) estimate that fiscal sustainability is achievable with small changes in the tax-to-GDP ratio. On the contrary to their findings, Doi et al. (2011) show that extremely high tax rate, additional 11% of GDP, is required to stabilize the debt to GDP ratio when they use more recent data. Other two approaches also show negative results on sustainability.

Hansen and İmrohoroğlu (2011) use a standard growth model, amended to include debt, to measure the size of the fiscal burden in the form of additional taxes required to meet these obligations that maintain current promised levels of per capita public pension and health services. The fiscal adjustment needed is about a 30 percentage point increase in taxes on either consumption or labor income. They find that the latter is far more distortionary than the former, leading to a significant loss in welfare, highlighting the need to contain public spending and explore policies to enlarge the tax base.

In this paper, we use a very rich, detailed overlapping generations structure to evaluate the severity of the demographic and fiscal challenges Japan is facing. Our approach is similar to Storesletten (2003), who uses a life-cycle model with complete markets to assess the impact of immigration policies in Sweden. We calculate projections of future government budget balances and debt, and conduct counterfactual 'accounting' exercises to assess the impact of possible fiscal responses to future shocks and how these policies change the fiscal sustainability in Japan.

We do not model individual decisions on consumption/saving and labor/leisure choices. As such, our model is not suitable to conduct a welfare analysis to study the effects of reforms or the demographic change. Instead, we incorporate significant details of the pension system in Japan, including the distinction of three different categories of pension programs, eligibility, non-linear functions of benefits and contributions/premium in each program. We estimate age-consumption and age-earnings profiles from micro data and use these to produce asset holdings in the model. In addition, we capture the unique and important heterogeneity among the labor force, male versus female, regular vs irregular employment, which have very important implications for the funding of the pension program. All of these important details are essential in understanding the current evaluation of the Japanese pension program, as well as its future projection.

Due to computational complexity, however, it is impossible to incorporate all of these in a model in which individuals are optimizing. We view our paper as a natural first step and develop a rich, detailed measurement device to identify which events or policies are more critical than the others. Then, as a second and critical step, we intend to develop an optimizing model with a manageable state space to conduct welfare analysis in future research.

3 Model

In this section, we start with a description of the government accounts that will allow us to compute implications of policies and several scenarios on the future path of Japanese government macroeconomic outcomes. Later in the section we will describe the economic environment and individual variables.

3.1 Government and fiscal policies

The government raises revenues through taxation and issuance of one-period real debt to finance public consumption transfers to individuals as well as debt repayment and interest payments on outstanding debt. The government also runs the public pension scheme and provides pension benefits to retirees.

Government budget: In each period the government finances its expenditures G_t, transfers to individuals TR_t, pension benefits to retirees P_t and the cost of debt servicing through taxation T_t, issuance of new debt B_{t+1}, and collection of pension premium PR_t. At the beginning of period t, besides the government debt B_t, it holds assets in the pension fund denoted as F_t, which can be used to pay for the pension benefits. Therefore the net debt of the government is $B_t - F_t$. The government budget constraint is given as follows.

$$B_{t+1} - F_{t+1} = (1 + r_{b,t})B_t - (1 + r_{f,t})F_t + G_t + TR_t + P_t - T_t - PR_t \tag{1}$$

Here $(1 + r_{b,t})B_t$ is the principal and interest payments on the stock of government debt. We assume that the government issues one-period, real bonds at interest rate $r_{b,t}$, and we abstract from money creation and the inflation. $r_{f,t}$ denotes the return on the pension fund.

Our objective is to calculate a time path for B_{t+1} between 2011 and 2100 under various assumptions on the economic environment, fiscal and monetary policies, demographics, labor force participation and employment type. As such, we must pay careful attention to how we compute the right hand side of equation (1). In other words, we would like to tie these to data and observed behavior as much as possible. We describe below how the aggregates in (1) are composed of individual variables. As we describe details in the following sections, $n_{i,j,e,t}$ denotes the number of individuals in the state vector of each individual $\{i, j, e\}$ at time t, which represents age i, gender j and employment type e.

$$\begin{aligned}
T_t &= \tau_{c,t} \sum_{i,j,e} c_{i,j,t} n_{i,j,e,t} + \tau_{a,t} r_{a,t} \sum_{i,j,e} a_{i,j,t} n_{i,j,e,t} + \tau_{l,t} \sum_{i,j,e} y_{i,j,e,t} n_{i,j,e,t} + \tau_{ls,t} \sum_{i,j,e} n_{i,j,e,t} \\
TR_t &= \sum_{i,j,e} tr_t n_{i,j,e,t} \\
G_t &= \sum_{i,j,e} g_t n_{i,j,e,t} \\
P_t &= \sum_{i,j,e} p_{i,j,e,t} n_{i,j,e,t} \\
PR_t &= \sum_{i,j,e} \tau_{p,t}(y_{i,j,e,t}) n_{i,j,e,t}
\end{aligned}$$

T_t represents taxes on four sources of revenues; consumption at proportional rate $\tau_{c,t}$, capital income at rate $\tau_{a,t}$, labor income at rate $\tau_{l,t}$ and a lump-sum tax of $\tau_{ls,t}$. tr_t represents exogenous non-pension transfer payments given to individuals. g_t denotes exogenous per-capita government purchases for individuals at time t. $p_{i,j,e,t}$ represents the pension benefit to each retiree. $\tau_{p,t}(y_{i,j,e,t})$ is the contribution to the public pension system by each working-age insured individual, which depends on earnings $y_{i,j,e,t}$ and employment type.

Pension benefit: Pension benefits in Japan follow a three-tiered structure; the basic pension (*Kiso Nenkin*), the employees' pension insurance (*Kosei Nenkin Hoken*) and an optional scheme.[2] The government runs the first two schemes jointly.[3] Individuals between the ages of 20 and 59 are eligible and required to participate in the basic pension and the benefit is a fixed amount if an individual has been insured throughout the period of eligibility. The benefits from the employees' pension insurance are based on career earnings of an individual. To approximate the system, we assume that the pension benefits $p_{i,j,e,t}$ consist of two parts, a lump-sum component, which represents the basic pension and a part that is proportional to average earnings of an individual, which approximates the employees' pension insurance. More details are provided in section 4.3.

The payment of the public pension benefits is financed by the combination of the premium paid by the insured, contribution from the general government budget and the pension fund. The law of motion for the pension fund is given as follows.

$$F_{t+1} = (1 + r_{f,t})F_t + PR_t + X_t - P_t \tag{2}$$

Here X_t denotes the contribution from the general government budget to the payment of pension benefits.

[2]Note that the terminology, the national pension (*Kokumin Nenkin*) is also used to represent the insurance premium payment to receive the basic pension benefit, or sometimes the basic pension itself. To avoid confusion, we will only use the basic pension (*Kiso Nenkin*), which constitutes the first tier of the public pension system and is applicable for the entire population.

[3]The third optional retirement plan is a semi-private plan, which is closer to a private saving plan and we will not explicitly model it.

The above computations rely on estimates of income by an age i individual of gender j, with a type e employment at time t and how this object is related to the consumption and asset holding of the same individual. Once we specify these objects, then our aggregation rules above will yield the model's implications on the future path of government assets B_{t+1}.

3.2 Demographics

Our model is populated by individuals that differ in age, gender and employment status. We denote the state vector of an individual at time t as $\{i, j, e\}$. i represents the age of an adult individual, $j \in \{m, f\}$ the gender (male or female) and e the employment status as discussed in section 3.3. The age of an individual including dependent children is denoted as $\widetilde{i}$, differently from the adult age i.

Individuals can live up to $\widetilde{I}$ years. Life-time is uncertain and agents of age $\widetilde{i}$ and gender j at time t face a conditional probability of $s_{\widetilde{i},j,t}$ to survive from age $\widetilde{i}$ at time t to age $\widetilde{i}+1$ at time $t+1$. The fertility rate (the number of children per woman in a year) of an age $\widetilde{i}$ female at time t is given as $\phi_{\widetilde{i},t}$.

Individuals become adult and enter the market economy at age I_A and begin economic activities, participating in the labor market and making consumption and saving decisions.

We denote by $\widetilde{n}_{\widetilde{i},j,t}$ the number of individuals of age $\widetilde{i}$ and gender j at time t and by $\widetilde{\mathbf{n}}_t$ the $2\widetilde{I} \times 1$ vector of age groups by gender.

The law of motion of the population between time t and $t+1$ is given by $\widetilde{\mathbf{n}}_{t+1} = \Gamma_t \widetilde{\mathbf{n}}_t$, where Γ_t is a time varying matrix of size $2\widetilde{I} \times 2\widetilde{I}$ composed by fertility rates and survival probabilities of individuals of both genders.

$$\widetilde{\mathbf{n}}_t' = \left[\widetilde{n}_{1,m,t}, \widetilde{n}_{2,m,t}, \cdots, \widetilde{n}_{\widetilde{I},m,t}, \widetilde{n}_{1,f,t}, \widetilde{n}_{2,f,t}, \cdots, \widetilde{n}_{\widetilde{I},f,t}\right],$$

$$\Gamma_t = \left[\begin{array}{ccccc|ccccc}
0 & 0 & \cdots & \cdots & 0 & 0.5\phi_{1,t} & 0.5\phi_{2,t} & 0.5\phi_{3,t} & \cdots & 0.5\phi_{\widetilde{I},t} \\
s_{1,m,t} & 0 & \cdots & \cdots & 0 & 0 & 0 & \cdots & \cdots & 0 \\
0 & s_{2,m,t} & \cdots & \cdots & 0 & 0 & 0 & \cdots & \cdots & 0 \\
\vdots & \cdots & \ddots & \ddots & \vdots & \vdots & \ddots & \ddots & \ddots & \vdots \\
0 & 0 & \cdots & s_{\widetilde{I}-1,m,t} & 0 & 0 & \cdots & \cdots & \cdots & 0 \\
\hline
0 & 0 & \cdots & \cdots & 0 & 0.5\phi_{1,t} & 0.5\phi_{2,t} & 0.5\phi_{3,t} & \cdots & 0.5\phi_{\widetilde{I},t} \\
0 & 0 & \cdots & \cdots & 0 & s_{1,f,t} & 0 & \cdots & \cdots & 0 \\
0 & 0 & \cdots & \cdots & 0 & 0 & s_{2,f,t} & \cdots & \cdots & 0 \\
\vdots & \ddots & \ddots & \ddots & \vdots & \vdots & \ddots & \ddots & \ddots & \vdots \\
0 & 0 & \cdots & \cdots & 0 & 0 & \cdots & \cdots & s_{\widetilde{I}-1,f,t} & 0
\end{array}\right],$$

In what follows, we define the adult age i, which starts at age I_A. The age of an individual $\widetilde{i} \geq I_A$ is $i \equiv \widetilde{i} - I_A + 1$.

3.3 Labor force participation and earnings

In each period an individual is employed at a regular job (R), a contingent job (C), self-employed (S) or not-working (U). The employment status is denoted as a state $e \in \{R, C, S, U\}$.[4] Earnings of type $\{i, j, e\}$ individuals at time t is $y_{i,j,e,t}$. Note that $y_{i,j,e,t} = 0$ for individuals that are not working.

In section 4, we will describe in detail how we estimate six age-earnings profiles of 3 types of workers of each gender using Japanese data. These profiles will form the basis of our calculation of individuals' consumption and asset profiles, in addition to calculating personal income tax revenues and pension premiums.

3.4 Consumption and asset profiles

In order to calculate revenues from consumption and capital income taxation, it is necessary to impute the path of consumption and wealth for each individual over time, given their income profiles.

We assume that an individual's age-consumption profile relative to the life-time wealth defined as the discounted sum of disposable incomes is time-invariant. We allow, however, the number of dependent children to affect the consumption allocations. The factor of adjustment by an additional dependent child will be time-invariant, but the total adjustment will vary as the fertility rates and the number of dependent children at each age evolve over time. We assume that the consumption of both male and female individuals of the same age will be adjusted by the same fraction to account for the consumption of dependent children.

Individuals are assumed to be dependent children for $I_A - 1$ periods. Each dependent is supported by a pair of male and female (parents) of the same age for their consumption. The consumption of an individual is adjusted according to the number of dependent children. Let $\tilde{d}_{t,\tilde{i},k}$ denote the number of dependents of age k that parents of age $\tilde{i}$ support at time t, which coincides with $\phi_{\tilde{i}-k+1,t-k+1}$.[5] The total number of children for a mother of age $\tilde{i}$ at time t is given as $d_{t,\tilde{i}} = \sum_{k=1}^{I_A-1} \tilde{d}_{t,\tilde{i},k}$.

We estimate the age-specific fraction of the discounted present value of income $\tilde{\lambda}_i$ consumed at each age i from the consumption data for individuals. The factor $\lambda_{i,t}$ takes into account the equivalence adjustment in consumption allocation for children implied by the path of fertility rates. $\lambda_{i,t} = \tilde{\lambda}_i(1 + d_{t,\tilde{i}}\nu)$ where ν represents adult consumption equivalence for dependent children.

[4]The first represents full-fledge employment (*seishain* or *seiki-koyou*) and the second is employment at a non-regular, temporary or dispatch job (*hi-seishain* or *hi-seiki-koyou*). Note that the latter is different from a part-time job in the U.S. It does not necessarily mean that an individual with a contingent job works less than full-time equivalent hours. It is employment under a different type of contract than in a regular job, where employment is guaranteed only a fixed period and often the salary is significantly lower, as discussed in section 4.2. The last employment status, not-working, includes both unemployment and not-in-the-labor force.

[5]In this computation, we abstract from the death of children given the very low mortality rates of an infant and children.

Individuals are assumed to own no wealth as they enter the economy and start economic activities. We assume that there are annuity markets to cover the event of early death and each individual is entitled to keep the share of the assets of the deceased in the same cohort and gender. For simplicity, we also assume that the consumption profile is determined based on the expected life-time income and that individuals of a given cohort are assumed to have access to a technology that insures them against employment risks.

Therefore, consumption of an individual of gender j that belongs to cohort $t+1$ (that is individual "born" at the first adult age $i = 1$ at time $t + 1$) is given as follows.

$$c_{i,j,t+i}(1+\tau_{c,t+i}) = \widehat{\lambda}_{i,t} \sum_{m=i_A}^{I} \frac{1}{\prod_{k=1}^{m}[1+r_{a,t+k}(1-\tau_{a,t+k})]} S_{m,j,t+m}$$
$$\sum_{e} \frac{n_{m,j,e,t+m}}{\sum_e n_{m,j,e,t+m}} \left[(1-\tau_{l,t+m})y_{m,j,e,t+m} - \tau_{p,t+m}(y_{m,j,e,t+m}) - \tau_{ls,t+m} + p_{m,j,e,t+m} + tr_{m,j,e,t+m}\right] \tag{3}$$

where $\widehat{\lambda}_{i,t} = \lambda_{i,t} S_{i,j,t+i} / \prod_{k=1}^{i}[1 + r_{a,t+k}(1 - \tau_{a,t+k})]$. $S_{i,j,t+i} \equiv \prod_{k=1}^{i} s_{k,j,t+k}$ is the unconditional survival probability of gender-j agent born at time $t+1$ until age i at time $t+i$. The summation on the right hand side of the equation represents the expected life-time net income discounted by the sequence of the interest rates and survival probabilities to reflect the access to the annuity markets. The age-specific profile of assets can be computed recursively given the life-cycle profile of income net of taxes and transfers and the path of consumption. They will be used to compute the tax base for capital income taxation.

$$c_{i,j,t+i}(1+\tau_{c,t+i}) + s_{i,j,t+i}a_{i+1,j,t+i+1} = (1-\tau_{l,t+i})y_{i,j,e,t+i} - \tau_{p,t+i}(y_{i,j,e,t+i}) - \tau_{ls,t+i}$$
$$+p_{i,j,t+i} + tr_{i,j,e,t+i} + [1 + r_{a,t+i}(1-\tau_{a,t+i})]a_{i,j,t+i}$$

4 Parametrization of the model

We calibrate parameters of the model to approximate the Japanese economy in 2010, which is the initial year to start simulation. The model period is one year. Table 1 summarizes the parametrization of the model.

Table 1: Parameters of the model

Parameter	Description	Values/source
Demographics		
$\{\phi_{\tilde{i},t}\}_{\tilde{i}=1}^{\tilde{I}}$	fertility rates	IPSS (2012)
$\{s_{\tilde{i},j,t}\}_{\tilde{i}=1}^{\tilde{I}}$	conditional survival probabilities	IPSS (2012)
$\tilde{I}$	maximum age	110 years old
I_A	adult age	20 years old
Labor market		
$\{y_{i,j,e,t}\}$	earnings	see text, Figure 5
Technology		
r_a	return on savings	3%
g^w	TFP and wage growth rate	1.5%
Government		
τ_l	labor income tax	10%
τ_c	consumption tax	5% (in 2010)
τ_a	capital income tax	35%
τ_p	pension contribution	see text
r_b	interest rate on government debt	1%
r_f	return on pension fund asset	2%
$i_{R,b}$,$i_{R,e}$	retirement age	see text

We now turn to a more detailed description of the sources of our estimates and data.

4.1 Demographics

Individuals enter the economy at the age of 20, and live to a maximum age of 110, i.e., $I_A = 21$ and $\tilde{I} = 111$. Conditional survival probabilities $s_{\tilde{i},j,t}$ and fertility rates $\phi_{\tilde{i},t}$ are based on the estimates and projections of the National Institute of Population and Social Security Research (IPSS) released in 2012. The IPSS provides the population projection for Japan between 2011 and 2060. As we focus on the transition dynamics from 2010 to 2100, we use the conditional survival probabilities and fertility rate in 2060 to assume the same rates from 2060 to 2100. The projections of fertility rates and survival probabilities consist of three variants of estimates; low, medium and high variants of each. We use the medium variants of both the fertility and survival probability rates as a benchmark and examine other projections in section 6. Figure 2 shows the three variants of the total fertility rate (TFR).[6] In 2010, the TFR is 1.39 and it is projected to remain at around 1.35 until 2060, which accelerates declining population. Figure 3 plots the life expectancy by gender under three scenarios. The life-expectancy is projected to rise by more than 4 years by 2060, which further increases the old-age dependency ratio.

[6]The population projection by the IPSS provides future fertility rates of women between 15 and 49.

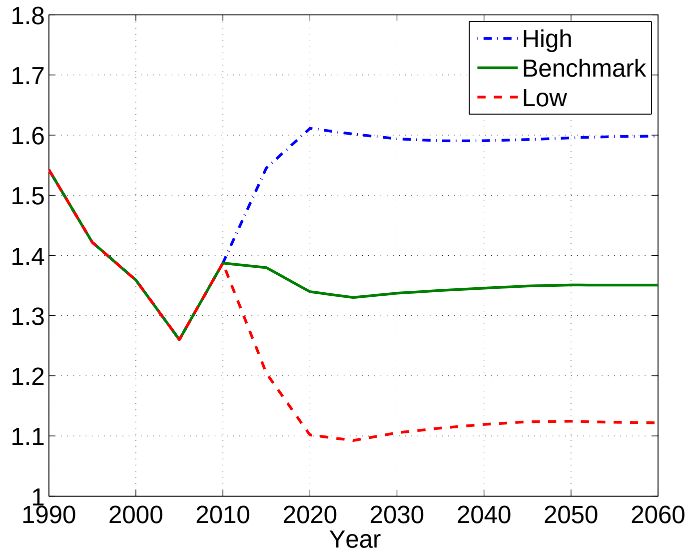
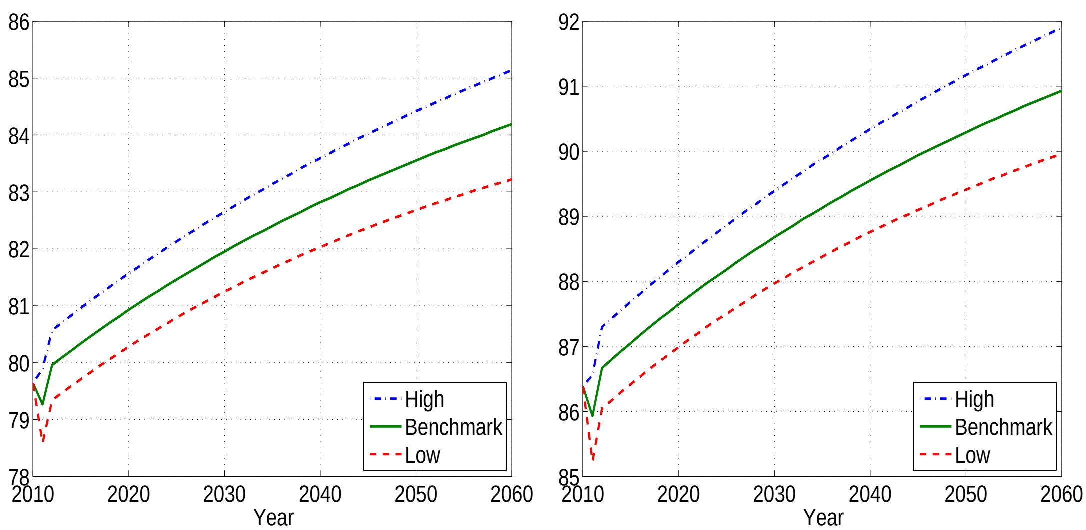


Figure 2: Total Fertility Rate



(a) Male

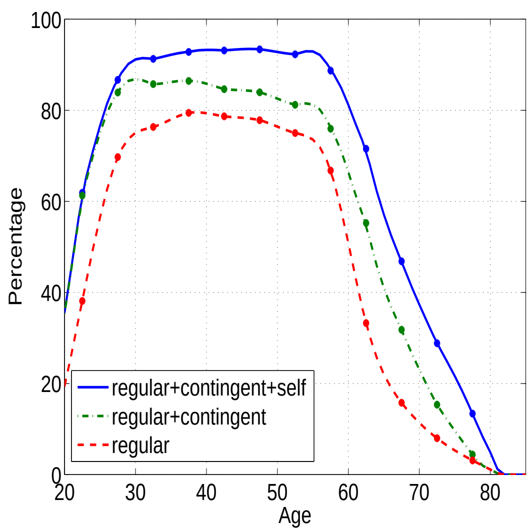
(b) Female

Figure 3: Life Expectancy

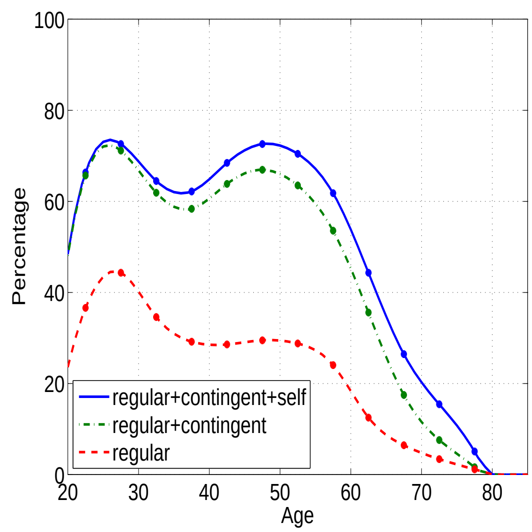
For the population distribution in 2010, we use the actual distribution by age and gender from Population Census by the Ministry of Internal Affairs and Communications. We compute the population dynamics starting from the initial population distribution and then using the age-specific fertility rates and conditional survival probability rates, which evolve over time. The number of dependents $\{\tilde{d}_{t,\tilde{i},k}\}$ is also calculated from the projected population distribution and fertility rates.

4.2 Labor market and earnings

We assume that there are three types of employment and compute the labor force participation rates of regular (R), contingent job (C) and self-employed (S) male and female workers from the Labor Force Survey in 2010 by the Ministry of Internal Affairs and Communications.[7] Not-working (U) is defined as the residual of the labor force participation rates of the three categories and includes individuals who are either unemployed or not in labor force. Figure 4 shows the cumulated labor force participation rate by the employment type and gender. Labor force participation rates of male workers are higher at most ages. The profile of female workers exhibits an M-shape due to withdrawals from the labor force at child-bearing ages in late 20s to around age 50.[8] We assume that some individuals continue to work beyond the retirement age when they start to collect pension benefits, consistently with the data as shown in the Figure 4. We also assume that the employment status distribution at each age is constant. We have chosen to distinguish among the three types of employment since as will be described later, public pension contribution and benefit depend on the employment status and there is a significant difference in average earnings among them.



(a) Male



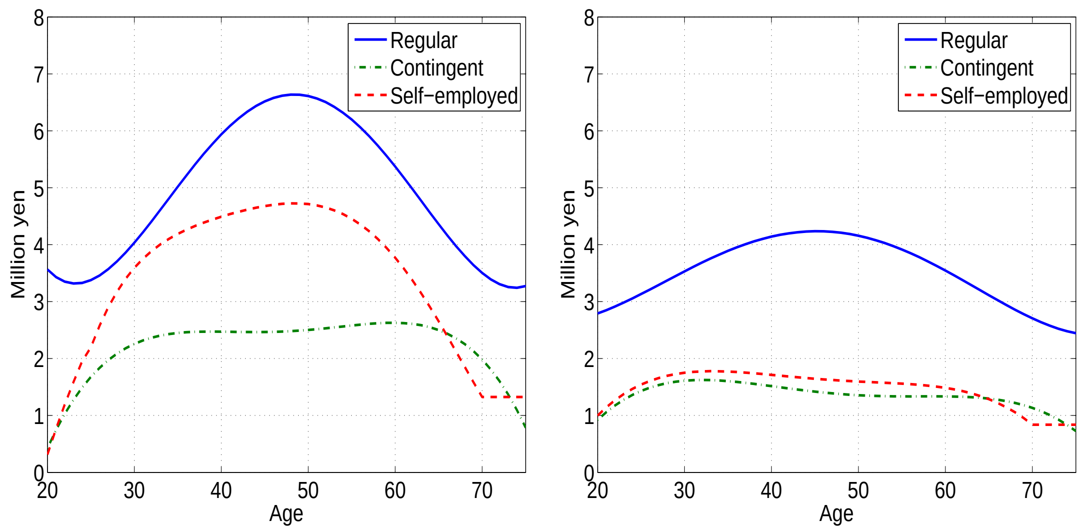
(b) Female

Figure 4: Labor Force Participation Rate

[7]We use the following categories for regular job worker, contingent job workers and self-employed workers respectively: Regular job workers consist of "regular employee (*seiki koyou*)" and "executive of company or corporation". Contingent job workers are defined as workers who are employed as "part-time worker, side-job worker (*arbeit*)", "dispatched worker from temporary labor agency", "contact employee or entrusted employee" or "other". Self-employed are "self-employed worker with/without employee", "doing piecework at home", or "family worker". Not-working is the sum of "unemployed person" and "not in labor force".

[8]Lise et al. (2013) document that the recent pattern for female labor participation rate in Japan looks similar to that the 1985 in the UK.

Earnings profiles of regular workers and contingent job workers are computed from the Basic Survey on Wage Structure (BSWS) in 2010, which is conducted by the Ministry of Health, Labour, and Welfare. The BSWS collects survey data from private establishments, which implies that it targets regular/non-regular employees, and self-employed workers are not covered in the survey. We use the National Survey of Family Income and Expenditure (NSFIE) in 2004 to compute the earnings profile of self-employed workers.[9] The NSFIE collects data on annual income of both household head and spouse. As we can identify gender, age and occupation of household head and spouse, we can calculate age-earnings profiles of self-employed workers for male and female separately.[10] We assume that the shape of the earnings profiles is invariant over time although the economy-wide wage growth shifts up the profiles. Figure 5 shows the age-earnings profiles of the three types of employment for each gender, smoothed with polynomial functions.



(a) Male (b) Female

Figure 5: Approximated Annual Earnings Profiles by Employment Types

4.3 Government

Public pension: The Japanese public pension system has three insurance categories of pension subscribers. The three categories are closely related to the employment types that we described in section 4.2. Category 1 subscribers of the pension scheme are

[9] The NSFIE aims to cover all Japanese households which includes not only self-employed workers but employees and retirees. Thanks to its large sample of over 50,000, we can calculate earnings of self-employed workers by age. Genda and Kambayashi (2002) investigate income of self-employed workers using the NSFIE. For details on the NSFIE, see Lise et al. (2013).

[10] We use the following categories of occupation as self-employed worker: "merchants and artisans", "private administrators", "households with income from agriculture, forestry and fishery", "professional services". Annual income is the sum of "wage and salaries", "income from agriculture, forestry and fishery", "income from business other than agriculture, forestry and fishery", and "homework".

students, farmers, self-employed individuals, some non-regular (*hiseiki koyou*) workers that are not offered employees' pension insurance, and all others not in categories 2 or 3. Category 2 insured are regular (*seiki koyou*) workers in establishments with more than 5 employees and category 3 consists of non-working spouses of category 2 workers, who essentially are housewives married to regular workers.

Individuals in each type of employment are assigned to the three categories of pension subscription and we do so to match the distribution across categories by gender as reported in the subscription survey conducted by the Ministry of Health, Labour and Welfare.[11] For male, we assume that all regular workers are category 2 subscribers and that all contingent job and self-employed workers as well as those not working are category 1 subscribers. For female, we assume that all regular workers are category 2 subscribers. Contingent job workers constitute the largest fraction of female workers above age 35. We allocate female contingent job workers of each 5-year age group to the three categories of pension subscription so that we match the age-category distribution as reported in the survey.[12] Self-employed workers belong to category 1. For non-employed individuals, we assume that about 40% belong to category 1 and 60% to category 3, except for younger age groups in 20s, when a larger fraction of non-working female are of category 1 than 3, accounting for a larger number of unmarried female in this age group.

As discussed in section 3.1, the two main pillars of the public pension schemes in Japan are the basic pension (*Kiso Nenkin*) and the employees' pension insurance (*Kosei Nenkin Hoken*). All citizens in Japan between age 20 and 59 are covered under the basic pension, which constitutes the first-tier of the public pension system. The employees' pension insurance is available only for category 2 workers (See Figure 6).[13] Although some companies provide optimal schemes such as private defined contribution pension plans as the third-tier, we do not consider them explicitly in the model.

The retirement age has differed by the pension programs and by gender. The normal retirement age for the basic pension has been 65. The eligibility age for the employees' pension insurance has been rising from 60 (male) and 56 (female) and will reach 65 for a cohort born in 1961 (male) and 1966 (female).[14] We will incorporate the transitional retirement ages by the program and gender in the model. We denote by $i_{R,b,t}$ the retirement age for the basic pension for individuals born at time t (cohort t) and by $i_{R,e,t}$ for

[11] http://www.mhlw.go.jp/toukei/list/141-1.html (in Japanese).

[12] We set the fraction of female contingent job workers that are category 1 subscribers falls from 62.5% at age 20-24 to 40% at 25-29, 22.5% at 30-34 and 20% at 35-54. The fraction of category 3 subscribers rises from 7.5% at 20-24 to 30% at 25-29, 47.5% at 30-34 and 50% at 35-54. The category 2 subscribers constitute 30% across all age groups.

[13] More concretely, the second-tier consists of the employees' pension insurance and mutual aid pension (*Kyosai Nenkin*). Public officer and teachers are included in the mutual aid pension, not the employees' pension insurance. However, as the insurance payments and benefits of these two are very similar, we combine both the employees' pension insurance and mutual aid pension and treat them as the employees' pension insurance in the second-tier.

[14] It is possible to apply for early payment of pension benefits starting at age 60 or delayed payment after the pensionable age. The benefits are adjusted to reflect the penalty and credit associated early and delayed withdrawal of benefits, respectively. The assumption of a common retirement age is mainly for simplicity but the majority of individuals start to collect benefits at the full retirement age of 65 (MHLW, 2011).

the employees' pension insurance. The retirement age has differed by gender and by the insurance programs. For cohorts born before 1934, the retirement age of the employees' insurance program was 60 for males and 56 for females and the basic pension's retirement age was 60 for both male and female, but all the retirement ages are set to rise gradually and they will all reach 65 for cohorts born after 1965.

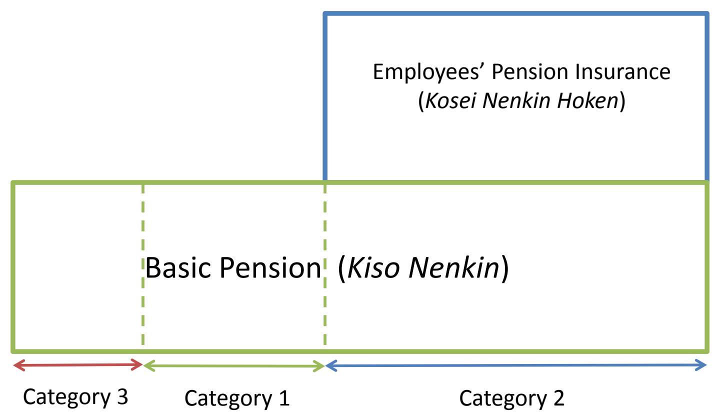


Figure 6: Public Pension System in Japan

We assume that all individuals between age 20 and 59 participate and contribute to the basic pension and start receiving benefits at age 65. The maximum annual benefit of the basic pension is 792,100 yen in 2010 for an individual who has contributed for the maximum of the 40 years. The benefit is reduced proportionally according to the number of months that the individual was not covered and did not contribute. Since not all individuals contribute for all years, the actual benefits can be lower than the maximum amount. The average annual basic pension benefit for recipients at the normal retirement age of 65 was 679,572 yen in 2010, which is the amount that we use as the amount of basic pension benefits in the simulations.

The second pillar of the Japanese pension system is the employees' pension insurance and the benefits are tied to premium contribution that is linked to earnings. Only category 2 insured persons can receive the earnings-related part of the public pension.

We approximate the pension benefits of a retiree using a formula given below.

$$p_{i,j,t} = (1 + x_{t,t-i}) \left[p^b_{i,j,t} + \xi_{t,t-i} \times \overline{y}_{i,j,t} \right], \tag{4}$$

where $p^b_{i,j,t}$ is the basic pension for a retiree of age i and gender j at time t, $\xi_{t,t-i}$ affects the replacement rate, and $\overline{y}_{i,j,t}$ denotes their average past earnings. Due to past pension reforms, $\xi_{t,t-i}$ depends on the individual's birth year $t - i$. We set $\xi_{t,t-i}$ to match the total amount of the second-tier payment with the data. $x_{t,t-i}$ is the macroeconomic slide factor that is explained below.

Contribution to the pension system $\tau_{p,t}(y_{i,j,e,t})$ depends on the three categories of insurance. Category 1 insured person pays a fixed amount to the basic pension system.

The monthly premium for the basic pension will rise from the current 14,940 yen by 280 yen every year to 16,900 yen in 2017. Thereafter, the premium stays at 16,900 yen. Category 2 insured persons, who are typically salaried workers, contribute a constant fraction of labor earnings between age 20 and 69. The tax rate on earnings for the employer pension is set to rise from the current 16.058% in 2010 by 0.354 percentage points every year to 18.3% in 2017. Thereafter, the rate stays at 18.3%. It includes both the first-tier and second-tier payments. Category 3 insured persons, who are dependent spouses of category 2 workers, contribute nothing, because the premium is considered as paid by her/his spouse.

Macroeconomic slide: Faced with demographic aging, the Japanese government has introduced an automatic adjustment scheme of pension benefit after the public pension reform in 2004, called the "macroeconomic slide", to attain the budget balance for the public pension system. The main idea is that the growth rate of public pension benefit keeps less than the sum of the aggregate real wage growth rate and inflation rate.

$x_{t,t-i}$ in equation (4) is the slide factor that represents the adjustment through the macroeconomic slide and it is determined as follows.

First, denote by s_t the "slide adjustment factor," which consists of two parts; one that reflects the change in the number of the insured and the second that is associated with a rise in life-expectancy (or expected duration of pension receipt). The slide adjustment rate is approximately estimated at 0.9% (0.6% and 0.3% for each factor) on average. In the official projection by the government, they assume the slide adjustment occurs from 2012 to 2038 for the basic pension and to 2019 for the employees' pension insurance.[15]

In the benchmark case, we assume inflation rate of 1% to work the macroeconomic slide although it may appear to be slightly higher than the realized inflation rates in recent years.[16] Denote the inflation rate as π_t and growth rate of real wage as g_t^w. The slide factor $x_{t,t-i}$ is given as

$$\begin{aligned} x_{t,t-i} &= (1+g_t^x)x_{t-1,t-i-1}, \\ g_t^x &= \begin{cases} \max\{g_t^* - s_t, 0\} & \text{if} \quad g_t^* \geq 0, \\ g_t^* & \text{if} \quad g_t^* < 0. \end{cases} \end{aligned} \tag{5}$$

For new recipients (*Shinki-saitei*), who have just become retired, g_t^* in (5) is defined as $g_t^* = g_t^w + \pi_t$. For existing recipients (*Ki-saitei*), $g_{t,t-i}^* = \pi_t$. Therefore, if the sum of the wage growth rate and the inflation rate is strictly larger than the slide adjustment rate, the actual replacement rate gradually declines as time goes by.

For example, if the inflation rate is 1.0% and the wage growth rate is 2.0%, the benefits of successive retiree cohorts would increase by 3.0% normally. With the macroeconomic

[15]The final year in which the macroeconomic slide stops is endogenously determined from the simulation, called the actuarial valuation for public pension system (*Zaisei Kensyo*), by the government. It is determined to satisfy the following two criteria; (1) The budget for public pension balances in about 100 years, when (2) The government can maintain the balance in the public pension fund, which amounts to one year benefit in 2105. Because the basic pension (Kiso Nenkin) fund does not have sufficient balance compared with the employees' pension insurance, the adjustment is expected to last longer for the basic pension.

[16]In fact, the macroeconomic slide does not work after introducing the scheme in 2004 due to deflation.

slide, however, if the slide adjustment factor s_t is 0.9%, the actual change will be only 2.1%. In the same year, the benefits of existing retirees will increase by $1.0 - 0.9 = 0.1\%$. Note that for given wage growth and inflation rates, the adjustment differs by cohort $t - i$, because the slide adjustment rate s_t varies over time.

Public pension fund and Japanese government debt: The pension fund F_t follows the dynamics described in equation (2). The initial asset F_{2010} at the beginning of 2010 is set at 178.3 trillion yen, the level of total assets in all public pension programs at the end of 2009.[17] We assume that the return on the pension fund $r_{f,t}$ is 2.0%, which is close to the average real return of the fund in the last decade.[18]

The government debt B_t evolves according to the formula (1). Initial debt B_{2010} at the beginning of 2010 is set at 678.6 trillion yen, or about 140% of the GDP, which corresponds to the total liabilities of central and local government net of financial assets at the end of 2009. More concretely, from the SNA table "Closing Stocks of Assets/Liabilities classified by the Sub-sectors of General Government", liabilities of central and local governments in 2009 were 991 trillion yen, or 207% of GDP. To calculate the net government debt, we subtract financial assets of 490 trillion yen and exclude the total assets of 178 trillion yen held in the public pension fund from the net liabilities, since we compute the path of the pension fund separately as F_t in the model.[19] We assume that the interest rate paid on the government debt $r_{b,t}$ is 1% in the baseline case and also run simulations with alternative assumptions of the interest rate.

Taxes: Consumption tax rate $\tau_{c,t}$ in 2010 is set at 5%. As already scheduled by the government, we let the consumption tax rate rise to 8% in 2014 and 10% in 2015. Based on Hayashi and Prescott (2002) and updated by Hansen and İmrohoroğlu (2011), we set the capital tax rate $\tau_{a,t}$ at 35%. Labor tax rate $\tau_{l,t}$ is set at 10% to match the tax revenue in the model with the data.[20] In addition to taxes on consumption, capital and labor income, we levy a lump-sum tax $\tau_{ls,t}$ on each individual to match the total tax revenues in 2010, 78.6 trillion yen.

Government purchases: We assume that per capita general government purchases of goods and services g_t is independent of age, gender and employment status, and grows with the TFP growth rate. Total general government net purchases, which consist of central government purchases, local government purchases and social security funds, in

[17]The pension fund includes *Kiso Nenkin*, *Kosei Nenkin Hoken*, and three types of mutual-aid pension (*Kyosai Nenkin*). For details, see `http://www.mhlw.go.jp/topics/nenkin/zaisei/04/` (in Japanese).

[18]More precisely the rate of return was 2.16% in 2002-2011 and it was 0.63% in 2006-2011 due to the global financial crisis. For details, see "*Nenkin tsumitatekin unyou houkokusho*" by the Ministry of Health, Labour and Welfare, 2011.

[19]The assets and liabilities include those of local and central government, as well as social security fund, except for the amount held in the public pension fund.

[20]Gunji and Miyazaki (2011) show that average *marginal* tax rates on labor incomes in Japan range from 14% to 21%. However the average tax rate, which is relevant in our model, is much lower than the marginal rates in general and also because a large number of workers pay less due to tax deduction and exemption. The total tax revenue from labor income is approximated by using the tax rate of 10%.

2010 are 77.6 trillion yen and we set g_{2010} in 2010 to match this amount. Per capita expenditures will grow at the growth rate of the TFP. The net government expenditure is the sum of "expenditures and payment", "other payment", and "asset expenses" after subtracting "net interest payment", "asset income" and "other receipt".

Transfers: The transfers tr_t are also assumed to be distributed in a lump-sum manner. Total transfers (excluding pension benefits) TR_t in 2010 is 18.2 trillion yen.[21] tr_{2010} is set to match the total transfer and it grows thereafter at the TFP growth rate. The transfers include, in addition to social security benefits in cash, unfunded employee social benefits and social assistance benefits.

Government budget balance during the transition: Under the current public pension system in Japan, the government transfers a part of tax revenues to public pension budget for the purpose of supporting the basic pension system, which is represented as X_t in equation (2). More precisely, 50% of the total benefit expenditures of the basic pension is supported by the transfer. Thus we set X_t at 1/2 of the basic pension expenditures in each year.

Once we have the premium PR_t, contribution from the general government budget X_t, and the payment of the public pension benefit P_t, the dynamics of the pension fund F_t is endogenously determined from equation (2). In the equation, the reserve funds F_{t+1} will adjust to absorb the gap between the contribution and the benefit as long as the value is non-negative. When the fund runs out and reaches the floor of zero, the deficit will be financed by the general government budget through the change in X_t, which then rises above 1/2 of the basic pension benefits.

With the values of tax revenues T_t, government purchases G_t, transfers to individuals TR_t and reserve fund F_t and F_{t+1}, we can compute the path of the Japanese government bond B_t in the future using equation (1).

4.4 Technology

We assume that the interest rate on individuals' saving is 3% on an annual basis, which is the average of the return on the government bond of 1% and the return on private capital of 4%, using the weight of the size of the total capital and the outstanding government bond.[22]

We assume a wage growth rate of 1.5%, based on the historical average of the total factor productivity growth rate.[23] We assume that both the interest rate and the wage growth rate are constant over the simulation period between 2010 and 2100. In section 6 we run sensitivity analysis on both rates and study how they affect the path of key macroeconomic variables.

[21] Adding the pension benefits P_t of 49.0 trillion yen, the transfer is 67.2 trillion yen.

[22] Sakuragawa and Hosono (2010) discuss fiscal sustainability of Japan from the relationship between the interest rate and GDP growth rate.

[23] We assume the Cobb-Douglas production function $Y_t = K_t^{\alpha}(A_t L_t)^{1-\alpha}$ with the capital ratio α is set at 0.38. The TFP growth rate is 2.3% in 1981-2011 and 1.2% in 2000-2011.

4.5 Consumption profiles

We assume that the market is complete and an individual's consumption at age i is determined by equation (3), where the present discounted value of net income is allocated for consumption at each age using the weight parameter λ_i, following a similar method used in Attanasio et al. (2006, 2007) and Storesletten (2003). We match the individuals' consumption profile in the model with the empirical one, which is a hump-shaped profile as shown in Figure 7.

Generally the consumption differs across cohorts and it may be affected by business cycles. We remove such cohort and year effects following the approach by Aguiar and Hurst (2013). We use the Family Income and Expenditure Survey (FIES) by the Ministry of Internal Affairs and Communications, which is a monthly diary survey with information on earnings, income and expenditures of Japanese households. See appendix A for more details of the database and estimation procedures.

Following Aguiar and Hurst (2013), we run the following regression:

$$\ln C_{it} = \beta_0 + \beta_{\text{age}} D^{\text{age}}_{it} + \beta_c D^{\text{cohort}}_{it} + \beta_t D^{\text{time}} + \beta_{\text{fam}} \mathbf{X}_{it} + \epsilon_{it},$$

where we impose $\sum_{t=1981}^{2008} \beta_t = 0$ and $\sum_{t=1981}^{2008} t\beta_t = 0$. $\mathbf{X}_{it}$ represents a vector of household characteristics such as a gender dummy, a marital status dummy, the number of adults, and the number of children in each household. A vector of age dummies D^{age}_{it} represents adult-equivalent consumption profile over life cycle.

After deriving the adult consumption profile $\widetilde{\lambda}_i$, using the number of children at each age $d_{t,\widetilde{i}}$ implied by the current fertility rates and adult consumption equivalence of dependent children ν, we obtain the age-profile of individuals in the model λ_i. Figure 7 shows both the coefficients on age dummies D^{age}_{it} and the smoothed profile of adult consumption over the life-cycle that we use in the model.

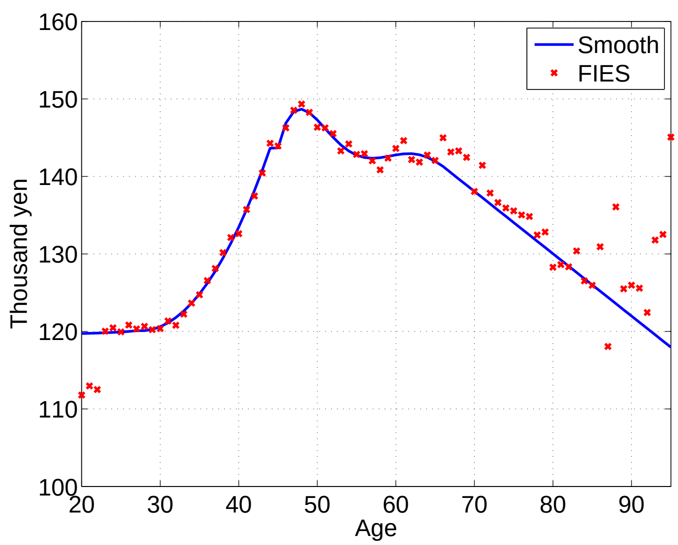


Figure 7: Approximated Consumption Profile

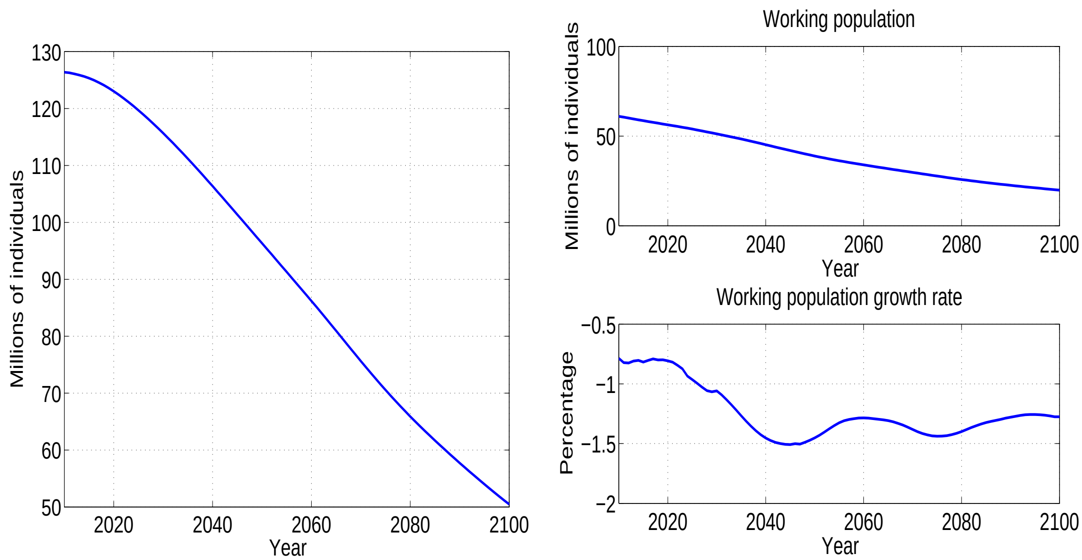
5 Numerical results

In this section, we present forecasts for future paths of net government bonds and the pension fund, $\{B_t, F_t\}_{t=2010}^{2100}$, and other endogenous macroeconomic indicators that are implied by our own model, given exogenous demographics, government expenditures, and estimated consumption behavior in Japan. We would like to emphasize that our analysis is an accounting exercise based on the assumptions of partial equilibrium and the complete market, taking the consumption allocation and individual labor supply behavior over the life-cycle as exogenous and estimated from micro data. We make this choice in order to gain on the side of individual heterogeneity, complexity in numerous dimensions as discussed in previous sections, and realism in how we represent the details of the Japanese economic agents and current rules as applied to the public pension system.

Therefore, the main thrust for our modeling strategy is to develop a large and realistic measuring device to quantify which aspects of the macroeconomy are important in helping Japan achieve fiscal balance.

After we complete this accounting exercise, we plan to dial back the size of the state space and allow individuals to endogenously make their consumption-saving and labor supply decisions. Only in this general equilibrium framework can we identify which government economic policies can induce the private sector to behave in a way that helps Japan achieve fiscal balance in the future. This exercise is left for our future research.

Benchmark transition In our model, the projected demographic transition and future policy actions drive the dynamics of the labor force, fiscal variables and macroeconomic indicators. The time paths of total population and working population in our baseline case are shown in Figure 8.



(a) Total Population (b) Working Population

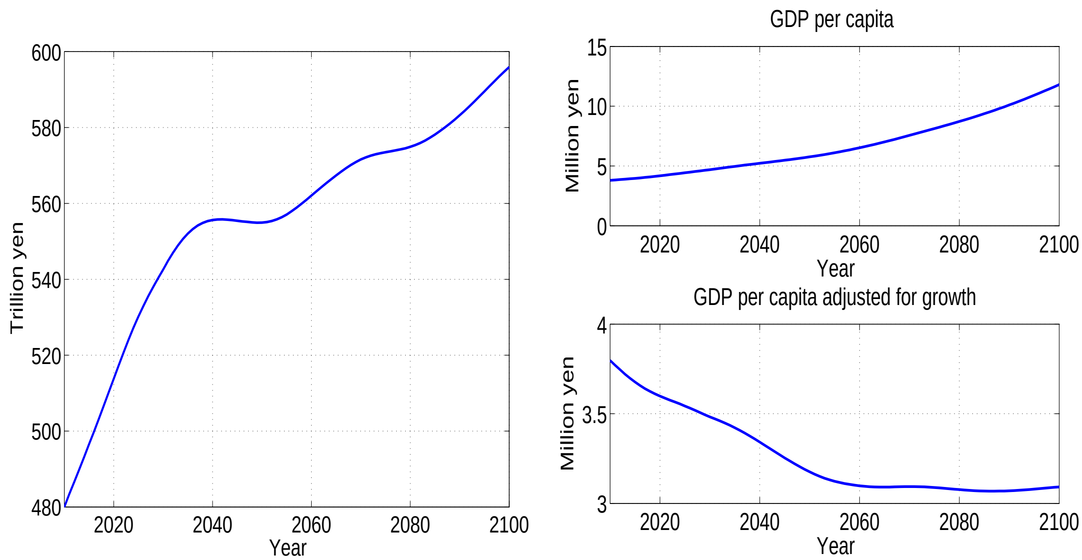
Figure 8: Projected Demographics: 2010-2100

For most of the years between 2010 and 2100, the rate of decline in the working population is higher than 1% but less than 1.5%. The rate of decline of the population (not displayed) is smoother and less than that for the working population mainly due to the rise in longevity.

We mention the population dynamics because the behavior of GDP and GDP per capita are driven by demographics in our model. More concretely, we assume that the GDP grows by the following equation:

$$GDP_{t+1} = (1 + g_t^w)(1 + g_t^n)GDP_t,$$

where g_t^n is the working population growth rate and the initial GDP in 2010, GDP_{2010}, is set at 480 trillion yen. We abstract from inflation everywhere in the model except where we assume the inflation rate of 1% in computing the macroeconomic slide of the public pension and adjusting the benefits in real values. All the yen values presented are in terms of 2010 yen.



(a) GDP

(b) GDP Per Capita

Figure 9: Projected GDP and GDP Per Capita (in 2010 yen) : 2010-2100

GDP per worker grows at 1.5% annually, consistent with our 'balanced growth' assumption of $g_t^w = 1.5\%$ growth in the average real wage. Total GDP, on the other hand, is the product of GDP per worker and total working population whose growth rate is negative and changes over time and makes the growth rate of GDP always positive but lower than 1.5% per year. Figure 9 shows the path of GDP and GDP per capita. Since the growth rate of the population is higher (less negative) than that of the working population, GDP per capita grows at less than 1.5%. If we eliminate the effect of the TFP growth, GDP per capita will decline sharply as shown in the bottom right panel of the figure due to the decline in the size of the labor force.

We now display our model's forecasts of debt to GDP ratio. Figure 10 below depicts the net debt to GDP ratio, using two alternative definitions of debt. The first frame defines net debt as publicly held net debt net of the pension fund. This construct is directly comparable to the publicly held net debt in United States and other OECD countries. The second frame ignores the pension fund and may be the more familiar definition.

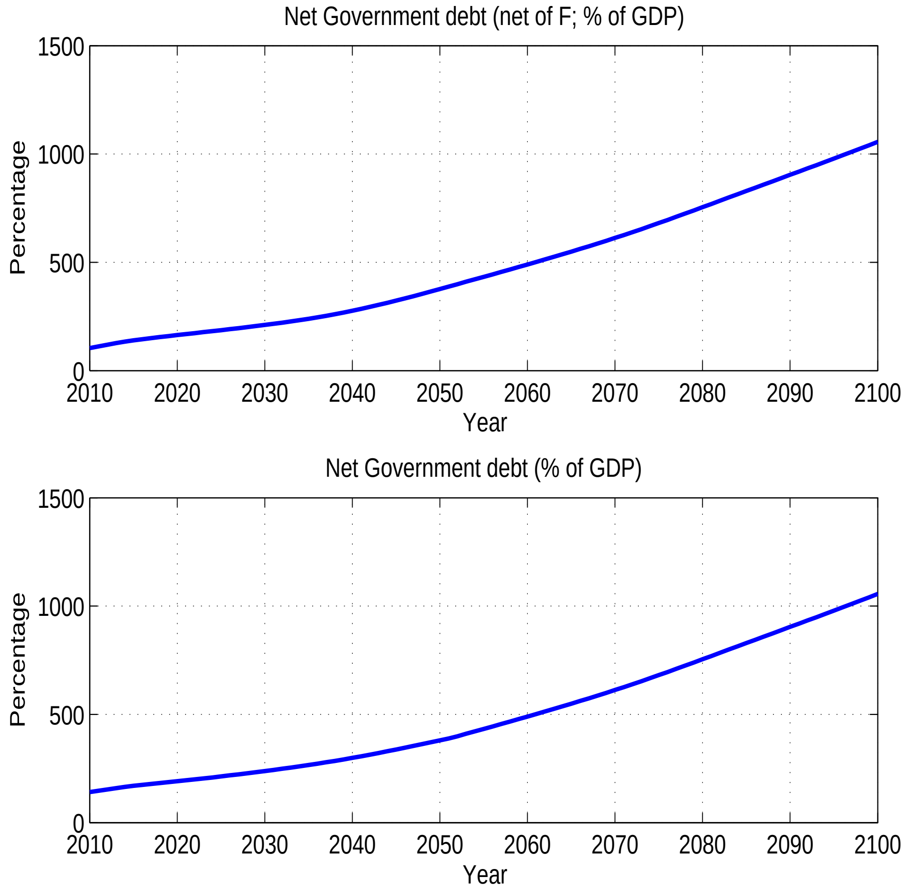


Figure 10: Net Government Debt to GDP Ratio

According to Figure 10, the ratio of net debt to GDP, $(B_t - F_t)/Y_t$, will reach 164% in 2020, 211% in 2030, 276% in 2040, 377% in 2050, and, 490% in 2060 when demographic projections end.

As the second frame of Figure 10 shows, when the assets held in the pension fund is excluded, the debt to GDP ratio is just under 191% in 2020; it is almost 300% in 2040, reaching 490% in 2060.

It is difficult to evaluate these numbers in the absence of a theory of debt that would have provided some insight. However, such theory does not exist yet, and we can only compare these enormous debt levels to recent experiences of debt-ridden economies. When international bond markets started to aggressively unload Greek bonds, their debt to GDP ratio was around 150%. The ratio rose further afterwards even though there were substantial haircuts and outright default.

Of course, Japan is very different from Greece; it is a very large advanced economy. Most of the Japanese debt is held by Japanese individuals and institutions (more than 92%) and they seem to continue to demand Japanese Government Bonds despite very low yields. Our model, like others in the literature, is silent on what a dangerous threshold is for the debt to GDP ratio. Our simulations indicate that the ratio can go near 300% in early 2040s if there is no change in current policy and demographic projections. Below, we will examine the main contributors to the explosion in the debt to GDP ratio.

Consider net new borrowing (as a ratio to GDP) given by

$$\frac{(B_{t+1}-F_{t+1})-(B_t-F_t)}{Y_t}=\frac{(G_t+TR_t-T_t)}{Y_t}+\frac{(P_t-PR_t)}{Y_t}+\frac{(r_{b,t}B_t-r_{f,t}F_t)}{Y_t}.$$

Above, we express net borrowing requirement (as a percentage of GDP) as coming from three distinct sources: (1) government purchases and transfer payments other than pensions, (2) burden on the budget from the pension deficit and (3) net interest paid on net government bonds (net of the pension fund returns).

Figure 11 shows this first decomposition of net borrowing.

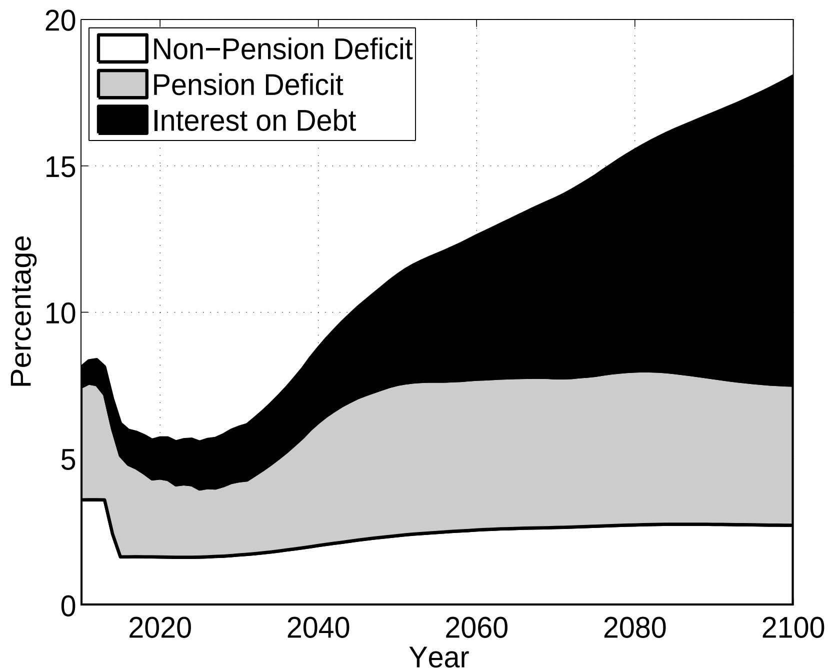


Figure 11: Sources of Net Borrowing (% of GDP)

From Figure 11, we can highlight several key findings:

- Pension and non-pension deficits contribute about the same, about 4% of GDP each, to new borrowing requirements over the next few years, with net interest on debt playing a much smaller role, thanks to the low real interest rate on JGBs in the current economic environment.

- With the consumption tax rate expected to rise from 5% to 10% in 2014-2015, there is a significant improvement in the non-pension deficit and then a gradual rise over time as non-pension transfers and health expenditures relative to GDP start to rise.

- There is an initial, significant decline, and later, a smooth decline in the pension deficit due to the reduction in replacement rates through the macroeconomic slide, the ongoing increase in the retirement age and a rise in the pension premium. However, in about 25 years the pension deficit starts to rise again, eventually stabilizing at about 5% of GDP annually.

- Net interest payments on JGBs eventually dominate net borrowing requirements despite the low 1% interest rate; the stock of debt is just too large and has to keep on rising to finance the increasing interest payment.

The government uses general tax revenues to finance 50% of the total basic pension benefits. Below, we will provide an accounting of the net borrowing requirement with this alternative classification of government accounts.

$$\frac{(B_{t+1} - B_t)}{Y_t} = \frac{(G_t + TR_t + X_t - T_t)}{Y_t} + \frac{(P_t - PR_t - X_t)}{Y_t} + \frac{(r_{b,t}B_t - r_{f,t}F_t)}{Y_t}.$$

Figure 12 shows this decomposition of net borrowing.

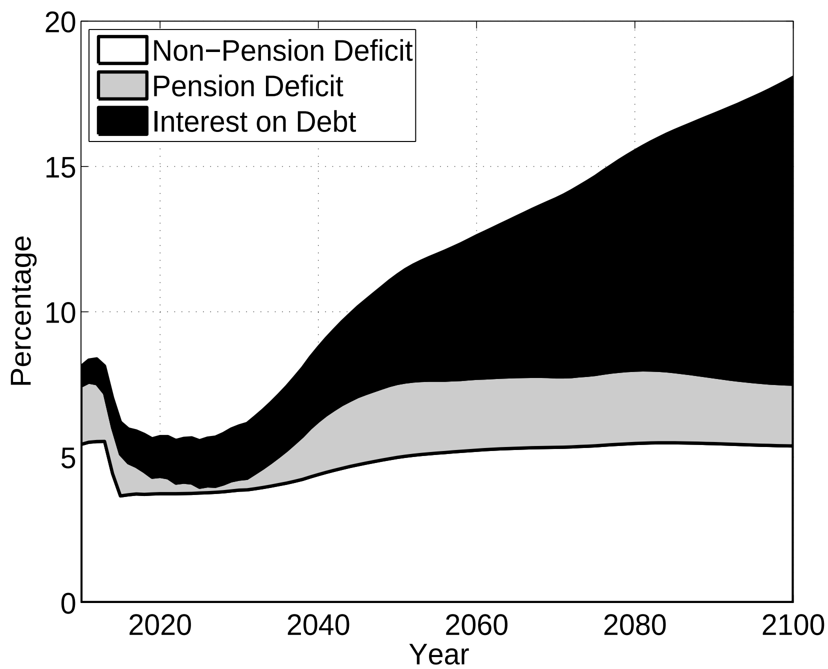


Figure 12: Sources of Net Borrowing (% of GDP)

Note that the above decomposition simply shifts the burden of pension payments onto the non-pension side of the government primary deficit. In other words, Figure 12 portrays a rosy picture of public pensions and a more depressing picture of non-pension budgetary items.

Now that we have presented some basic accounting, we can now dig deeper into the components and explore the factors behind the rise in the debt to GDP ratio.

Figure 13 shows the time path of major government accounts all expressed as a ratio to GDP: (i) purchases of goods and services, (ii) non-pension transfer payments, (iii) total pension payments, (iv) government's 50% contribution toward basic pension payments, (v) tax revenues and (vi) total pension premiums.

In the first frame of Figure 13, we observe a nearly 4 percentage point increase in the ratio of government purchases to GDP. The reason for this increase is our assumption that GDP rises at the TFP growth rate of 1.5% plus the growth rate of working population, which is lower than the growth rate of total government expenditures, which is 1.5% plus the growth rate of the entire population. Once population dynamics stabilize around 2060, this ratio also stabilizes. However, until then, government purchases imposes an increasing burden on government finances. Any reform that would reduce the projected growth of government purchases, for example in public health expenditures, would reduce the fiscal pressures to raise taxes and slow down the growing need to borrow from the public.

The second frame of Figure 13 shows the ratio of (non-pension) transfer payments to GDP. Once again, GDP rises more slowly than non-pension transfers, and the additional burden introduced by this increase is about an annual 1% of GDP in terms of new borrowing.

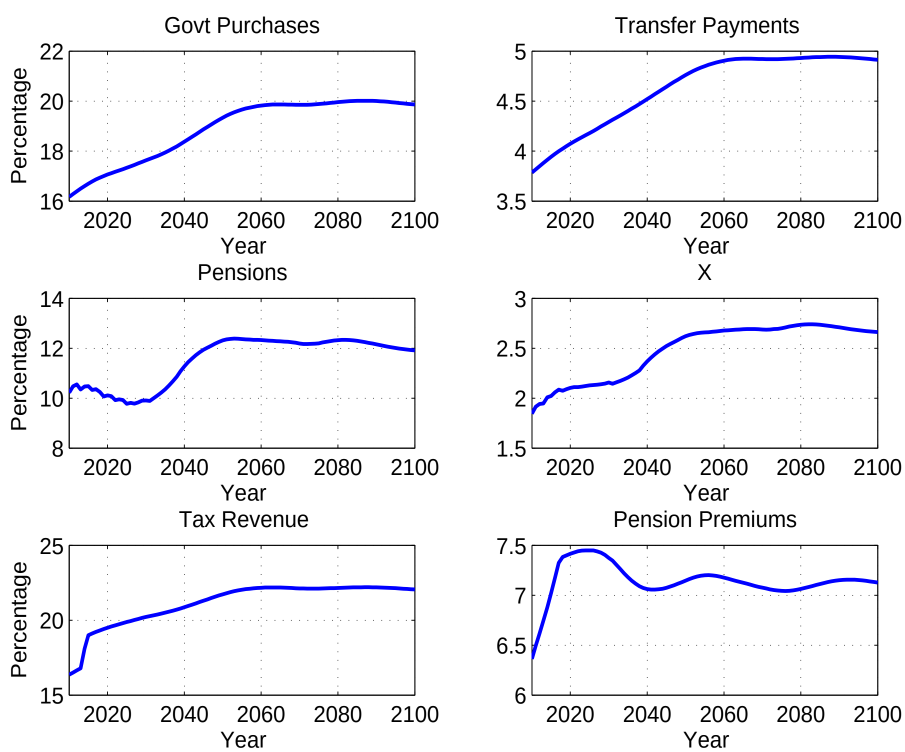


Figure 13: Decomposition of Government Accounts (% of GDP)

Pension payments, on the other hand, create a significant burden on the budget despite the macroeconomic slide. In the third frame of Figure 13, the ratio of total pensions to GDP falls by about 0.7 percentage point due to the macroeconomic slide, but once the macroeconomic slide ends, it rises quickly to reach above 12% of GDP in mid 2040s. Clearly, pension reform would have to be a part of any fiscal policy package that deals with bringing about fiscal sustainability. A related figure is depicted in the fourth frame as the payment out of general tax revenues made by the government. This payment amounts to half of total basic pension payments. Despite the macroeconomic slide, the Japanese government has to use a significant fraction of resources to finance total pension payments, over and above what the pension premiums can finance.

How are the tax revenues projected to deal with these large expected government expenditures? In the fifth frame of Figure 13, the ratio of tax revenues (excluding pension premiums) to GDP is projected to rise significantly due to the expected rise in the consumption tax in 2014-2015. After then, tax revenues (that include capital income tax revenues and lump sum taxes that represent import taxes and duties) are assumed to rise at the same rate as the tax base of consumption, labor and capital income, while GDP rises more slowly as the size of working population shrinks quickly. Once again, as demographic transition converges by 2060, so does this ratio.

Finally, the sixth frame in Figure 13 displays the ratio of total pension premiums collected to GDP. As the contribution rate for employees' pension insurance is scheduled to rise from 16.058% in 2010 by 0.354% every year to 18.3% in 2017 and the lump-sum premium for the basic pension rises, this ratio reaches a peak of nearly 7.5% of GDP, and eventually settles around 7% of GDP.

Figure 13 suggests that taking a closer look at reforms in the government expenditures could yield significant relief to the projected budget deficits. As total GDP grows at a rate less than the growth of real wages and productivity ($g_t^w = 1.5\%$), due to the decline in the size of working population, government purchases will become a larger burden on the budget over time. Our model predicts an eventual 4% increase in the ratio of government purchases to GDP. If taxes are not raised to finance this increase, a new burden of about 4% would add to the government debt every year.

The detailed government accounts displayed in Figure 13 suggest that there are three avenues to achieve fiscal balance: (i) G_t must be contained and the near-4% of GDP increase prevented, (ii) T_t must be raised further, perhaps by enlarging the tax base and the number of taxpayers, and (iii) the pension deficit must be reduced.

We now look more closely at the Japanese pension program. As the population ages, there are increasing numbers of retirees receiving pension. At the same time, the macroeconomic slide helps reduce the replacement rate of the pension benefits.

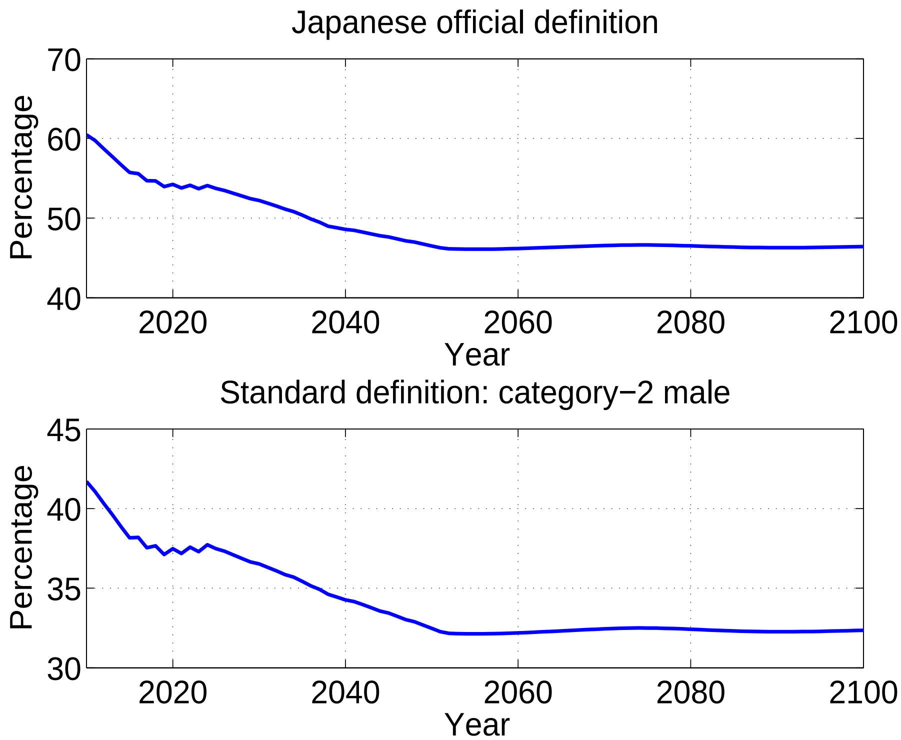


Figure 14: Pension Replacement Rate

Figure 14 shows the projected pension replacement rates using two definitions. The first frame shows the replacement according to the Japanese official definition. It is the total pension benefit for a "typical" household at the age of 65 that consists of a husband who is category 2 insured and a housewife who receives the basic pension only, expressed as a ratio to the cross-sectional average disposable earnings of category 2 insured male workers. With the macroeconomic slide in effect, the replacement rate falls from 60% to about 46%. Using a different definition, where the replacement rate is taken as the ratio of category 2 insured male to the cross sectional average earnings of category 2 male, we again see a significant reduction from above 42% to about 32%. Although there is a significant increase in the number of retirees after 2010, the macroeconomic slide reduces the average pension per retiree and therefore there is not much change in the ratio of total pensions to GDP as we saw in Figure 13.

The impact of these projections on the pension fund can be seen in Figure 15.

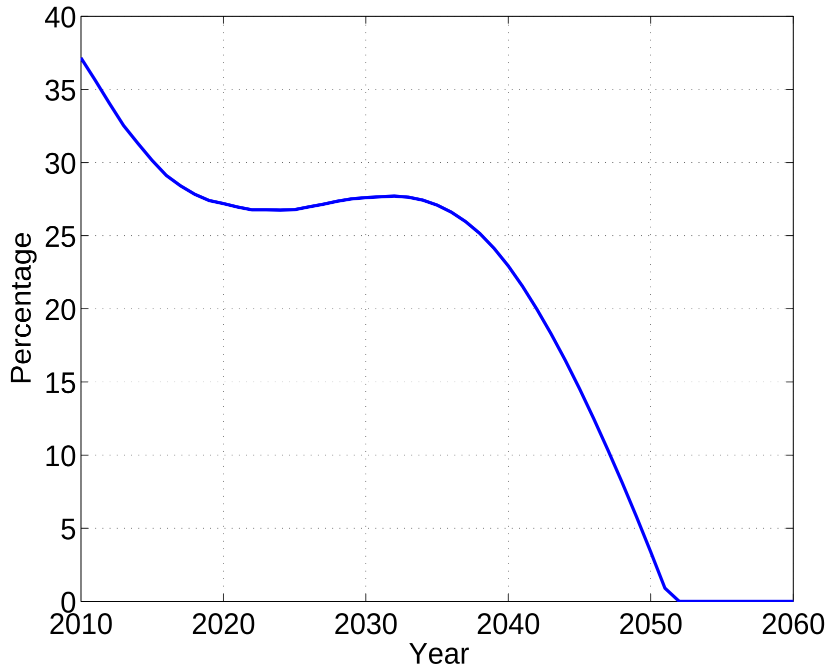


Figure 15: Pension Fund (% of GDP)

Since the pension balance is negative and significant at about 4% of GDP in 2011, the pension fund begins its steep decline fueled by the retirement of babyboomers in 2010s, from about 37% or GDP to about 27% of GDP. This occurs despite the ongoing macroeconomic slide that reduces the benefit paid to each retiree. Thereafter the pension deficit declines as higher premiums are collected and lower per capita benefits are distributed to pensioners. As a result, the pension deficit falls to 2.5% in 2020s. Since 50% of total pensions are paid for from general tax revenues, this reduction in the pension deficit gives a pause in the fall of the fund until mid 2030s. The pension deficit rises back to its older and higher levels and settles around 5% of GDP and this restarts the decumulation of the fund and an eventual exhaustion in early 2050s.

6 Sensitivity

No macroeconomic slide How important is the macroeconomic slide introduced in 2004 and amended since then? Figure 16 shows the pension fund under the counterfactual assumption that the pension rules follow pre-2004 arrangements and ignore the reforms of the macroeconomic slide.

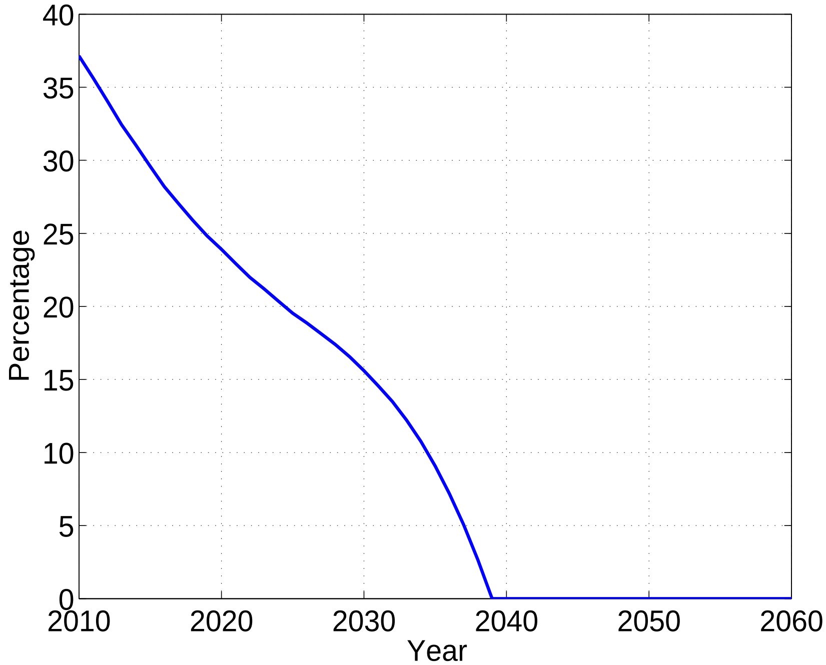


Figure 16: Pension Fund (% of GDP): without macroeconomic slide

Without any significant reductions in pension benefits or increases in premiums, the pension fund is very quickly depleted and disappears before 2040. This counterfactual simulation highlights the quantitative significance of the macroeconomic slide in containing the burden of pensions on the government budget.

If the macroeconomic slide were not implemented, Japan would experience additional increases in the debt to GDP ratio. By 2020, this would add 6.3% to the ratio of JGBs to GDP, but by 2030 it would amount to an extra 20.6% and by 2050 an extra 76.5%, including the added burden of higher interest payments due to a larger stock of debt. Clearly, the macroeconomic slide works to reduce the pension deficit and the overall fiscal burden during the transition period due to the retirement of an increasing number of individuals.

Productivity growth In our baseline simulation, we assume a real wage growth rate of 1.5%, in part to be consistent with official forecasting in calculating future pension benefits and premiums. Below, we present alternative results that assume growth rates of 0.5% and 2.5% instead.

Table 2: Effects of Different Wage Growth Rates on Fiscal Sustainability

	$\frac{(B_t - F_t)}{Y_t}$		
g_t^w	0.5%	Baseline (1.5%)	2.5%
2010	1.042	1.042	1.042
2020	1.879	1.641	1.427
2030	2.751	2.109	1.593
2040	4.007	2.762	1.863
2050	5.890	3.766	2.358
2060	8.181	4.898	2.880

In Table 2, a higher real wage growth of 2.5% allows for a longer period of time until debt to GDP ratio goes above 200% as tax revenues grow faster than the benchmark case. Still, the fiscal balance is not achieved with debt to GDP ratio at historically unprecedented highs.

On the other hand, slower growth, such as a 0.5% real wage growth, brings the fiscal day of reckoning much faster, and makes the case for fiscal reform urgent. The ratio of debt to GDP goes over 200% in soon after 2020. The growth rate of real GDP in Japan has been below 2.5% over the last two decades and this table suggests that unless a growth miracle occurs, policymakers should not count on significant increases in tax revenues coming from faster economic growth.

In order to see how growth affects the decomposition of the budget deficit into components, consider Table 3 below.

Table 3: Effects of Different Wage Growth Rates on Sources of Borrowing

g_t^w	0.5%	Baseline (1.5%)	2.5%
		$\frac{(G_t+TR_t-T_t)}{Y_t}$	
2010	0.0396	0.0359	0.0316
2020	0.0202	0.0164	0.0127
2030	0.0213	0.0171	0.0135
2040	0.0248	0.0203	0.0167
2050	0.0285	0.0237	0.0201
2060	0.0305	0.0256	0.0221
		$\frac{(P_t-PR_t)}{Y_t}$	
2010	0.0395	0.0386	0.0376
2020	0.0359	0.0270	0.0190
2030	0.0386	0.0253	0.0142
2040	0.0574	0.0421	0.0297
2050	0.0691	0.0517	0.0375
2060	0.0704	0.0515	0.0363
		$\frac{(r_{b,t}B_t-r_{f,t}F_t)}{Y_t}$	
2010	0.0067	0.0067	0.0067
2020	0.0162	0.0137	0.0115
2030	0.0256	0.0183	0.0126
2040	0.0398	0.0253	0.0150
2050	0.0589	0.0373	0.0208
2060	0.0818	0.0490	0.0272

Table 3 presents a detailed accounting of the reasons for the debt the GDP ratio to increase. In 2010, non-pension budget deficit contributes 44.2% of the net borrowing requirement, which amounts to 3.59% of GDP. Pension deficit creates a fiscal burden of a similar magnitude, 47.5% of the total for 2010, which is 3.86% of GDP. The burden of net interest on government's net debt is only 0.67% of GDP. The total net borrowing requirement in 2010 is 8.12% of GDP.

According to Table 3, slower real wage growth mostly affects the pension budget deficit. When the labor income tax base grows slower than in the benchmark simulation, total pension premiums and taxes collected decrease, creating a larger deficit and net borrowing requirement. The opposite is true with a higher real wage growth rate.

Slower or faster real wage growth has an indirect impact on the contribution of net interest payments on government debt to the net increase in debt. As the tax base grows slower than in the benchmark case, there is a larger debt arising from higher pension and non-pension deficits. In addition, the reduction in the pension fund reduces the return that the government makes on the fund. As a result, net interest paid on the government's net debt eventually becomes the largest component in net borrowing by

2050.

Table 4: Effects of Different Returns on the Pension Fund on Fiscal Sustainability

		$\frac{(B_t - F_t)}{Y_t}$	
$r_{f,t}$	1%	Baseline (2%)	3%
2010	1.042	1.042	1.042
2020	1.673	1.641	1.607
2030	2.169	2.109	2.034
2040	2.855	2.762	2.634
2050	3.885	3.766	3.576
2060	5.028	4.898	4.664

Returns on the pension fund Table 4 shows the net debt to GDP ratios for selected years different assumptions on the return to the pension fund assets. Clearly, this has a very small impact on the overall net debt as the ratio of the pension fund to GDP is relatively small, and projected to decline in the future.

Returns on the government debt However, if the interest rate on government debt is higher than the 1% assumed for the benchmark case, the resulting impact on fiscal balance can be disastrous. For example, if the real interest rate on government debt is 3%, then net debt to GDP ratio will exceed 200% in 2020, and 300% in 2030 as shown in Table 5.

Table 5: Effects of Different Returns on Government Debt on Fiscal Sustainability

			$\frac{(B_t - F_t)}{Y_t}$		
$r_{b,t}$	-1%	0%	Baseline (1%)	2%	3%
2010	1.042	1.042	1.042	1.042	1.042
2020	1.334	1.481	1.641	1.816	2.005
2030	1.451	1.751	2.109	2.535	3.041
2040	1.680	2.151	2.762	3.555	4.582
2050	2.144	2.819	3.766	5.098	6.977
2060	2.637	3.540	4.898	6.964	10.126

On the other hand, a lower real interest rate on government bonds significantly reduces the fiscal burden. For example, if the interest rate is zero, then the 200% debt to GDP threshold is postponed for another decade. In addition, if Japan experiences inflation, and in particular, inflation in excess of the nominal interest rate of government bonds, then the decline in the real value of the stock of government bonds helps contain the fiscal problem for several decades. In this case, more moderate reform in expenditures or small increases in tax revenues may bring about fiscal sustainability. However, this case assumes a negative 1% real interest rate on JGBs for nearly a century and it is difficult to expect that Japanese bondholders would not demand better terms to hold this asset voluntarily.

Different fertility projections There are three versions of the fertility projections produced by the National Institute of Population and Social Security Research (IPSS): low, medium, and high variants. Table 6 shows the net debt to GDP ratios for selected years for the three variants of fertility projections. Higher fertility raises the relative share of working cohorts in the population and tends to improve fiscal balance. However, whichever variant happens to be realized, there is very little difference on the fiscal position of Japan. This may come as a surprise at first glance. However, an improvement in tax revenues as the tax base increases is nearly completely offset by similar increases in per capita expenditures, both during working years and also in retirement. As a result, higher or lower fertility has only small impact on the net debt to GDP ratio, even in the long run.

Table 6: Effects of Different Fertility Projections on Fiscal Sustainability

	$\frac{(B_t - F_t)}{Y_t}$		
	Low Fertility	Baseline Fertility	High Fertility
2010	1.042	1.042	1.042
2020	1.638	1.641	1.644
2030	2.085	2.109	2.134
2040	2.729	2.762	2.800
2050	3.812	3.766	3.723
2060	5.144	4.898	4.680

Different survival projections Table 7 displays the net debt to GDP ratios for selected years for low, medium, and high survival rate projections made by the IPSS. Here, the impact on fiscal sustainability is even smaller. Longer lives raise the fiscal burden as the share of elderly in the society increases. However, the quantitative impact seems to be very small.

Table 7: Effects of Different Survival Projections on Fiscal Sustainability

$\frac{(B_t - F_t)}{Y_t}$

	Low Survival	Baseline Survival	High Survival
2010	1.042	1.042	1.042
2020	1.641	1.641	1.643
2030	2.096	2.109	2.113
2040	2.725	2.762	2.784
2050	3.690	3.766	3.820
2060	4.477	4.898	4.993

7 Experiments

Pension rules The population is aging very rapidly in Japan and this is putting significant pressure on the pension system. If the government undertook additional pension reform, how much would this impact the debt to GDP ratio in the future?

Table 8: Effects of Different Pension Rules on Fiscal Sustainability

$\frac{(B_t - F_t)}{Y_t}$

	Baseline	$i_R = 70$	Benefit cut by 10%	$i_R = 70$ and Benefit cut by 10%	Earnings tax rate up by 5%
2010	1.042	1.042	1.042	1.042	1.042
2020	1.641	1.625	1.518	1.504	1.639
2030	2.109	2.027	1.852	1.779	1.980
2040	2.762	2.478	2.339	2.083	2.417
2050	3.766	3.154	3.117	2.566	3.159
2060	4.898	3.964	3.996	3.147	3.994

Table 8 summarizes the impact on Japan's net government debt to GDP ratio under significant pension reforms. Raising the retirement age to 70 has a small effect in the short run, a larger effect in the long run, but still does not bring about a sizeable reduction in debt to GDP over the next 30+ years.[24] Just by itself, raising the retirement age from the current 65 to 70 is insufficient in achieving fiscal balance in Japan.

Cutting pension benefits by 10% reduces debt to GDP (by reducing the pension deficit) more significantly in the short-run. Similarly, raising the earnings tax rate on

[24]Raising the retirement age to 67 has very little impact in the short run, and only a minor effect by 2060.

employers' pension part by 5 percentage points slows down the increase in debt to GDP ratio.

What seems to help the most is a combination of raising the retirement age to 70 and reducing benefits by 10%. The debt to GDP ratio is still under 200% until 2040 under this combination of new pension rules. The findings in Table 8 highlight the need to consider bolder reforms in the pension system, but at the same time, point to other policies in conjunction with pension reform in order to establish fiscal sustainability.

Table 9 presents the net borrowing requirements in selected years when the retirement age is raised to 70 and there is a 10% cut in pensions.

Table 9: Retirement at Age 70 and 10% Benefit Cut

	$\frac{(B_t-F_t)}{Y_t}$	$\frac{(G_t+TR_t-T_t)}{Y_t}$	$\frac{(P_t-PR_t)}{Y_t}$	$\frac{(r_{b,t}B_t-r_{f,t}F_t)}{Y_t}$
2010	1.042	0.034	0.028	0.007
2020	1.504	0.014	0.015	0.011
2030	1.779	0.014	0.007	0.013
2040	2.083	0.017	0.007	0.014
2050	2.566	0.022	0.019	0.017
2060	3.147	0.024	0.021	0.021

The decrease in the share of retirees in the population has a positive impact on the non-pension deficit. The biggest impact, however, is naturally on the pension deficit. It drops below 1% for two decades and then hovers about 1% for a long time. With significant improvement in the pension and non-pension budget balances, the debt to GDP ratio increases much more slowly and the interest burden is much smaller than in the benchmark case. Still, if the goal is to restore fiscal balance and bring the debt to GDP ratios to levels in the last two decades, then additional policies must be put on the table.

Consumption tax Table 10 displays the net debt to GDP ratio when the consumption tax is raised beyond 10%, which is the current law and expectation. We assume that the consumption tax rate increases 1% per year from 2016 and reaches 20% in 2025. According to our simulations, we can expect a sizeable reduction in the debt to GDP ratio when the consumption tax rate is raised to 20%.

Table 10: Effects of Higher Consumption Tax Rates on Fiscal Sustainability

	$\frac{(B_t - F_t)}{Y_t}$		
$\tau_{c,t}$	10%	15%	20%
2010	1.042	1.042	1.042
2020	1.641	1.590	1.581
2030	2.109	1.849	1.696
2040	2.762	2.279	1.916
2050	3.766	3.027	2.430
2060	4.898	3.891	3.050

A higher consumption tax reduces the non-pension deficit significantly. In fact, when it is raised to 20%, the non-pension budget balance becomes positive and helps in reducing the overall net borrowing requirements. However, the pension deficit remains unchanged and these findings highlight the importance of pension reform or much higher levels of taxation or a combination of these policies in order to bring about fiscal sustainability to Japan.

In order to highlight the factors that cause the depletion of the pension fund and the continued increase in the debt to GDP ratio in the long run, consider Figure 17 which shows the decomposition of net borrowing requirements into pension, non-pension, and interest payment sources.

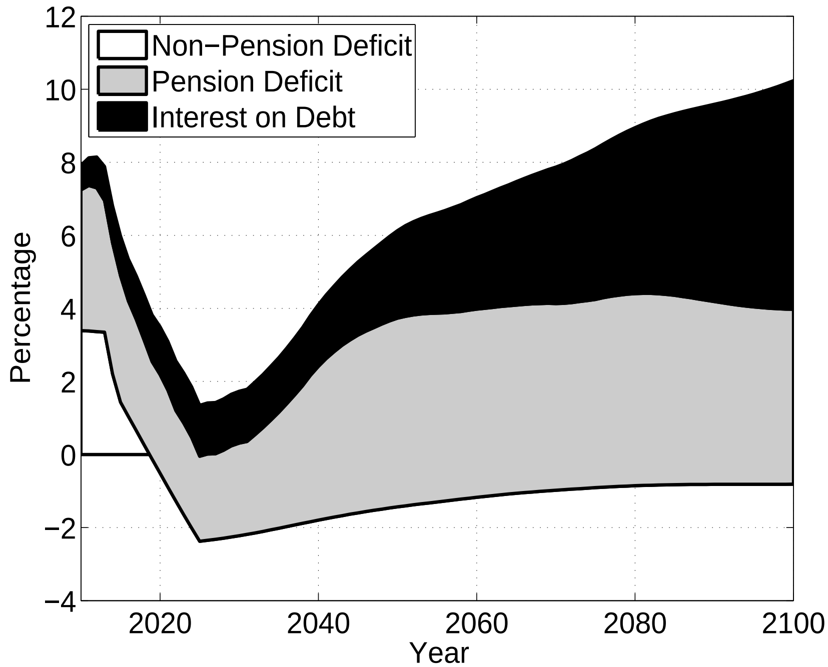


Figure 17: Sources of Net Borrowing Requirements (% of GDP): consumption tax at 20%

Figure 17 indicates that the non-pension deficit is eliminated through 2100 and turned into a surplus. The pension deficit is unaltered, and, together with the increasing burden of interest payments, the ratio of net debt to GDP continues to rise out of control.[25]

Female labor force participation Female labor force participation (FLFP) in Japan is among the lowest in advanced OECD economies. In Table 11, we consider the effect of different FLFP rates on the net debt to GDP ratio.

Below, scenario (A) assumes a rise in the average FLFP rates to those for males at each age holding unchanged the relative shares of three employment types as regular, contingent job, and self-employed, conditional on participation. Scenario (B) assumes a rise in the share of regular employment for females and convergence of employment type distribution to the level of males at each age, with no change in the average FLFP rate at each age. Finally, scenario (C) assumes that (A) and (B) occur simultaneously.

[25] In an unreported experiment, we calculated the consumption tax that would be sufficient to finance the fiscal burden related to aging and stabilize the debt to GDP ratio at around 80%. We found that a 35% consumption tax is needed. Note, however, that this is likely to be a lower bound for a consumption tax rate that will restore fiscal balance because we abstract from the negative effects of a higher consumption tax on the private sector behavior. Indeed, when Hansen and İmrohoroğlu (2011) take the distorting effects of a higher consumption tax into account, they find that a consumption tax higher than 45% is needed to achieve fiscal sustainability.

Table 11: Effects of Female Labor Force Participation on Fiscal Sustainability

		$\frac{(B_t - F_t)}{Y_t}$		
	Baseline	FLFP (A)	FLFP (B)	FLFP (C)
2010	1.042	1.042	1.042	1.042
2020	1.641	1.513	1.611	1.474
2030	2.109	1.757	1.968	1.591
2040	2.762	2.208	2.453	1.844
2050	3.766	2.940	3.265	2.351
2060	4.898	3.788	4.204	2.960

Table 11 shows that a significant increase in the FLFP, especially under scenario (C), provides medium term relief to the fiscal burden. Indeed, the improvement in the debt to GDP ratio under scenario (C) is greater than that under a consumption tax rate of 20%, as the last columns of Tables 10 and 11 indicate.

Figure 18 reveals why higher FLFP under scenario (C) significantly improves fiscal projections.

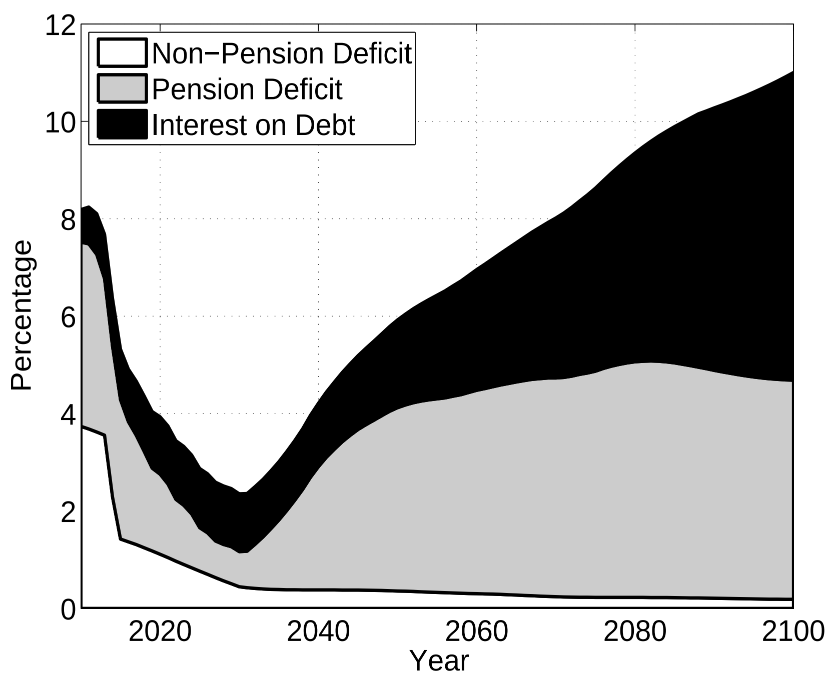


Figure 18: Sources of Net Borrowing Requirements (% of GDP): FPFP scenario (C)

First, the pension tax base is greatly (and immediately) increased, and the pension balance improves significantly. Although females now receive larger total pensions that result from higher labor market earnings, they also contribute larger pension premiums on their employers' pension. Since the latter starts immediately, there is a significant relief to the pension budget. Eventually, the pension deficit grows to an annual rate of about 4% of GDP, somewhat smaller than that in the benchmark case.

Second, when females participate in labor market activities at rates comparable to their male counterparts, the non-pension part of the budget is almost permanently brought to balance.

These results emphasize the quantitative importance of raising the female labor force participation rates in Japan. With positive effects in both the pension and the non-pension (and therefore in the interest burden as well), designing policies that incentivize higher labor market activities among females seems very promising.

8 Conclusion

Most advanced economies are currently facing significant demographic and fiscal problems. Among them, Japan leads the world in the speed of aging and the level of the public debt. In this paper, we build a detailed overlapping generations model and use estimates from Japanese micro data to simulate future paths of fiscal quantities. Our findings suggest that absent any change in current policies, Japan will continue to run large pension and non-pension deficits and the debt to GDP ratio will continue to reach unprecedented highs, with interest payments on the debt becoming the biggest and growing burden.

We find that no single policy or economic outcome considered can restore fiscal balance in Japan. Among the alternative scenarios employed, pension reform that extends retirement age to 70 and cuts benefits by 10% reduces the pension deficit significantly and helps to slow down the growth of government indebtedness. An increase in the consumption tax from the scheduled 10% to 20% turns the non-pension deficit into a surplus immediately and for several decades. However, the unchanged pension deficit results in large new borrowing and the ratio of debt to GDP resumes its rise. An increase in the female labor force participation that makes both the participation rates and employment types of females similar to those of males has a larger impact. This outcome improves both the pension and the non-pension balance, but large deficits still persists into following decades. Only a combination of these and other outcomes may accomplish the huge task of achieving fiscal balance in Japan.

Of course, there are other policies that can make a large impact. In particular, a guest worker program or comprehensive tax reform that would help reduce distortions and increase the tax base and provide future dividends. These outcomes and other reforms are left for future research.

References

Aguiar, M. and E. Hurst (2013). Deconstructing lifecycle expenditure. *Journal of Political Economy*. Forthcoming.

Attanasio, O., S. Kitao, and G. L. Violante (2007). Global demographic trends and social security reform. *Journal of Monetary Economics 54*(1), 144–198.

Attanasio, O. P., S. Kitao, and G. L. Violante (2006). Quantifying the effects of the demographic transition in developing economies. *The B.E. Journals in Macroeconomics, Advances in Macroeconomics 6*(1). Article 2.

Braun, R. A. and D. Joines (2011). The implications of a greying Japan for public policy. Working Paper.

Broda, C. and D. E. Weinstein (2005). Happy news from the dismal science: Reassesing Japanese fiscal policy and sustainability. In T. Ito, H. Patric, and D. E. Weinstein (Eds.), *Reviving Japan's Economy*, pp. 39–78. Massachusetts: The MIT Press.

Doi, T., T. Hoshi, and T. Okimoto (2011). Japanese government debt and sustainability of fiscal policy. *Journal of the Japanese and International Economies 25*(4), 414–433.

Genda, Y. and R. Kambayashi (2002). Declining self-employment in Japan. *Journal of the Japanese and International Economies 16*(1), 73–91.

Gunji, H. and K. Miyazaki (2011). Estimates of average marginal tax rates on factor incomes in Japan. *Journal of The Japanese and International Economies 25*(2), 81–106.

Hansen, G. and S. İmrohoroğlu (2011). Fiscal reform and government debt in Japan: A neoclassical perspective. Working paper.

Hayashi, F. and E. C. Prescott (2002). The 1990s in Japan: A lost decade. *Review of Economic Dyamics 5*(1), 206–235.

Hoshi, T. and T. Ito (2012). Defying gravity: How long will Japanese government bond prices remain high? NBER Working Paper No. 18287.

Hoshi, T. and A. Kashyap (2012). Policy options for Japan's revival. NIRA Report.

İmrohoroğlu, S. and N. Sudo (2010). Productivity and fiscal policy in Japan: Forecasts from the standard growth model. IMES Discussion Paper Series, 10-E-23.

İmrohoroğlu, S. and N. Sudo (2011). Will a growth miracle reduce debt in Japan. IMES Discussion Paper Series, 11-E-01.

Lise, J., N. Sudo, M. Suzuki, K. Yamada, and T. Yamada (2013). Wage, income and consumption inequality in Japan, 1981-2008: from boom to lost decades. Working paper.

Ministry of Health, Labour and Welfare (MHLW), Pension Bureau (2011). Annual report on the public pension system (in Japanese, *Kosei nenkin hoken, Kokumin nenkin jigyo no gaikyo*).

Sakuragawa, M. and K. Hosono (2010). Fiscal sustainability of Japan: A dynamic stochastic general equilibrium approach. *Japanese Economic Review 61*(4), 517–537.

Storesletten, K. (2003). Fiscal implications of immigration - a net present value calculation. *Scandinavian Journal of Economics 105*(3), 487–506.

A Estimation of consumption profile

We use the Family Income and Expenditure Survey (FIES), which is compiled by the Statistics Bureau, Japanese Ministry of Internal Affairs and Communications, for the period 1981–2008 to estimate individual's consumption profile by age.[26] The FIES is a monthly diary survey that collects the earnings and expenditures of households and it also reports characteristics including household members' ages, gender, occupation, and marital status. The survey contains approximately 8,000 households per month and has a panel structure although we do not use the panel dimension directly. We define consumption as the sum of nondurable, service, semidurable and durable expenditures, excluding housing expenditure. We equivalize the household consumption using OECD equivalent scale after deflating the variables with CPI.

Following Aguiar and Hurst (2013), we run the following regression:

$$\ln c_{i,t} = \beta_0 + \beta_{\text{age}} D_{i,t}^{\text{age}} + \beta_c D_{i,t}^{\text{cohort}} + \beta_t D^{\text{time}} + \beta_{\text{fam}} \mathbf{X}_{i,t} + \epsilon_{i,t},$$

where $D_{i,t}^{\text{age}}$ is a vector of age dummies (for ages 20-95), $D_{i,t}^{\text{cohort}}$ is a vector of five-year birth cohort dummies, and D^{time} is a vector of year dummies. $\mathbf{X}_{i,t}$ represents a vector of household characteristics such as a gender dummy, a marital status dummy, the number of adults, and the number of children. We impose the following two restrictions, $\sum_{t=1981}^{2008} \beta_t = 0$ and $\sum_{t=1981}^{2008} t\beta_t = 0$, on the regression coefficients. Because of collinearity among age, cohort (birth year) and calender year, it is impossible to estimate the age dummies without the restrictions.

We use the age dummies $D_{i,t}^{\text{age}}$ as adult consumption profile controlled by the cohort and time effects. We restrict the age dummies between 20 and 95 because the household head aged over 95 is very few in the dataset. Since the age dummies are not smooth over life cycle, we smooth out the age dummies using polynomials. We extend the consumption profile to age 110.

[26]For more details on the dataset, see Lise et al. (2013)