Fiscal sustainability in Japan: what to tackle?*

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Abstract

Japan leads advanced economies in terms of the speed and magnitude of demographic aging and has the highest debt to GDP ratio. Furthermore, public pension, medical and long-term care (LTC) expenditures are projected to far outpace revenues and create even more severe fiscal burdens. In this paper, we develop an accounting model populated with overlapping generations of individuals and incorporate social insurance programs in detail, use most recent estimates of Japanese micro data and government demographic projections to discipline the earnings and labor supply profiles of heterogeneous agents and their cohort shares, and simulate future paths of fiscal and macroeconomic indicators. Our numerical results suggest that absent any change in current policies, Japan will continue to run large pension, public health, LTC, and basic deficits and the debt to GDP ratio will continue to reach unprecedented highs, with growing interest payments. Although no single policy tool can address fiscal consolidation, a combination of policies is found to achieve sustainability: raise the retirement age to 67, cut pensions by 10%, raise copays of health and LTC insurances to at least 20% for all, and find policies to propel female employment and earnings and to narrow the gap with their male counterparts, and increase consumption tax rate to 15%. Under these changes, the debt to output ratio in 2050 would be lower than that in 2020.

Keywords: Fiscal balance, social security, medical expenditures, health insurance, long-term care insurance, demographic aging, Japanese economy, female labor force participation, overlapping generations.
JEL Classification: H60, H55, J11

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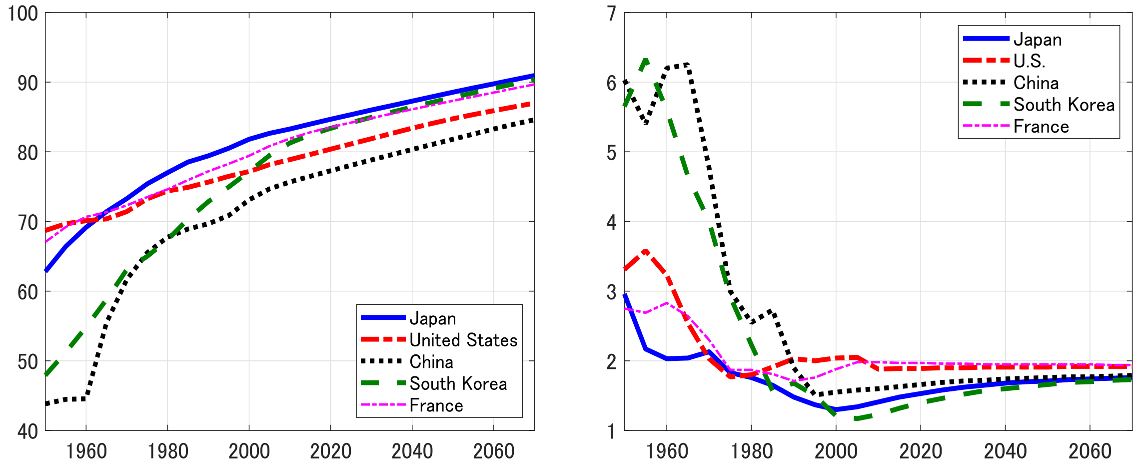
1 Introduction

Japan is the fastest aging economy among advanced nations. The dependency ratio, defined here as the ratio of the number of individuals aged 65 and older to the number of individuals between 20 and 64 years old, is 48% in 2015 and will rise to 80% by early 2050s and stay at around 80% during the second half of the century.[1] Expenditures for age-related social insurance programs such as pensions, public health care and long-term care insurance are projected to rise significantly, far outpacing the projected revenues and insurance premia collected. As a result, the fiscal outlook for Japan is predicted to further deteriorate as researchers and policymakers search for ways to achieve sustained fiscal consolidation.

Trends in demographics and female labor force participation (FLFP) in selected economies Japan is already the oldest society in the world having experienced aging earlier and in a more severe fashion than any other economy. However, aging is a widespread phenomenon and it will be useful to demonstrate projected demographics in selected key economies. In particular, Figure 1 shows life expectancy and fertility in Japan, United States, China, South Korea, and France.[2]



(a) Life Expectancy (b) Fertility Rate

Figure 1: Actual and Projected Demographics

Life expectancy has increased very sharply in Japan after 1950, is highest currently,

[1]The figures are based on the 2017 projections of the National Institute of Population and Social Security Research (IPSS).

[2]In addition to the fact that these four additional economies are experiencing similar trends in demographics, United States and China are the largest two economies in the world, and, France is a representative Euro area economy. The consideration of South Korea is mostly due to the fact that the fertility rate is very low and even below that in Japan, and therefore highlights the importance of exploring policies that can mitigate the fiscal effects of the huge projected rise in its dependency ratio. The data on these demographic variables are from United Nations' World Population Prospects, the 2017 Revision.

and projected to remain so through 2070. Total fertility rate in Japan, shown in Figure 1(b), is significantly lower than those in Unites States and France, although the gap is projected to close over the next few decades. South Korea has even lower fertility rates and will surpass Japan in terms of old age dependency ratio after 2060 as Figure 2 shows. The total fertility rate in China also declines sharply due to the one-child policy.

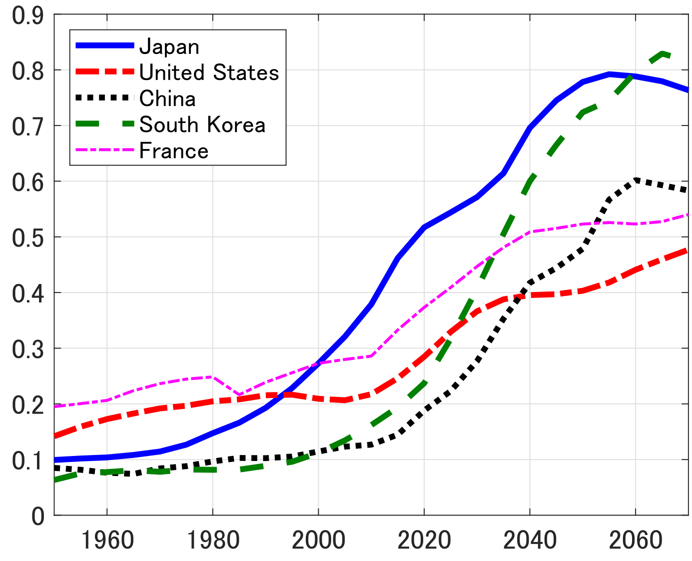
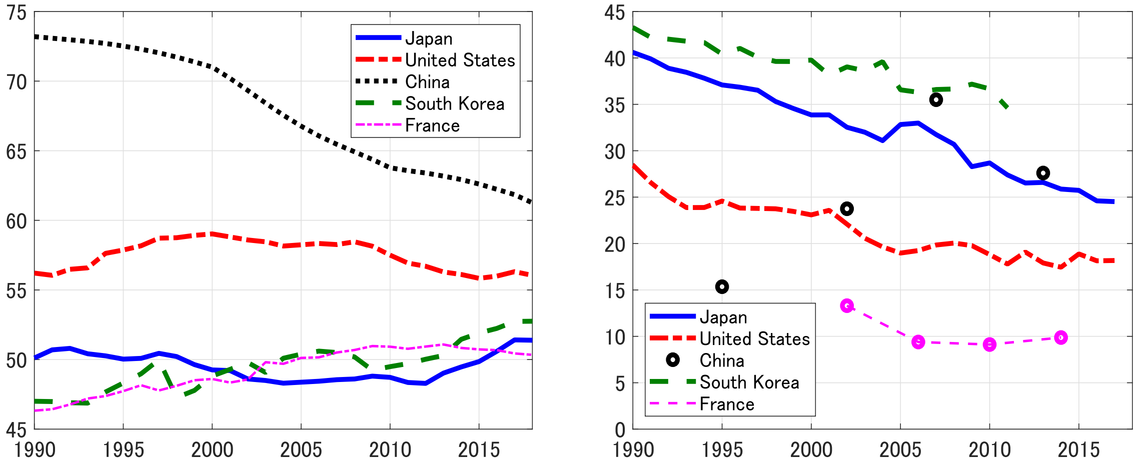


Figure 2: Old Age Dependency Ratio

The old age dependency ratio is rising in all five economies in Figure 2 but currently it is highest in Japan and will remain so over the next several decades. The focus of this paper is to explore the fiscal consequences of aging in Japan and the potential success of various policies and outcomes in achieving fiscal sustainability.

Among the outcomes considered in this paper are further gains in female labor force participation and their wages. Figure 3 shows the FLFP (over 15 years old) and the female wage gap in Japan, United States, China, South Korea, and France.[3]

[3]FLFP data are from the International Labor Organization (ILO) database ILOSTAT. Wage data are from OECD for United States, Japan, France and South Korea. For China, wage data come from Song et al. (2017) who use the 1995, 2002, 2007, and 2013 waves of the China Household Income Project (CHIP) survey data. These data are not comprehensive or consistent with the OECD data but nevertheless may be useful for a rough comparison.



(a) FLFP

(b) Wage Gap

Figure 3: FLFP and the Wage Gap

FLFP among those aged above 15 in Japan is still lower than in the US but the gap is narrowing fast among those in the prime age. The wage gap is defined as the difference between the median earnings of men and women as a ratio of median earnings of men. This wage gap is shrinking everywhere, but Japan is still behind the U.S., with South Korea catching up from behind slowly. It is difficult to interpret the sparse observations in China.

As part of our study of policies and outcomes that may help achieve fiscal sustainability in Japan, we will consider the effects of an increase in the FLFP and narrowing the gap against male counterparts, whose participation rate stands at about 70%. We also consider scenarios to narrow the wage gap in Japan.

The key takeaway is that the demographic transitions are somewhat similar across major economies in the world and that increases in the FLFP or reductions in the wage gap may play a part in mitigating the fiscal burdens of aging. Japan happens to present a very strong case study with its already old population and the highest current old age dependency ratio.

Related literature While debt to GDP ratios were relatively low in the early 1990s in Japan, successive fiscal stimulus packages and rising expenditures on the social security system have raised the quantity of Japanese government bonds (JGBs) to unusually high levels. Given the interest and concerns on how Japan would cope with the unprecedented demographic aging and fiscal challenges, there has been a growing literature on finding solutions to achieving fiscal sustainability. Broda and Weinstein (2005) estimate that fiscal sustainability is possible with small changes in the tax-to-GDP ratio. Doi et al. (2011), however, use the same fiscal instrument and argue that a very high tax rate, equivalent to an additional 11% of GDP, is required to stabilize the debt to GDP ratio when they use more recent data.

İmrohoroğlu and Sudo (2011a) use a neoclassical growth model to 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, they find that additional fiscal adjustments are needed to achieve fiscal sustainability. İmrohoroğlu and Sudo (2011b) study effects of productivity growth and find that only a growth miracle, such as a 6% real growth rate over 10 years, would be necessary to bring the debt to GDP to a manageable level. Hoshi and Kashyap (2012) demonstrate that zombie financing and very large spending programs have driven the projected fiscal burden of the demographic transition. In addition to recommending fiscal discipline and major regulatory reforms, they also suggest opening up the Japanese economy by re-designing immigration policies.

Braun and Joines (2015) develop an overlapping generations model with the demographic transition and argue that in the absence of any reform, achieving fiscal sustainability will necessitate a consumption tax rate of about 30-45%. They show that a health care reform that raises the co-pay for the elderly to that for working age individuals, which is 30%, would contain the increase in the consumption tax to 23%. Kitao (2015) quantifies the fiscal cost of demographic transition and argues that pension reform to scale down benefits and raising the retirement age can significantly lower the fiscal burden, assisted by an increase in private saving and labor force participation in both intensive and extensive margins.

Hansen and İmrohoroğlu (2013) use a model with endogenous debt and show that the fiscal adjustment of about 30-40% of total consumption expenditures is necessary to maintain current promised levels of public pension and health services. Hoshi and Ito (2014) assess fiscal sustainability, and argue that there is an upper bound on the private sector's ability to buy further JGBs and 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 severe fiscal consolidation, financial instability and even high inflation.

İmrohoroğlu et al. (2017) develop a general equilibrium model to measure the impact of alternative guest worker programs in Japan. Depending on the size and skill distribution of guest workers, they argue that these programs may mitigate Japan's fiscal imbalance problem with a relatively manageable increase in the tax burden.[4] İmrohoroğlu et al. (2016) build a microdata-founded overlapping generations structure calibrated to various micro data and official demographic projections and produce time paths for macroeconomic aggregates from 2010 to 2100. Their quantitative results suggest that the pension and non-pension related budget deficits both contribute to a rise in the fiscal burden in the long-run and argue that a combination of policy reforms and changes in the economic environment would be necessary to achieve a fiscal balance.

[4]For example, when 200,000 guest workers with 50% of the productivity level of their Japanese counterparts are allowed temporarily for 10 years, the consumption tax rate that achieves fiscal sustainability would be 3 percentage points lower relative to the benchmark transition. A more ambitious immigration program that resembles the current U.S. workplace environment in which 16.4% of employment is foreign born leads a consumption tax that is 6 to 10 percentage points lower than the benchmark transition.

Contributions of the paper The previous literature cited above abstracts from some key details of the social insurance programs and also restricts the amount of heterogeniety in agent types. In most cases, this is done for computational reasons and helps the paper focus on important aspects of the analysis of aging. In addition, this approach also is crucial in quantifying the welfare effects of various policy changes.

An alternative and complementary approach is to abstract from optimization but instead incorporate key details of the social insurance programs and also allow for a rich amount of agent heterogeneity. This paper builds a micro-data based, large-scale accounting model populated with overlapping generations of individuals for Japan in which agents differ in age, gender, employment status, income, and asset holdings, and incorporates the rules of the Japanese social insurance system, including the public pensions, health insurance and long-term care insurance in detail.

This paper extends İmrohoroğlu et al. (2016) in key dimensions and follows a strategy similar to Storesletten (2003), that uses a life-cycle structure 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 various fiscal responses to future shocks and how these policies impact fiscal sustainability in Japan.

Most importantly, we treat not only the public pensions as in İmrohoroğlu et al. (2016), but also public health and long-term care insurances programs separately from other government expenditure and revenue items. We include detailed payment arrangements through the insurance programs, as well as the system of premium and copay payments that differ by age, employment types and earnings of individuals. We show that it is quantitatively important to incorporate finances of these insurance programs in evaluating the future paths of fiscal variables in Japan.[5]

We also use the latest demographic projections and micro data to calibrate the benchmark economy and to compute the transition dynamics. We use age and gender specific projections of survival probabilities and population size based on the 2017 projection of the National Institute of Population and Social Security Research (IPSS). Our earnings estimates for employed workers are obtained from the most recent Basic Survey on Wage Structure (BSWS) in 2015, by the Ministry of Health, Labor and Welfare (MHLW). For self-employed workers we use the National Survey of Family Income and Expenditure (NSFIE) in 2015. Our estimates of consumption profiles come from the Family Income and Expenditure Survey (FIES) by the Ministry of Internal Affairs and Communications.

Our main findings are summarized as follows. First, it is difficult to achieve fiscal sustainability with a single tool. This finding has not changed from that of İmrohoroğlu et al. (2016), but we quantify the breakdown of factors that contribute to the projected deficits and paths of expenditures and revenues of each social insurance program. The four expenditure items, (i) public pension, (ii) public health insurance, (iii) public long-term care insurance and (iv) interest payment on the public debt, will be nearly equally important in generating the path of rising government debt during the coming decades.

[5]In addition, we have a separate corporate sector so that our model can be calibrated to match corporate tax revenues in the data. The model is carefully calibrated to yield tax revenues and expenditures that match their data counterparts.

Second, there are strong and positive effects from higher productivity growth and increases in female employment (with wage increase and employment regularization). More female participation and increased earnings will not only increase income tax revenues but also the budgets of all three social insurance programs. A large effect occurs because of changes in the contribution they make to insurance programs, the amount of which is tied to various individual states and most importantly to the employment status in Japan. Efforts of policymakers in such directions will be essential for the fiscal soundness in the long-run. We note, however, these two items may be the most difficult to influence with a simple policy tool and they require significant structural reforms.

Third, increasing the consumption tax rate from the current 8% to 10% in 2019 reduces fiscal pressures in the short run. A further increase to a level that is comparable to other advanced economies would help alleviate accumulation of debt significantly.

Fourth, achieving fiscal sustainability is difficult but not impossible. For example, a combination of policies, raising the full retirement age to 67, cutting pension benefits by 10%, raising the copays in public medical expenditures and long-term care spending to 20%, increasing the female earnings and employment characteristics to those of men, and raising the consumption tax rate to 15%, achieves fiscal sustainability very quickly and leads to significant fiscal consolidation with a lower debt to GDP ratio in 2050 than that in 2020.

One shortcoming of our paper is that we do not model individual decisions on consumption/saving and labor/leisure choices. Therefore, our model is not suitable to conduct a welfare analysis to study the effects of reforms or the demographic change. We estimate life-cycle profiles of consumption, labor supply and earnings from the most recent Japanese micro data, derive individuals' consumption at each age using these estimates and the present value of life time resources constraint under the complete markets assumption, back out the asset holdings from the period budget constraint, and use the 2017 IPSS demographic projections to produce forecasts of future fiscal and macroeconomic indicators. On the one hand, this is clearly a shortcoming of our approach. On the other hand, this abstraction allows us to incorporate significant details of the pension and health insurance systems in Japan, including the distinction of different categories of social insurance programs (public pension, health insurance and long-term care insurance), eligibility, non-linear functions of benefits and contributions/premium in each program. In addition, we capture the unique and important heterogeneity among the labor force, male versus female, regular, irregular (contingent) and self-employment, which have very important implications for the cash flow of the pension and public health and LTC programs and for the projections of fiscal variables in the future.

By incorporating such details, we are able to study effects of a number of policy changes that are currently debated in the policy circle, such as an increase in the normal retirement age and changes in the copay system of health and long-term care insurance programs, as well as some trends that have started to take place, such as a rise in FLFP, changes in their employment types and a rise of their relative wage.

The remainder of the paper is organized as follows. We present the model in section 2. Details of the calibration and estimation strategy are given in section 3.The benchmark results, sensitivity analyses and policy experiments are discussed in section 4. Section 5 concludes.

2 Overlapping Generations Structure

2.1 Demographics

An individual at time t is characterized by a state vector $\{i, j, e\}$. i represents the age of an individual, $j \in \{m, f\}$ denotes the gender (male or female) and e indicates the employment status. The age of an individual including ages of 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 starting to consume and save disposable income.

We denote by $\widetilde{n}_{\widetilde{i},j,t}$ the number of individuals of age $\widetilde{i}$ and gender j at time t. The adult age i starts at age I_A, and the age of an individual $\widetilde{i} \geq I_A$ is $i \equiv \widetilde{i} - I_A + 1$. The maximum adult age is defined as $I = \widetilde{I} - I_A + 1$.

2.2 Labor force participation and earnings

In Japan, individuals are hired as, implicitly or explicitly, either a regular worker or an irregular/contingent worker. The former is full-fledge employment (*seishain* or *seiki-koyou*) and workers are retained semi-permanently typically with an access to public pension and health insurance through employers. The latter is employment at a non-regular, temporary or dispatch job (*hi-seishain* or *hi-seiki-koyou*) and jobs are less stable and do not always come with public insurance coverage through employers.[6] Another form of working is to run one's own business as self-employed worker.

We assume that 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 $e \in \{R, C, S, U\}$. Earnings of type $\{i, j, e\}$ individuals at time t is $y_{i,j,e,t}$. $n_{i,j,e,t}$ represents the number of individuals of adult age i, gender j, and employment type e at time t.

In section 3, we will describe in detail how we estimate age-earnings profiles for 3 types of workers of each gender using Japanese micro data. These profiles will form the basis of our calculation of individuals' consumption and asset profiles, in addition

[6]The distinction is different from that of a part-time job vs a full-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. The last employment status, not-working, includes both unemployment and not-in-the-labor force.

to calculating personal income tax revenues, premiums for public pension and insurance programs and their benefits.

2.3 Consumption and asset profiles

In order to calculate revenues from consumption and capital income taxation, it is necessary to compute 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 income, 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. Let $\tilde{d}_{t,\tilde{i},k}$ denote the number of dependents of age k that parents of age $\widetilde{i}$ support at time t, which coincides with $\phi_{\tilde{i}-k+1,t-k+1}$.[7] The total number of children for a mother of age $\widetilde{i}$ 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. $\lambda_{i,t} = \tilde{\lambda}_i(1 + d_{t,i}\nu)$, where ν represents adult consumption equivalence for dependent children.

Individuals are assumed to own zero wealth as they enter the economy and start economic activities. For simplicity, we also assume that the consumption profile is determined based on the expected life-time income when they become economically active and that individuals of a given cohort and gender insure among themselves against employment risks.

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

$$c_{i,j,t+i}(1 + \tau_{c,t+i}) = \widehat{\lambda}_{i,t} \sum_{s=1}^{I} \frac{1}{\prod_{k=1}^{s}[1 + r_{a,t+k}(1 - \tau_{a,t+k})]}$$

$$\sum_{e} \frac{n_{s,j,e,t+s}}{\sum_e n_{s,j,e,t+s}} \left[y_{s,j,e,t+s} - \tau_{s,j,e,t+s} + p_{s,j,t+s} + tr_{t+s} + b_{t+s} - \widetilde{m}_{s,t+s} - \widetilde{lc}_{s,t+s} \right], \quad (1)$$

where

$$\widehat{\lambda}_{i,t} = \lambda_{i,t} / \prod_{k=1}^{i}[1 + r_{a,t+k}(1 - \tau_{a,t+k})], \quad (2)$$

[7]In this computation, we abstract from the non-survival of children given the very low mortality rates of an infant and children.

and

$$\tau_{i,j,e,t} = \tau_{l,t} y_{i,j,e,t} + \tau_{ls,t} + \tau_{p,t}(y_{i,j,e,t}) + \tau_{m,t}(y_{i,j,e,t}) + \tau_{lc,t}(y_{i,j,e,t}). \tag{3}$$

$\tau_{i,j,e,t}$ denotes an individual's tax and premium payment to the government, consisting of labor income taxes at rate $\tau_{l,t}$, lump-sum taxes $\tau_{ls,t}$ and premiums of public pension $\tau_{p,t}(y_{i,j,e,t})$, health insurance $\tau_{m,t}(y_{i,j,e,t})$, and long-term care insurance $\tau_{lc,t}(y_{i,j,e,t})$, as shown in (3). $p_{i,j,t}$, tr_t and b_t represent public pension benefits, government transfers and private transfers, respectively. $\widetilde{m}_{j,t}$ and $\widetilde{lc}_{j,t}$ denote individual's medical and long-term care copays, respectively.[8]

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, as shown below. Asset holdings will be used to compute the tax base for capital income taxation.

$$\begin{aligned} a_{i+1,j,t+i+1} = \sum_e \frac{n_{i,j,e,t+i}}{\sum_e n_{i,j,e,t+i}} \{ & y_{i,j,e,t+i} - \tau_{i,j,e,t+i} + p_{i,j,t+i} + tr_{t+i} + b_{t+i} \\ & - \widetilde{m}_{i,t+i} - \widetilde{lc}_{i,t+i} + [1 + r_{a,t+i}(1 - \tau_{a,t+i})] a_{i,j,t+i} - (1 + \tau_{c,t+i}) c_{i,j,t+i} \}. \end{aligned}$$

2.4 Government and fiscal policies

In each period the government finances its purchases of (non-health) goods and services G_t, (non-pension) transfer payments to individuals TR_t, pension benefits to retirees P_t, medical insurance benefits M_t^g, long-term care insurance benefits LC_t^g and the cost of debt servicing, through taxation on individuals T_t and on corporations TC_t, issuance of new debt B_{t+1}, and collection of premiums PR_t for public pension, medical insurance and long-term care insurance programs. At the beginning of period t, the government owes debt B_t and holds assets in the pension fund denoted as F_t, which can be used to pay for pension benefits. Therefore the net debt of the government is $B_t - F_t$. The net debt evolves as follows.

$$\begin{aligned} B_{t+1} - F_{t+1} &= (1 + r_{b,t}) B_t - (1 + r_{f,t}) F_t \\ &\quad + G_t + TR_t + P_t + M_t^g + LC_t^g - T_t - TC_t - PR_t. \end{aligned} \tag{4}$$

$(1 + r_{b,t}) B_t$ 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 inflation. $r_{f,t}$ denotes the return on the pension fund.

Our objective is to calculate a time path for B_{t+1} between 2015 and 2100 under various assumptions on the economic environment including fiscal policies, demographics, labor force participation and distribution of employment types.

We describe below how the aggregate variables in (4) are composed of individual

[8] $\widetilde{m}_{j,t}$ may include health insurance copay for dependent children, depending on the age of an individual, as discussed in section 3.

variables. The government accounts are given by

$$
\begin{aligned}
T_t &= \tau_{c,t}\sum_{i,j,e} c_{i,j,t}n_{i,j,e,t} + \tau_{a,t}r_{a,t}\sum_{i,j,e} a_{i,j,t}n_{i,j,e,t} + \tau_{l,t}\sum_{i,j,e} y_{i,j,e,t}n_{i,j,e,t} + \tau_{ls,t}\sum_{i,j,e} n_{i,j,e,t},\\
TR_t &= \sum_{i,j,e} tr_t n_{i,j,e,t},\\
G_t &= \sum_{i,j,e} g_t n_{i,j,e,t},\\
P_t &= \sum_{i,j,e} p_{i,j,t}n_{i,j,e,t},\\
M_t^g &= \sum_{\widetilde{i},j,e}(1-\eta^m_{\widetilde{i},t})m_{\widetilde{i},t}\widetilde{n}_{\widetilde{i},j,e,t},\\
LC_t^g &= \sum_{i,j,e}(1-\eta^{lc}_{i,t})lc_{i,t}n_{i,j,e,t},\\
PR_t &= \sum_{i,j,e}\left[\tau_{p,t}(y_{i,j,e,t}) + \tau_{m,t}(y_{i,j,e,t}) + \tau_{lc,t}(y_{i,j,e,t})\right]n_{i,j,e,t}.
\end{aligned}
$$

T_t represents taxes collected from individuals on four sources of revenues; consumption at rate $\tau_{c,t}$, capital income or returns from saving at $\tau_{a,t}$, labor income at $\tau_{l,t}$ and a lump-sum tax of $\tau_{ls,t}$. TC_t denotes taxes collected from corporations, which evolve exogenously in the model. tr_t represents exogenous non-pension per-capita transfer payments given to individuals. g_t denotes exogenous per-capita government purchases for individuals at time t. $p_{i,j,t}$ represents pension benefits to each retiree. $m_{\widetilde{i},t}$ and $lc_{i,t}$ denote gross medical and long-term care expenditures and $(1-\eta^m_{\widetilde{i},t})$ and $(1-\eta^{lc}_{i,t})$ represent the fraction paid by each public insurance program. We assume that the part of medical expenditures incurred by dependent children $\widetilde{i} < I_A$ and not covered by the health insurance program is paid equally by adults at age 20-64. Individuals' copays for health and long-term care insurances, $\widetilde{m}_{i,t}$ and $\widetilde{lc}_{i,t}$, are given as

$$
\begin{aligned}
\widetilde{m}_{i,t} &= \eta^m_{i,t}m_{i,t} + I_{1\le i\le 45}\cdot m_t^d,\\
\widetilde{lc}_{i,t} &= \eta^{lc}_{i,t}lc_{i,t}.
\end{aligned}
$$

m_t^d denotes the portion of health insurance copay for dependent children; $m_t^d = \sum_{\widetilde{i}=1}^{I^A-1}\left[\eta^m_{\widetilde{i},t}m_{\widetilde{i},t}\sum_{j,e}\widetilde{n}_{\widetilde{i},j,e,t}\right]/\sum_{j,e,1\le k\le 45} n_{k,j,e,t}$, incurred only if the agent is at age 20-64.

$\tau_{p,t}(y_{i,j,e,t})$ is the contribution to the public pension system by each working-age insured individual, which depends on earnings $y_{i,j,e,t}$. $\tau_{m,t}(y_{i,j,e,t})$ and $\tau_{lc,t}(y_{i,j,e,t})$ denote premiums to the medical and long-term care insurance programs.

Public pension system: The public pension system in Japan consists of two parts; the basic pension (*Kiso Nenkin*) and the employees' pension insurance (*Kosei Nenkin Hoken*).[9] 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

[9]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.

insured throughout the period of eligibility and adjusted for periods of no insurance and no premium payment. The benefits from the employees' pension insurance are based on an individual's contribution tied to career earnings of an individual. To approximate the system, we assume that the pension benefits $p_{i,j,t}$ 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 3.3.

The payment of 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.

$$F_{t+1} = (1 + r_{f,t})F_t + PR_t + X_t - P_t. \tag{5}$$

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

These 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 debt B_{t+1}.

3 Parameterization of the model

The model period is one year. We start the simulation of the model in 2015 and calibrate parameters to approximate micro and macro characteristics of the Japanese economy in 2015. We will focus on the simulations between 2015 and 2100.

3.1 Demographics

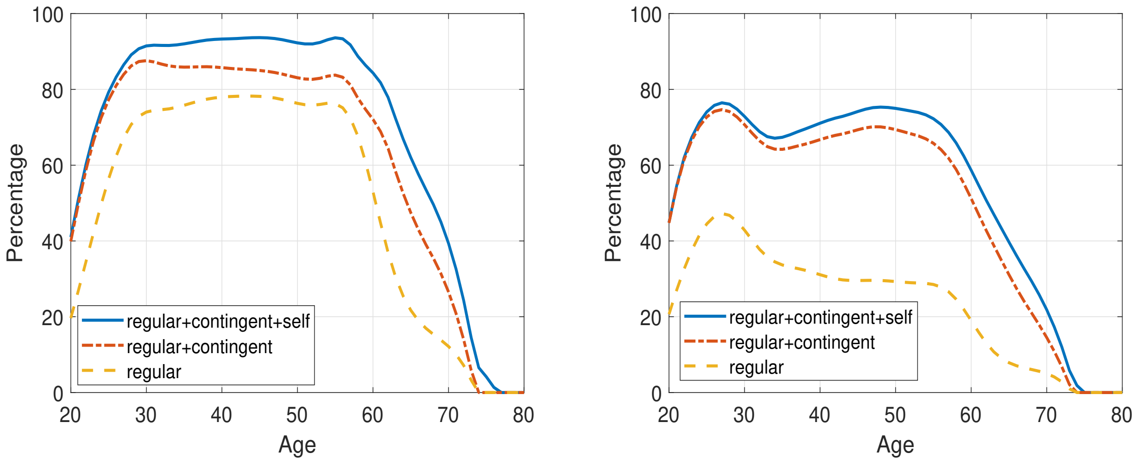
We assume that individuals enter the economy and can start working at the age of 20. The maximum age of an individual in the model is 105. Age-specific survival probabilities and fertility rates are based on the estimates and projections of the National Institute of Population and Social Security Research (IPSS). The official projections of these variables are available up to 2065 and we assume that they remain at the same values after 2065. The number of dependent children is calculated with the projected age-specific fertility rates.

3.2 Labor force participation and earnings

We use the Labor Force Survey of 2015 by the Ministry of Internal Affairs and Communications to compute the distribution of employment types by gender. Individuals are in one of four employment states; regular job (R), contingent (C), self-employment (S) and

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.

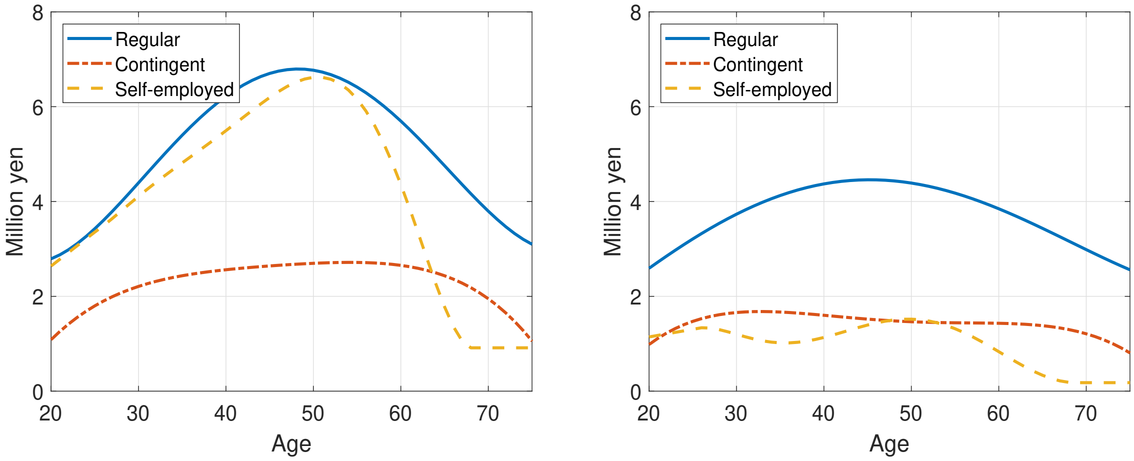
not working (U). The last state includes individuals who are either unemployed or not in the labor force. Figure 4 shows the labor force participation rates by employment type and gender. Labor force participation rates of males stay high at around 90% from late 20s to 50s. The number of regular workers decline sharply in 60s as many individuals face retirement ages set by employers. The profile of females exhibits an M-shape as a large number of women withdraw from the labor force in late 20s and 30s and at child-bearing ages. Participation rates rise again in 40s and 50s as they return to work, though the number of regular jobs does not show a rise and many of them resume working at contingent jobs.



(a) Male (b) Female

Figure 4: Labor force participation rate

Earnings profiles of employed workers are computed from the Basic Survey on Wage Structure (BSWS) in 2015, by the Ministry of Health, Labor and Welfare (MHLW). The BSWS does not cover self-employed workers and we use the National Survey of Family Income and Expenditure (NSFIE) in 2010-2015. We assume that the shape of earnings profiles is invariant over time and the level of earnings will rise with the economy-wide wage growth.



(a) Male

(b) Female

Figure 5: Earnings by employment types

In section 4, we also consider alternative scenarios about convergence of female employment and wages to those of male workers.

3.3 Government

Public pension: All adults in Japan are covered by the public pension system and belong to one of the three coverage categories. Category 2 insured are regular workers in establishments with more than five employees and category 3 insured are non-working dependent spouses of category 2 workers.[10] Category 1 subscribers of the public pension scheme are all others not in categories 2 and 3 and include self-employed individuals, farmers, students, some contingent workers that are not offered a pension at work and non-working individuals who are not in category 3. As such, the three categories are closely related to the employment status (regular, contingent, self-employed and non-working) described above in section 3.2. Individuals in each type of employment are divided into the three categories of public pension and we do so to match the distribution across categories by gender and age as reported by the MHLW. The normal retirement age has been changing over time, depending on the pension scheme and gender, which we incorporate in the simulations.[11]

We assume that all individuals between ages 20 and 59 are covered by and contribute to the first tier of the public pension system, the basic pension, and start receiving benefits at age 65. In 2015, the maximum annual benefit of the basic pension is 788,900 yen for individuals who have contributed for the maximum of 40 years. The benefit is

[10]Not all workers in large firms are eligible for the coverage under category 2. Those working fewer hours or days than certain levels may not be offered the coverage at work and must be insured individually as category 1 or through spouses as category 3.

[11]The normal retirement age for the basic pension has been 65 since the pension system started in 1960. The retirement age for employees' insurance has been rising from 60 (male) and 56 (female) and will reach 65 for a cohort born in 1961 (male) and 1966 (female).

reduced proportionally according to the number of months that an individual was not covered and did not contribute. The average annual benefit paid to an individual at the normal retirement age of 65 was 678,900 yen in 2015 and we use this amount as the level of basic pension benefits in the simulations.

The second tier of the Japanese pension system is employees' pension insurance and the benefits depend on the contribution that individuals make while working for an employer offering the coverage. Only category 2 insured persons can receive the earnings-related part of the public pension. We approximate the pension benefits of a retiree with the formula

$$p_{i,j,t} = p^b_{i,j,t} + \xi_{t,t-i} \times \overline{y}_{i,j,t}.$$

The first term on the RHS denotes the basic pension for a retiree of age i and gender j at time t. $\xi_{t,t-i}$ affects the replacement rate and it depends on an individual's birth year $t-i$. $\overline{y}_{i,j,t}$ denotes their average past earnings.

Contribution to the public pension system $\tau_{p,t}(y_{i,j,e,t})$ differs across the three insurance categories. Individuals of category 1 pay a fixed amount to the basic pension system from age 20 to 59. The monthly premium is 15,590 yen in 2015. The pension tax on earnings for the employer pension is about 17.5% in 2015 will gradually increase to reach 18.3% in 2018 and stay constant thereafter. The payment is equally shared by an employer and an employee. For category 2 workers, the contribution proportional to earnings covers both the first-tier and second-tier payments. Category 3 insured persons, who are dependent spouses of category 2 workers, contribute none.

Note that there was a pension reform in 2004 which aimed to reduce benefits automatically with a rise in longevity and a decline in the number of the insured each year, through a mechanism called "macroeconomic slide." The slide, however, has not worked as expected and the adjustment was implemented for the first time only in 2015. Given the uncertainty about how the slide will function over the coming decades, we do not consider the automatic slide in the baseline transition. We will simulate a reform scenario and a transition in which benefits are reduced by a fixed percentage, and the reform would approximate effects of a successfully implemented macroeconomic slide.

Health and long-term care insurance programs: The Japanese government stipulates universal health insurance coverage to all individuals and long-term care to those at 40 and above.

Contribution to the health insurance system $\tau_{m,t}(y_{i,j,e,t})$ is tied to the categories of the public pension system described above. Individuals in category 1 of the pension system make a premium payment for the coverage and the amount differs by the household size, income and other conditions. In the model, we compute a lump-sum premium payment so the model matches the aggregate premium payment of individuals in the first category. Category 2 workers pay premium that is proportional to their earnings. The rate varies across "unions" (*kumiai*), groups that offer the coverage to employees and depends on the level of medical expenditures incurred in the group. There are about 1,400 health insurance unions (as of 2014) and some are organized within a firm or others are operated jointly by multiple firms in the same industry. Many small and medium-sized companies do not own their own health insurance unions and join the Japan Health Insurance Association (JHIA, *kyokai kenpo*), the largest insurance group administered by the government (MHLW). The premium rate of the JHIA increased over time to reflect the rise in the covered medical expenditures and stands at 10% of earnings, which is equally split by an employer and an employee. We use the premium rates of the JHIA in the computation. Category 3 individuals do not make any contribution to the health or long-term care insurance system.

Contribution to the long-term care insurance, $\tau_{lc,t}(y_{i,j,e,t})$, is also collected depending on the three categories of the pension coverage. Differently from health insurance, long-term care insurance covers individuals at and above age 40 only and the premium is collected from covered individuals. Individuals at ages between 40 and 65 and in category 1 make a premium payment that is set based on income and family size. Those in category 2 pay contribution proportional to their earnings. The premium rate varies over time and it can differ by the union through which they pay the premium. The rate at the JHIA stands at 1.58% in 2015. We use the actual premium rates of the JHIA in the simulation up to 2018 and assume that it will remain constant thereafter in the baseline scenario. For individuals above age 64, there is a premium which also varies by the individual's income. We compute per capita premium for the two age groups so we match each aggregate premium revenues for each group and use these values in the simulation.

The health insurance copay is age-dependent. The insurance covers 80% of gross expenditures for individuals at ages 0 to 5, 70% for ages 6-69, 80% for 70-74 and 90% for those above 74. The long-term care insurance covers 90% of gross expenditures of all the insured at and above age 40. We assume that the coverage rates are time-invariant in the baseline simulations and will analyze alternative policies.

Taxes: We let the model follow the path of the actual consumption tax rates in the past and also assume that the government will raise the tax rate from the current 8% to 10% in 2019. The capital income tax on return from individuals' riskless saving is set to 20%, which is the tax rate on interest income from a bank or from bond investment. Interest income from government bonds is also taxed at 20%.

We compute the effective labor income tax rate based on the total earnings in the model and total labor income tax revenues of 30.3 trillion yen and set $\tau_{l,t}$ at 12.9%.

Although we do not model the behavior of firms, the tax payment from the corporate sector is included in the government budget to approximate the size of the government and expenditures. We let a corporate sector generate profits, which evolve and grow exogenously at the economy-wide growth rate and pay taxes. We compute the effective corporate income tax rate based on corporate income and tax revenue data, which stands at 21.3% in 2015. We assume the same tax rate during the transition.

Finally we set a lump-sum tax $\tau_{ls,t}$ paid by each individual to match the total tax revenues of 100.0 trillion yen in 2015.

Transfers and other expenditures: Total transfers (excluding pension benefits) TR_t in 2015 are 15.2 trillion yen and per capita transfers are set to match the aggregate.

The government expenditures including spending for health and long-term care insurance programs net of premium payments are 84.2 trillion yen in 2015. We set per capita expenditures to match this amount in the initial year of the transition. We have both expenditures grow with the productivity growth during the transition.

Public pension fund and government debt: The pension fund F_t follows the law of motion as described in equation (5). X_t is contribution from the general government budget, which is set to 1/2 of total basic pension expenditures each year. The value of outstanding assets in the fund is 203.6 trillion yen in 2015 and it will be the initial value of the transition. We assume that the real return on the pension fund $r_{f,t}$ is 2.0%.[12]

The government debt evolves as in equation (4). The initial net debt B_t in 2015 is 831.6 trillion yen, or about 156% of GDP. From the SNA table, the stock of liabilities of central and local government in 2015 was 1,262 trillion yen, or 237% of GDP. We then subtract financial assets of 634 trillion yen and exclude the total assets of 203.6 trillion yen held in the public pension fund since we have the dynamics of the fund F_t separately from that of B_t, to obtain the net debt amount.[13] We assume that the interest rate paid on the government debt $r_{b,t}$ is 1% in the baseline scenario.

3.4 Technology and growth

We assume that wages grow at an annual rate of 1.5%, based on the historical average of the total factor productivity growth rate. We assume that the interest rate, which is set at 3%, and wage growth rate are constant over the simulation period between 2015 and 2100. In section 4, we consider alternative scenarios on various macroeconomic variables including the economy-wide growth rate.

3.5 Consumption profiles

We calibrate the consumption profile over the life cycle to match individual data. We extract the life cycle component of consumption expenditure of individuals, using the Family Income and Expenditure Survey (FIES) by the Ministry of Internal Affairs and Communications. The FIES is a monthly diary survey with information on earnings, income and expenditures of Japanese households.[14] All variables are deflated with CPI.

We follow the estimation strategy of İmrohoroğlu et al. (2016) and use the extended data set from 1981 to 2015. We estimate the following equation:

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

where C_{it} denotes expenditures of an individual, excluding purchase of a house. $D_{i,t}^{\text{age}}$ is a vector of age dummies for ages 20-95 which represents the pure life cycle component

[12] The nominal return for 2006-2015 was 2.68% (2.70% in 2001-2015) according to the Review of Operations in Fiscal 2015 of the Government Pension Investment Fund (GPIF).

[13] The net debt differs from the gross debt of the government before adjusting for the financial assets owned by the government, as often reported in the official statistics or projections.

[14] For more details on the data, see Lise et al. (2014).

of expenditures, and we extend the consumption profile to 105 by linear extrapolation. D^{time} is a vector of year dummies. Following Deaton (2011) and Aguiar and Hurst (2013), we impose the following two restrictions, $\sum_t \beta_t = 0$ and $\sum_t t\beta_t = 0$, on the regression coefficients. Because of collinearity among age, cohort (birth year) and calender year, it is impossible to estimate the age dummies without these restrictions. $D^{\text{cohort}}_{i,t}$ is a vector of five-year birth cohort dummies such as individuals born before 1924, between 1925-1929, between 1930-1934, etc. $\mathbf{X}_{it}$ represents a vector of household characteristics including the gender of the household head, the number of adults, and the number of dependent children below age 16 in each household.

4 Numerical results

4.1 Demographics

Before presenting numerical simulations and transition dynamics of macroeconomic variables, we will describe in detail the characteristics of the demographic transition that Japan will experience over the coming decades. The projections of mortality risk, fertility rates and population are based on the 2017 estimates of the National Institute of Population and Social Security Research (IPSS).

Figure 6 shows the age-distribution of population in 2017. The peak of the population is in late 60s, the first baby-boomers reaching the retirement age. The second baby boomers, currently in mid-40s, will follow the wave or retirement in about two decades. The population below mid 40s falls almost monotonically, as a result of a continuous decline in fertility rates since 1970s.

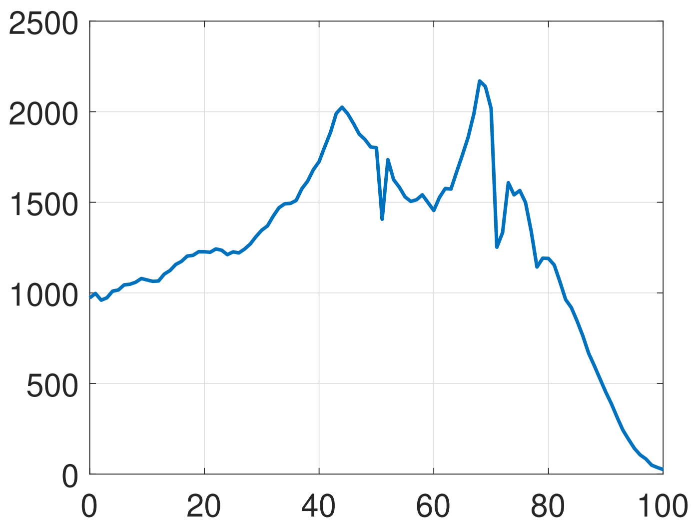


Figure 6: Population by age in 2017

Figure 7 shows the historical and projected total fertility rates. The total fertility rate now lies below 1.5 and is projected to remain at a low level until 2065, the last year of the official projections. The IPSS reports high and low scenarios, as indicated in figure 7. Even a high scenario predicts fertility rates well below the replacement level, around 2, that is needed to keep the population from falling.

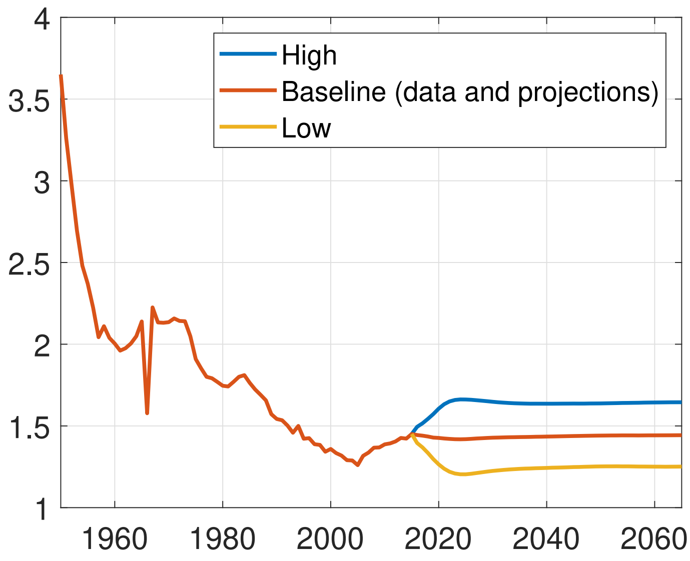


Figure 7: Total fertility rate: data and projections

The IPSS also reports long-run projections of the population beyond 2065, assuming that mortality risks and fertility rates remain constant thereafter. Figure 8 shows the population projections up to 2100 under the three scenarios of fertility rates. Under the baseline scenario, the population will be less than half of the level in 2015, reaching 60 million, by the end of the century. Depending on realized fertility rates, the total population could be higher or lower by about 10 million.

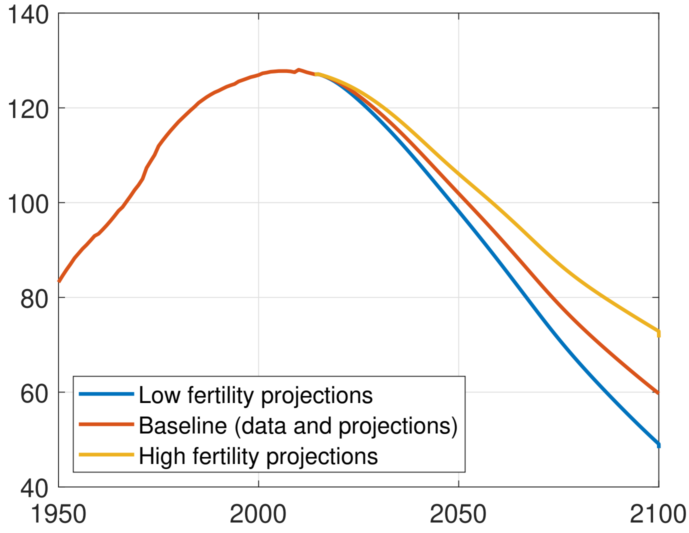


Figure 8: Total population projection (in millions): baseline and alternative fertility projections

While the number of newborns declines, people are living longer, offsetting the decline in population though not strongly enough to dominate the overall direction. Figure 9 shows the life-expectancy in the data and projections. Life-expectancy rose sharply in the last several decades, from about 60 for males and 63 for females in 1950 to 81 and 87 in 2015, respectively. It is expected to reach 85 for males and 91 for females by 2065 according to the IPSS projections.

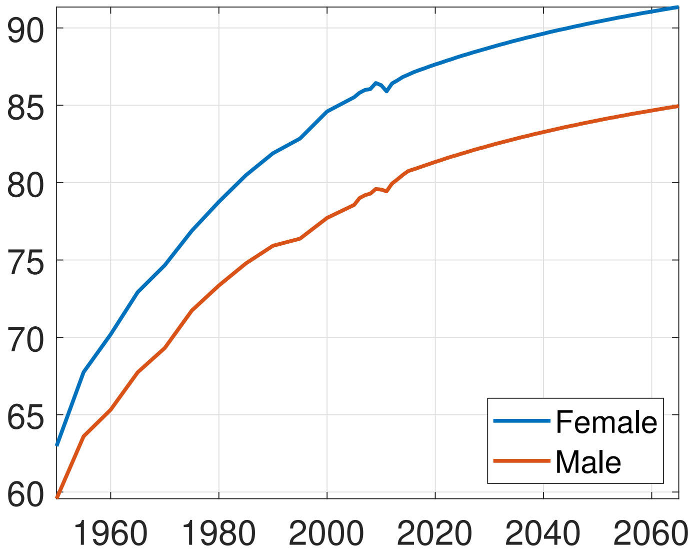
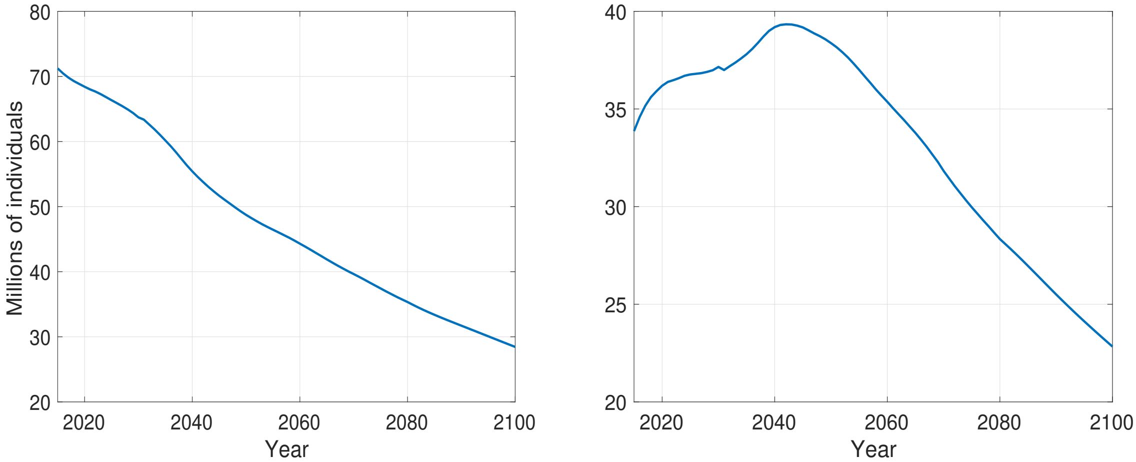


Figure 9: Life expectancy: data and projections

Chronically low fertility rates and a rise in longevity that Japan has experienced and will continue to see imply a rapid rise in the size of the elderly relative to the working age individuals. As shown in figure 10, the number of individuals at ages 20 to 64 will fall from 70 million in 2015 to less than 30 million by the end of the century. At the same time, the number of the elderly at and above 65 will rise until mid-2040s and generate a sharp increase in the old-age dependency ratio, as shown in figure 11. The ratio is already high at 48% in 2015 and will rise to 80% by early 2050s and stay at around 80% during the second half of the century.



(a) Young (age 20-64) (b) Old (age 65 and up)

Figure 10: Population by age group

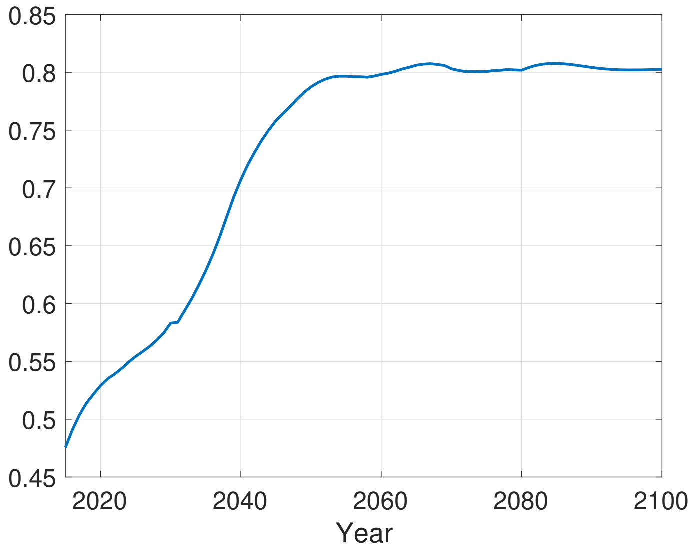
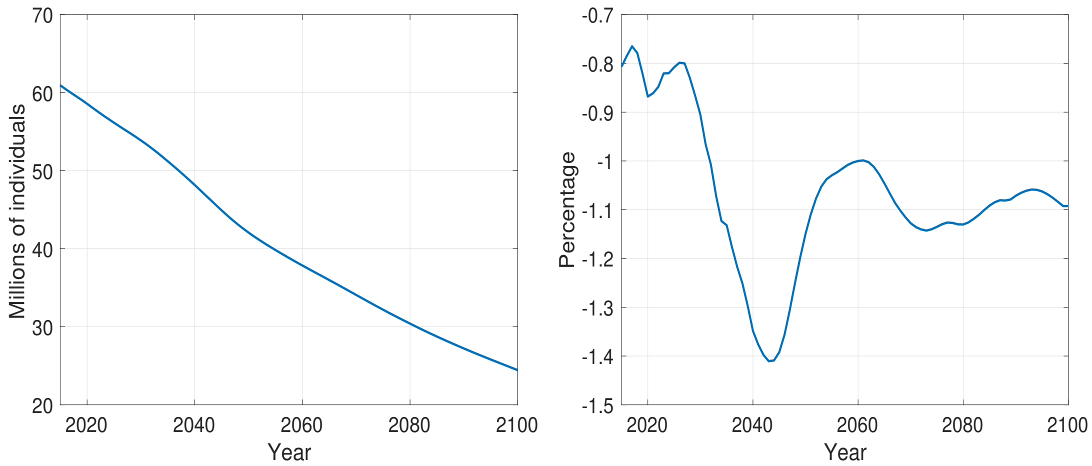


Figure 11: Dependency ratio (age 65 and up / age 20-64)

A high old-age dependency ratio implies a heavy fiscal burden to finance government transfer programs that are operated as a pay-as-you-go system. As shown in figure 12, working population will decline even faster than working age population as the distribution of the working-age population will become more concentrated among those closer to the retirement age because of the aging of baby boomers and the low fertility rates below the replacement rate. The growth rate of working age population remains negative throughout the century, lying below -1% for most years as shown in figure 12(b).

The changing demographics and age structure in Japan during coming decades lie at the center of the quantitative analysis of fiscal sustainability and various policy options that we will examine in the next section.



(a) Working population

(b) Growth rate

Figure 12: Working population and growth

4.2 Benchmark economy and transition

In this subsection, we present our model's projections for future paths of the key macroeconomic and budgetary indicators. In particular, we start with the measures of GDP and related quantities, and then focus on the fiscal variables which are driven entirely by the demographic projections, given our calibration using Japanese micro data sets and under the assumption of implementing current laws and social insurance policies without changes. In the baseline scenario, we will let the government debt B_{t+1} in the flow budget equation (4) adjust to absorb imbalances each year. Our model is calibrated to match the moments of Japanese data in 2015 and the first year of forecast is 2016.

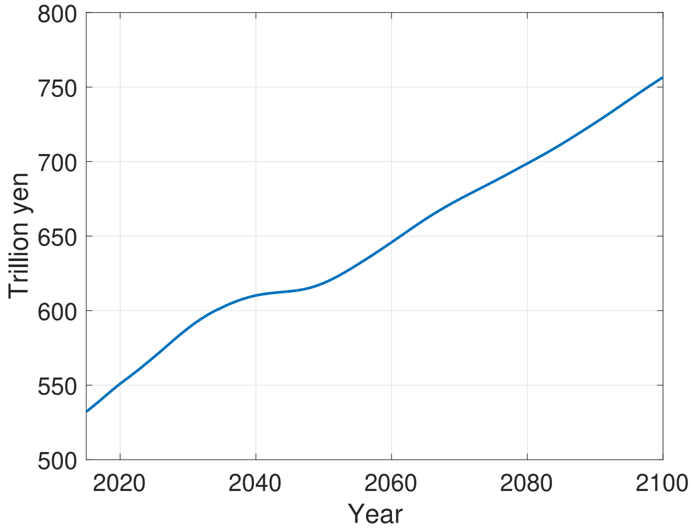
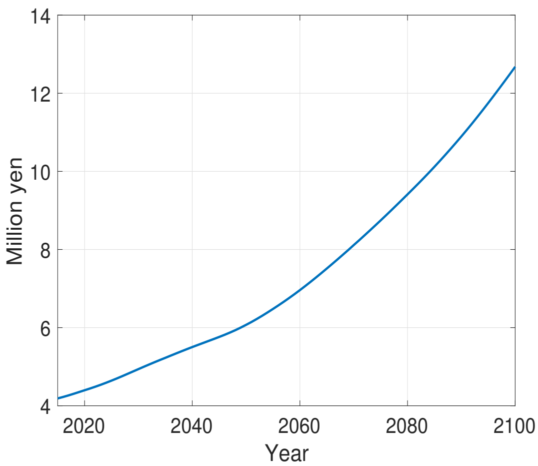
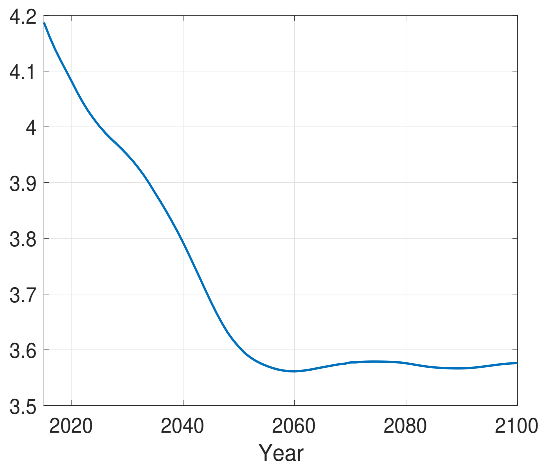


Figure 13: Aggregate output (GDP)(in 2015 yen)

Aggregate GDP and Living Standards In figure 13, we display the time path of GDP, starting from 2015, our calibration year. The rate of growth of GDP depends on the projected demographics and our assumption on the 'balanced growth rate' of GDP per capita of $g_t^w = 1.5\%$. Namely, $GDP_{t+1} = (1 + g_t^w)(1 + g_t^e)GDP_t$, where g_t^e is the growth rate of working population and $GDP_{2015} = 532.2$ trillion yen.[15] Aggregate GDP rises monotonically from its 2015 value of 532 trillion yen and this is entirely driven by our assumption of per capita growth of 1.5%, which is higher than the decline in the rate of growth of working population projected during the century. Figure 14(a) shows an increase in per capita GDP due to the same assumption.



(a) GDP per capita



(b) GDP per capita adjusted for growth

Figure 14: Output (GDP) per capita (in 2015 yen)

[15]Throughout the paper, we abstract from inflation and report real values of variables.

Note that if Japan does not produce the 1.5% wage growth and the third arrow of Abenomics fails, then our projections would show a sharp decline in the living standards of a typical Japanese worker with per capita GDP falling from about 4.2 million yen per year to just under 3.6 million yen by 2050, as shown in figure 14(b).

Total Government Receipts, Outlays, Budget Deficit, and Debt We will now focus on our model's projections of Japanese government debt and a decomposition of fiscal imbalances that contribute to the increase in the debt to GDP ratio. First, we display the projections of total government outlays and receipts in figure 15.

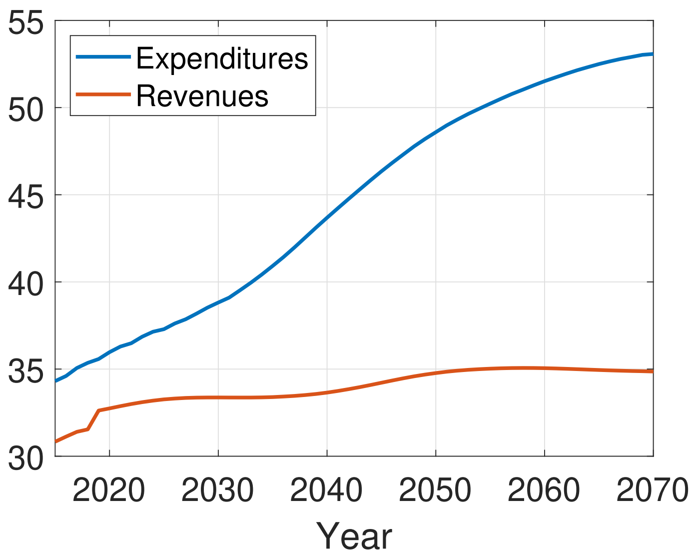


Figure 15: Total government outlays and receipts (% of GDP)

The planned increase in the consumption tax rate from 8% to 10% in 2019 is incorporated in the simulation and shows as an uptick in receipts in figure 15 and a downtick in total government budget deficit below. According to figure 15, total outlays are projected to exceed receipts into the foreseeable future and to grow at an increasing pace. Figure 16 shows the ratio of total government deficit to GDP and points to an increasing debt to GDP ratio to finance these deficits.

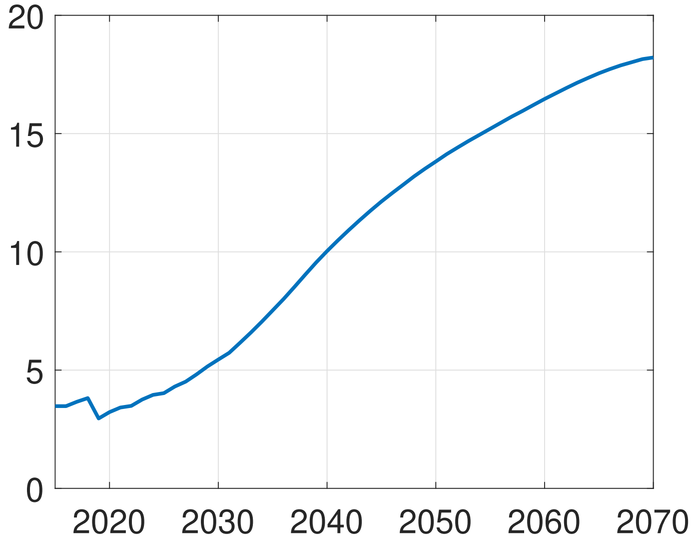


Figure 16: Total government budget deficit (% of GDP)

Figure 17 shows the time path of the net debt to GDP ratio, $(B_t - F_t)/Y_t$, starting from 2015. With the public pension fund subtracted from the outstanding, consolidated government indebtedness, this net debt to GDP ratio rises from 131.00% in 2020 to 228.72% by 2040 and monotonically increases to heights that are obviously unprecedented. The accounting model used in this paper portrays a sobering picture of how rapidly the Japanese fiscal outlook would deteriorate without any actions.

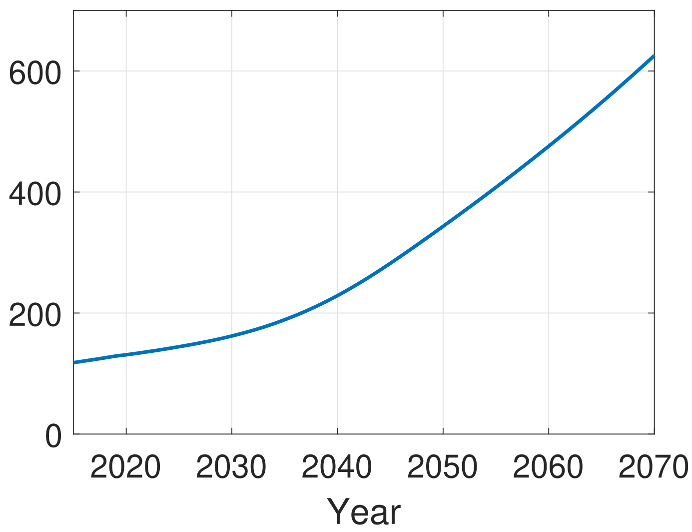


Figure 17: Net government debt to GDP ratio (net of F, %)

What Contributes to Net Borrowing? In order to quantify underlying factors that contribute to the rapid rise in the debt to GDP ratio, consider the following decomposition of a change in net debt to GDP ratio (total deficit) into five factors:[16]

$$\frac{D_t}{Y_t} \equiv \frac{(B_{t+1} - F_{t+1}) - (B_t - F_t)}{Y_t} = \frac{(G_t + TR_t - T_t - TC_t)}{Y_t} + \frac{(P_t - PR_{p,t})}{Y_t} + \frac{(M^g_t - PR_{m,t})}{Y_t} + \frac{(LC^g_t - PR_{lc,t})}{Y_t} + \frac{(r_{b,t}B_t - r_{f,t}F_t)}{Y_t}.$$

The total budget deficit (as % of GDP) has five components: (1) basic primary deficit excluding public pension, health and long-term care insurance, (2) public pension deficit, (3) health insurance deficit, (4) long-term care deficit and (5) net interest payments.

We are particularly interested in identifying which component of the government budget presents a larger fiscal challenge in the coming decades. Figure 18 displays the contribution to net borrowing from the five components of total government budget deficit.

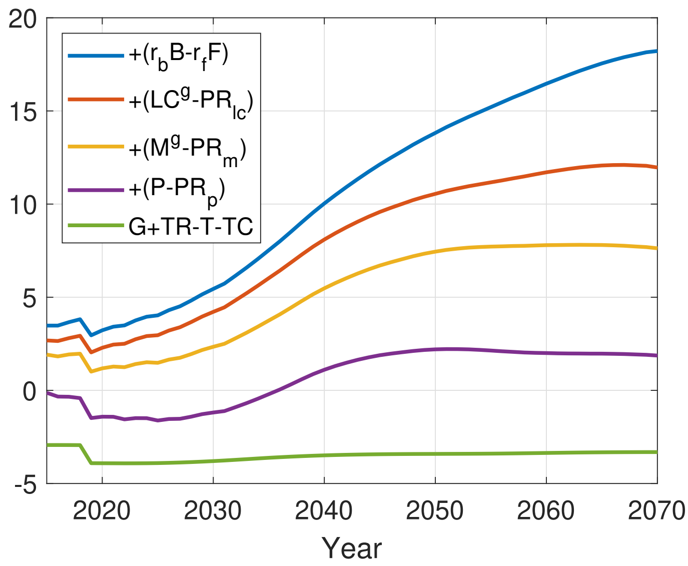


Figure 18: Sources of net borrowing

[16] Including the payment out of general tax revenues to finance 50% of the total basic pension benefits, the above break-down is re-written as follows.

$$\frac{(B_{t+1} - F_{t+1}) - (B_t - F_t)}{Y_t} = \frac{(G_t + TR_t + X_t - T_t - TC_t)}{Y_t} + \frac{(P_t - PR_{p,t} - X_t)}{Y_t} + \frac{(M^g_t - PR_{m,t})}{Y_t} + \frac{(LC^g_t - PR_{lc,t})}{Y_t} + \frac{(r_{b,t}B_t - r_{f,t}F_t)}{Y_t}.$$

Figure 18 clearly demonstrates that the three social insurance programs; public pension, health insurance and long-term care insurance, are the main contributors to the overall budget deficits, suggesting possible avenues to reform the Japanese social insurance programs to achieve fiscal sustainability. Note that the projected demographics start to stabilize after 2065 which is reflected in the stabilization of the components of total budget deficit related to social insurance programs. The main contributor to the deficits and hence the accumulation of debt, however, become net interest payments after 2065. Although we assume a real interest of 1% on government debt, the stock of debt reaches unprecedented levels and so do net interest payments.

In order to see the contributions of different components more clearly, table 1 provides decennial snap shots starting from 2020.

Table 1: Sources of Net Borrowing

Year	d_1	d_2	d_3	d_4	d_5	deficit	debt
2020	−0.0391	0.0250	0.0260	0.0110	0.0094	0.0322	1.3100
2030	−0.0380	0.0261	0.0353	0.0188	0.0123	0.0545	1.6204
2040	−0.0349	0.0459	0.0437	0.0262	0.0194	0.1003	2.2872
2050	−0.0341	0.0561	0.0525	0.0310	0.0327	0.1382	3.4331
2060	−0.0336	0.0536	0.0579	0.0391	0.0476	0.1646	4.7571
2070	−0.0331	0.0518	0.0576	0.0434	0.0625	0.1822	6.2539

basic primary deficit: $d_1 = (G_t + TR_t - T_t - TC_t)/Y_t$
pension deficit: $d_2 = (P_t - PR_{p,t})/Y_t$
heath insurance deficit: $d_3 = (M_t^g - PR_{m,t})/Y_t$
long-term care deficit: $d_4 = (LC_t^g - PR_{lc,t})/Y_t$
net interest payment: $d_5 = (r_{b,t}B_t - r_{f,t}F_t)/Y_t$
deficit: $D_t/Y_t = d_1 + d_2 + d_3 + d_4 + d_5$
debt: $(B_t - F_t)/Y_t$

According to table 1, the basic, non-social insurance part of the budget is in surplus of around 3.3% to 3.9% of GDP. Pension and public health deficits each contribute roughly equal parts to the total deficit to GDP ratio, about 5% each by 2050. The long-term care deficit starts at about 1.1% in 2020 but as the population aging accelerates, it reaches about 4% after 2060. The burden of the net interest payments becomes increasingly pronounced and reaches a level nearly equal to the rest of the contributions by 2050. This clearly highlights the importance of fiscal consolidation in the near future so that Japan can stabilize debt to GDP as early as possible.

Public Pension Fund Currently, Japan has a public pension fund equal to about 40% of GDP. With recent changes in the management of its portfolio, there has been an increase in the returns to this fund. However, the rapid increase in the dependency ratio will create increasing amounts of pressure on the pension system and this fund will eventually decline, as pension outlays further exceed pension receipts.

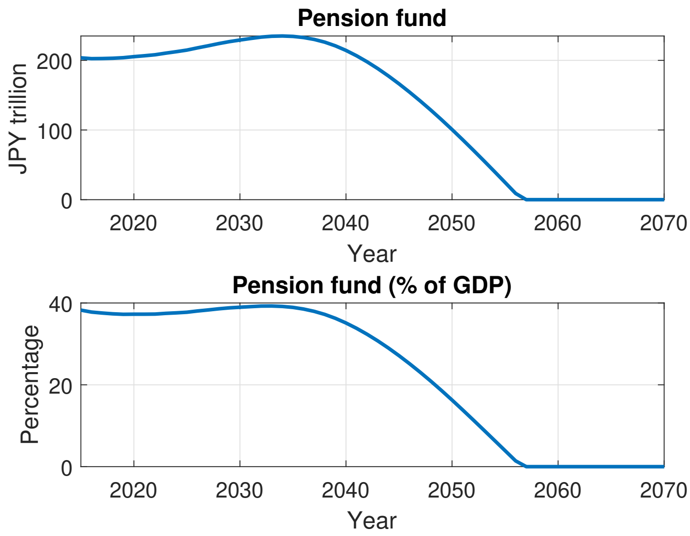
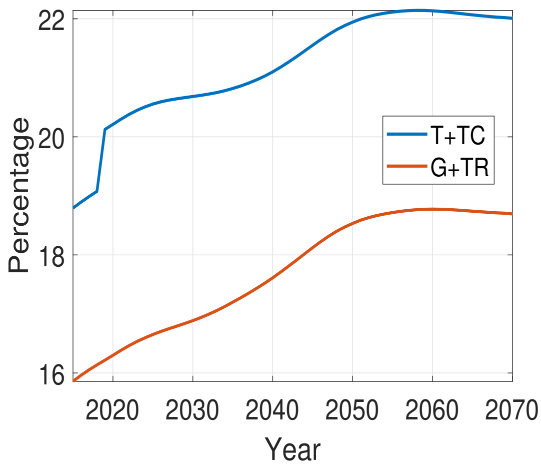


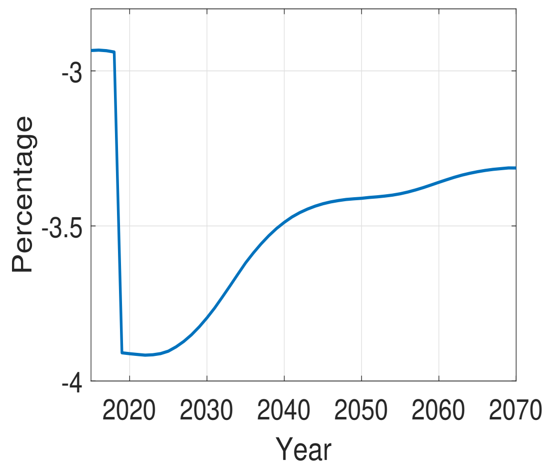
Figure 19: Pension fund (% of GDP)

Figure 19 displays the ratio of the public pension fund to GDP and indicates that it will be depleted in 2057 without any reform.

Basic Primary Outlays and Receipts Figure 18 and table 1 argue that the social insurance programs are projected to create very large deficits until the 2060s and with the resulting increase in the debt to GDP ratio net interest payments will then become the main contributor to the fiscal sustainability issue facing Japan. We will now look at the government accounts and the deficit in more detail.



(a) Expenditures, transfers and taxes

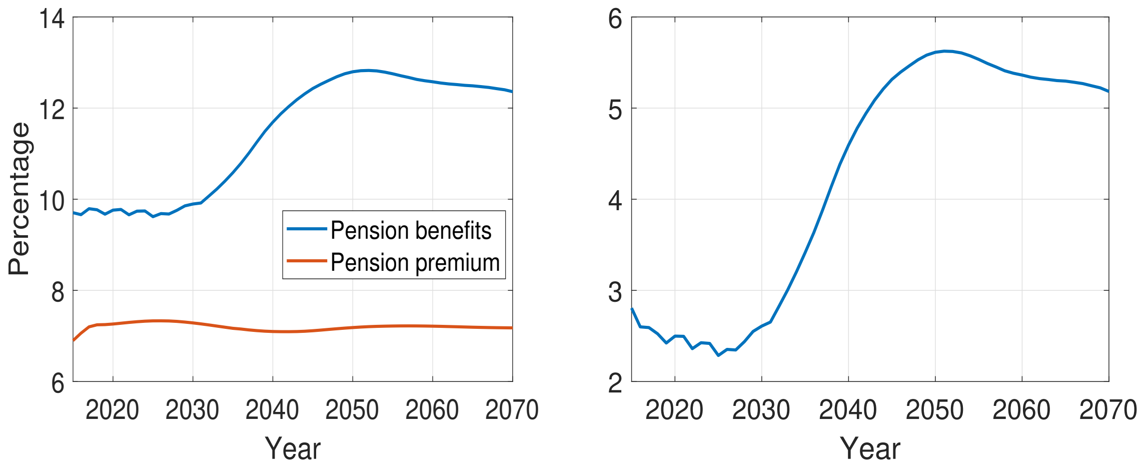


(b) Deficit $(G + Tr - T - TC)$

Figure 20: Budget decomposition (1): Basic primary balance excluding pension, health and long-term care insurance (% of GDP)

Figure 20 shows the projected paths of tax revenues and government purchases and transfers (other than pension, health insurance and long-term care) and the deficit created by this portion of government accounts. This portion of the budget is in surplus (the deficit is negative) and after the assumed increase in the consumption tax rate in 2019, the surplus converges to about 3.3% of GDP by 2060.

Pension Outlays and Receipts Figure 21 shows the public pension system's outlays, receipts and the deficit. The premiums collected for pensions remain relatively stable and converge to about 7.2% of GDP. Pension outlays, however, start at just under 10% of GDP, making the early deficits less than 3% of GDP, but accelerate after 2030 to just under 13% of GDP to stabilize around 12.2% of GDP. The sharp rise occurs after 2030 because of an increase in the size of cohorts reaching the normal retirement age of 65, as shown in figure 6.[17] As a result, the pension deficit rises from under 3% initially, increases to over 5.6% and stabilizes at about 5.2%. Each of these annual pension deficits raises debt to GDP by that amount directly, and, indirectly by raising the net interest payments in the future.



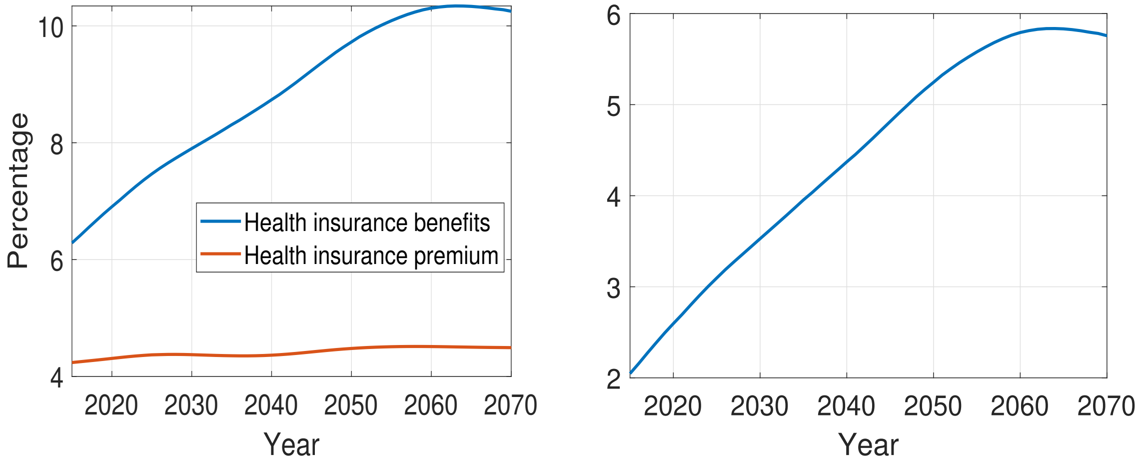
(a) Pension benefits and premium collected

(b) Pension deficit (benefits-premium)

Figure 21: Budget decomposition (2): Public pension (% of GDP)

Public Health Insurance Outlays and Receipts Figure 22 displays the public health insurance accounts. The health insurance premium remains stable relative to GDP, while aggregate health insurance outlays monotonically rise to about 10.2%, bringing the public health deficit to about 5.2% by 2050.

[17]The fertility rates declined sharply in 1950s after the first baby boom following the end of the war stabilized. The size of cohorts reaching 65 falls and stays at a low level until around 2030, which will prevent the benefits from rising as shown in figure 21.



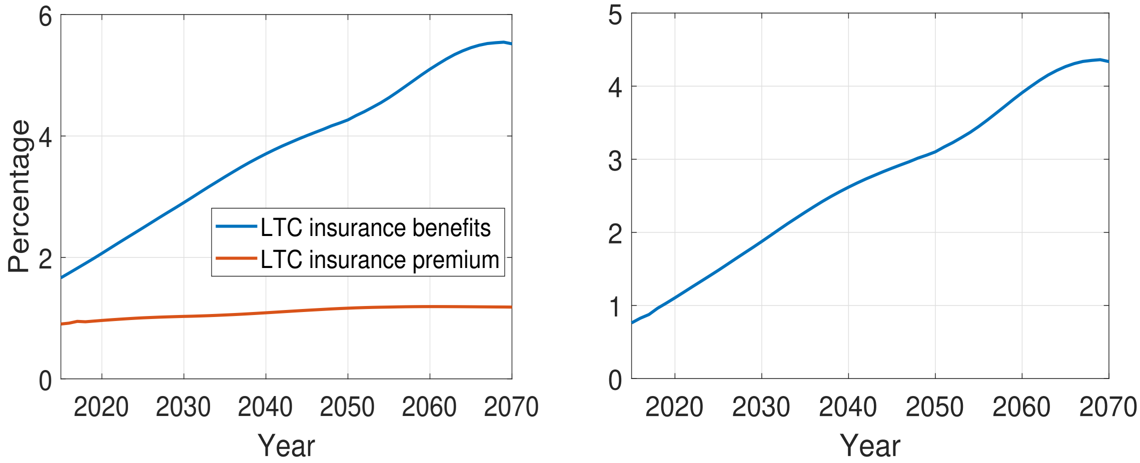
(a) Health insurance benefits and premium

(b) Health insurance deficit (benefits-premium)

Figure 22: Budget decomposition (3): Health insurance (% of GDP)

The publicly funded retirement and universal health insurance programs are projected to create a budget deficit of 10% of GDP by 2050, even without any further fiscal burden from the shortfall in the LTC part of the public social insurance accounts. In addition, the additions to debt to GDP will also raise the net interest payments, and contribute to fiscal problems.

LTC Outlays and Receipts The deficit caused by the public LTC program is currently just under 1%. With the projected aging, however, LTC outlays are predicted to rise monotonically to about 5.2% by 2070. With receipts remaining low at around 1.2% of GDP, this would create a deficit of about 4.2% of GDP, becoming a close third social insurance program to add to Japan's fiscal problems.

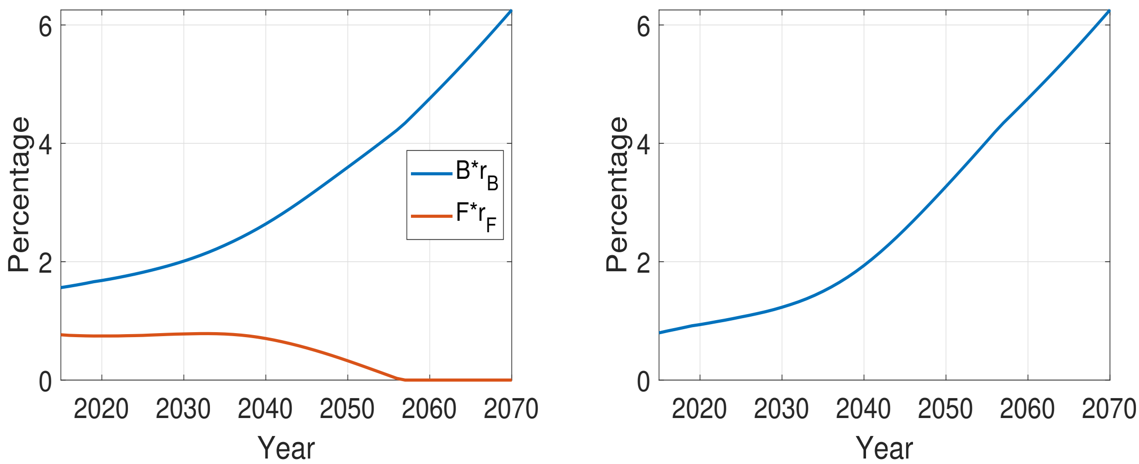


(a) LTC insurance benefits and premium

(b) LTC insurance deficit (benefits-premium)

Figure 23: Budget decomposition (4): Long-term care insurance budget (% of GDP)

Net Interest payments Figure 24 shows the interest payments on JGBs and the interest earned on the public pension fund, together with the difference between the two. As the public pension fund is projected to be depleted in 2057, the interest earned would disappear eventually. The total interest paid on JGBs, however, rises very sharply after 2020, making the net interest payments exceed 1% of GDP in 2023, 2% of GDP in 2041, and rising rapidly without any bound.



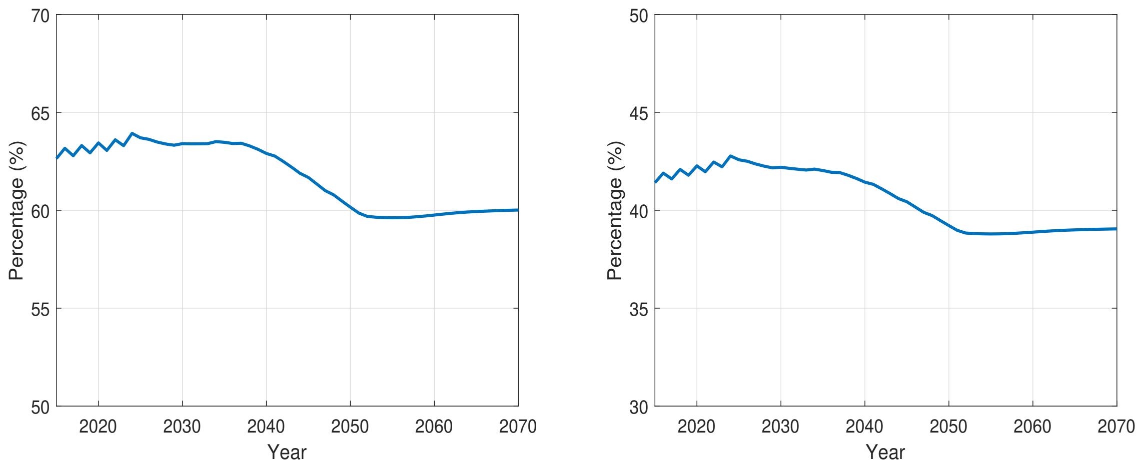
(a) Interest payment and receipt

(b) Deficit ($r_b B - r_f F$)

Figure 24: Budget decomposition (5): Debt services (% of GDP)

Figure 24 suggests that there is not much time to lose if the Japanese policymakers want to stop this unsustainable rise in the net interest payments and the debt to GDP ratio. If there is no significant fiscal consolidation soon, Japan's net debt to GDP ratio will exceed 150% in 2027 and 200% in 2037, while the public pension fund is still around 35-40% of GDP.

Public Pension Replacement Rates Figure 25 shows the projected pension replacement rates using two definitions. The first frame shows the replacement rate according to the Japanese official definition. It is the total pension benefit for what the government calls 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. This replacement rate falls from about 63% to about 60%. 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 reduction from about 42% to about 39%. According to our model's projections, while the dependency ratio rises rapidly, there is little change in the replacement rates regardless of which definition one uses. This suggests that pension reform would greatly help achieve fiscal sustainability.



(a) Japanese official definition

(b) Standard definition: category-2 male

Figure 25: Pension replacement rate

4.3 Sensitivity Analysis

In this subsection and the next, we consider the effects of alternative assumptions on future productivity growth rates, policy experiments and economic outcomes on future fiscal sustainability in Japan. We do not have a theory of debt and our focus is to instead document the effects on debt to output ratio from various policies and outcomes. As Japan has had a debt to output ratio of about 150% in the 2010s and may see a ratio closer to 200% in the near future, we look at outcomes that maintain such a level or lower as possibly delivering fiscal sustainability.

Alternative Wage Growth Rates Our baseline simulations assume that the wage grows at 1.5% per year.[18] A lower growth rate implies a smaller tax base in the future and therefore a worsening of the fiscal situation, whereas a higher growth rate could provide a significant relief during the transition.

Table 2: Alternative Wage Growth Rates: Deficits and Debt

	0.5%		1.0%		Baseline: 1.5%		2.0%		2.5%	
Year	deficit	debt	deficit	debt	deficit	debt	deficit	debt	deficit	debt
2020	0.038	1.335	0.034	1.322	0.032	1.310	0.030	1.297	0.029	1.284
2030	0.068	1.878	0.061	1.745	0.055	1.620	0.048	1.503	0.042	1.391
2040	0.124	2.950	0.112	2.600	0.100	2.287	0.090	2.009	0.080	1.761
2050	0.174	4.755	0.155	4.041	0.138	3.433	0.124	2.916	0.111	2.477
2060	0.209	6.981	0.185	5.759	0.165	4.757	0.147	3.935	0.131	3.263
2070	0.238	9.680	0.207	7.765	0.182	6.254	0.161	5.060	0.144	4.112

deficit $= D_t/Y_t$ and debt $= (B_t - F_t)/Y_t$.

According to table 2, if growth slows down to 0.5%, instead of the assumed 1.5%, then the debt to GDP ratio in 2060 would be 47% higher than that in the baseline case. Policies and institutions that enhance the long run growth prospects could help significantly with fiscal sustainability in Japan. Large gains come from the improvement of the pension deficits since the premium revenues will rise immediately with the wage growth, while the benefits of existing retirees do not increase immediately.

The depletion years for the public pension fund under alternative growth rates of 0.5%, 1.0%, 2.0%, and 2.5% are 2051, 2053, 2063, and, 2073, respectively. As mentioned before, the baseline depletion year is 2057.

Female Labor Force Participation and More Regular Jobs The female labor force participation rates in Japan are not very different from those in the United States. In fact, for prime age females (25-54), Japan has a higher FLFP rate than the U.S. However, there are two significant differences in the labor market outcomes for females in Japan when their experience is compared to that of males. First, the proportion of contingent job holders is much higher for females than males, and, second, earnings conditional on job type are much lower for females than males. In this subsection, we will consider experiments in which we change the labor market outcomes of females.[19]

[18] The wage growth in a general equilibrium model could be endogenously driven by different factors. Assessed in terms of the growth of the total factor productivity along a balanced-growth path, the 1.5% wage growth corresponds to a 1.0% growth rate in TFP when the capital share is one-third.

[19] Yamaguchi (2016) studies factors that influence wages of female workers in Japan and identifies positive effects of gender and opportunity-related policy, based on the linked Japanese employer and employee survey conducted by the RIETI.

In particular, we consider four experiments described below.[20]

- Scenario A: Female LFP rate = Male LFP rate; composition of regular/contingent/self employment is the same as in the baseline.
- Scenario B: Regular/contingent/self employment composition same as males: female LFP rate is the same as in the baseline.
- Scenario C: Both the composition of job types and the labor force participation rates are the same as males.
- Scenario D: Scenario C plus same earnings as males.

Table 3: Female LFP and More Regular Jobs: Deficits and Debt

	Baseline		Scenario A		Scenario B		Scenario C		Scenario D	
Year	deficit	debt	deficit	debt	deficit	debt	deficit	debt	deficit	debt
2020	0.032	1.310	0.031	1.295	0.030	1.310	0.028	1.294	0.018	1.260
2030	0.055	1.620	0.037	1.378	0.033	1.517	0.012	1.260	−0.012	1.080
2040	0.100	2.287	0.075	1.838	0.077	1.968	0.048	1.473	0.023	1.060
2050	0.138	3.433	0.106	2.712	0.112	2.874	0.077	2.072	0.050	1.409
2060	0.165	4.757	0.129	3.743	0.138	3.962	0.098	2.831	0.069	1.924
2070	0.182	6.254	0.145	4.925	0.157	5.242	0.113	3.744	0.082	2.587

deficit = D_t/Y_t and debt = $(B_t - F_t)/Y_t$.

According to table 3, a change in the labor market outcomes for females produces a significant fiscal relief in Japan. Having a higher fraction of females with jobs without changing the composition of job types or earnings in scenario A results in a reduction of deficits by 3.2% of GDP by 2050 and debt by 72.1% of GDP. The improvement in the deficit is even larger with Scenarios C and D. In fact, under Scenario D, there is a budget surplus in 2030 and the debt to GDP ratio actually declines for 3 decades; by 2070, debt to GDP ratio is just over 40% of what it would be under no change in female labor market outcomes.

More participation of female workers not only increases the tax base and aggregate output, but also improves the budgets of health and long-term care insurance programs and reduces their deficits because the contribution will rise significantly. The pension

[20] Raising the FLFP rate and, in particular, raising the fraction of females with regular jobs maybe too heroic. Although the FLFP rate has significantly increased recently, women still have a disproportionately high ratio of irregular jobs. Furthermore, significant changes in policies that would lead to these outcomes are likely to change factor prices. We abstract from these potential changes and argue that the outcomes considered can demonstrate their quantitative significance.

budget also improves but by less than those of the other two programs, because the government would eventually have to pay a larger amount of benefits once female workers with higher earnings reach the retirement age given that benefits are tied to the contribution. These results suggest that policies that improve female labor market outcomes would help significantly in achieving fiscal sustainability by having them contribute more out of their increased earnings.

The increases in the female participation in all the above cases suggest later depletion of the public pension fund. Under Scenario A, the year of depletion is 2065; Scenarios B and C produce depletion years of 2073 and 2091, respectively. Scenario D, on the other hand, put the fund at 17.7% (and declining) in 2100.

Increases in the Relative Price of Health and Long-term Care Services Medical expenditures rose by 2.4% per year on average for 10 years before 2015 according to the national medical expenditure statistics of the MHLW. According to the MHLW, some of this increase was due to aging and the increase in the elderly population. However, the unexplained part was still about 1.5% per year.

In this subsection, we present the results of experiments in which either the medical or long-term care expenditures rise by 10 to 20% in 10 or 20 years, in addition to the aging of the society. The level of expenditures is then assumed to remain permanently high at their new levels. This raises the public portion of medical expenditures and reduces the disposable (after out of pocket expenses) incomes of individuals.

Table 4: Medical and Long-term Care Inflation: Deficits and Debt

	Baseline		Med: 10% in 10		Med: 20% in 20		LTC: 10% in 10		LTC: 20% in 20	
Year	deficit	debt	deficit	debt	deficit	debt	deficit	debt	deficit	debt
2020	0.032	1.310	0.036	1.316	0.036	1.316	0.033	1.311	0.033	1.311
2030	0.055	1.620	0.062	1.687	0.067	1.697	0.057	1.641	0.059	1.644
2040	0.100	2.287	0.110	2.435	0.119	2.522	0.104	2.340	0.108	2.372
2050	0.138	3.433	0.150	3.682	0.161	3.871	0.143	3.529	0.148	3.603
2060	0.165	4.757	0.178	5.116	0.191	5.417	0.171	4.902	0.177	5.025
2070	0.182	6.254	0.196	6.731	0.211	7.155	0.189	6.458	0.197	6.642

deficit = D_t/Y_t and debt = $(B_t - F_t)/Y_t$.

The increase in the relative price of medical services and LTC raises deficits of each program, although it does not play a major role in changing the fiscal outlook. The budget deficit to GDP and the debt to GDP ratios are slightly higher with medical and long-term care price inflation.

Alternative Demographic Assumptions So far, we have relied on the projections of the IPSS that are based on the medium fertility and medium age-specific survival probability estimates. IPSS also estimates two different variants, high/low of each of the drivers of demographic transition and in this subsection we report our quantitative findings from these alternative demographic projections.

Table 5: Alternative Demographic Assumptions: Deficits and Debt

	Baseline		Low Fertility		High Fertility		Low Mortality		High Mortality	
Year	deficit	debt	deficit	debt	deficit	debt	deficit	debt	deficit	debt
2020	0.032	1.310	0.032	1.309	0.033	1.311	0.034	1.313	0.030	1.307
2030	0.055	1.620	0.053	1.611	0.056	1.631	0.060	1.659	0.048	1.581
2040	0.100	2.287	0.098	2.264	0.103	2.313	0.110	2.399	0.091	2.175
2050	0.138	3.433	0.142	3.477	0.135	3.386	0.152	3.657	0.125	3.209
2060	0.165	4.757	0.177	4.990	0.153	4.532	0.181	5.114	0.148	4.397
2070	0.182	6.254	0.209	6.875	0.158	5.692	0.203	6.775	0.162	5.732

deficit $= D_t/Y_t$ and debt $= (B_t - F_t)/Y_t$.

According to table 5, low and high fertility cases are quantitatively similar to the baseline results except in the long run. For example, by 2070, low fertility produced modest deterioration in the fiscal outlook whereas high fertility yields some small reductions in the debt to GDP ratio. Different mortality assumptions seem to have an impact earlier and the deficit to GDP ratios differ by 1.3 to 1.5 percentage points under the two variants.

For these four alternative demographic projections, the depletion years for the public pension fund are 2056, 2058, 2053, and, 2062, respectively.

Comparison with 2012 Demographic Projections The IPSS releases demographic projections every five years. We make comparison of the projections and changes in implied fiscal outcomes under the new projections. There has been improvement in fertility rates over the last several years and new projections reflected upward shifts in the fertility projections, as shown in figure 26. Although the change is relatively small at about 0.1, the improvement makes long-run projections of the population and old-age dependency ratio brighter. Figure 27(a) shows that the population would be higher by about 10 million by 2100 and the dependency ratio is lower by 4 to 5 percentage points. In the medium term, however, over the next few decades, the projection does not show a major difference.

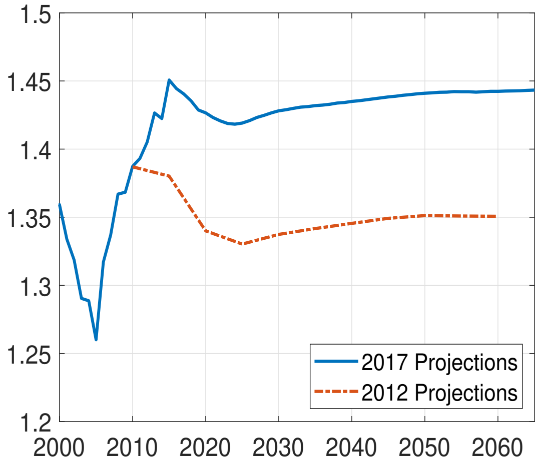
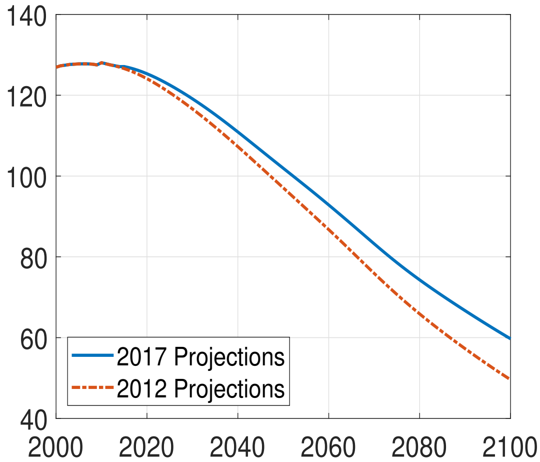
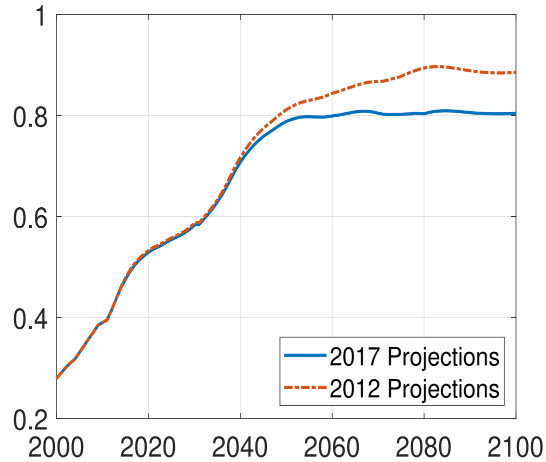


Figure 26: Total fertility rates: 2012 vs 2017 projections



(a) Population (millions)



(b) Old-age dependency ratio (age 65 and up/20-64)

Figure 27: 2012 vs 2017 demographic projections

Table 6 compares the fiscal situations under the two demographic projections. The difference between the two demographic projections appears to be small as far as the deficit to GDP ratios are concerned. However, the 2017 projections seem to have slightly improved the fiscal outlook. For example, the debt to GDP in 2060 is about 30 percentage points lower than that implied by the 2012 demographic projections. The year in which the public pension fund depletes under the older, 2012 projections, is 2056, one year earlier than implied by the newer 2017 demographic estimates.

Table 6: 2012 IPSS Projections: Deficits and Debt

Year	Baseline 2017 projections deficit	debt	2012 projections deficit	debt
2020	0.032	1.310	0.033	1.317
2030	0.055	1.620	0.054	1.637
2040	0.100	2.287	0.101	2.323
2050	0.138	3.433	0.144	3.554
2060	0.165	4.757	0.178	5.066
2070	0.182	6.254	0.205	6.909

deficit = D_t/Y_t and debt = $(B_t - F_t)/Y_t$

4.4 Policy Experiments

In this subsection, we describe the quantitative effects on future budget deficits and debt from a variety of policy experiments and economic outcomes. We do not presume that these policies are optimal or desirable in a Pareto sense. However, these are policies and outcomes that are openly discussed in current policy circles in Japan. For example, Prime Minister Abe has pledged, in September 2018, to raise the full retirement age beyond 65 and allow for pension benefit claiming beyond 70 years old. Indeed, the number of elderly workers, above 65 years old, has increased by about two million from 2014 to 2018. Similarly, there has been an increase in the FLFP recently, with an additional 1 millions female workers in employment over the past few years.

In addition, the consumption tax is set to increase from its current value of 8% to 10% later in 2019. Cuts in pension benefits, indexed to the size of the retiring cohort, and, increases in copay rates of the elderly are also being considered as part of an overall reform package. Therefore, the policies and outcomes explored in this section are among those that are publicly debated as ways to mitigate the looming fiscal crisis.

Extension of Full Retirement Age The full retirement age (FRA), the age at which workers become eligible for full retirement benefits, is 65 in Japan. In the United States, the 1983 social security reform has raised the FRA gradually so that the FRA will be 67 in 2027. In the experiments below, we extend the FRA from the current 65 to three alternative ages, 67, 69, and 71. We assume that the reform takes gradually and let the retirement age increase by one year every two years, starting in 2020. An increase of the FRA to 71, for example, will start in 2020 and the reform is complete in 2031.

Table 7: Extending FRA: Deficits and Debt

	Baseline		FRA 67		FRA 69		FRA 71	
Year	deficit	debt	deficit	debt	deficit	debt	deficit	debt
2020	0.032	1.310	0.031	1.309	0.031	1.309	0.031	1.309
2030	0.055	1.620	0.047	1.582	0.043	1.571	0.043	1.570
2040	0.100	2.287	0.086	2.137	0.073	2.053	0.065	2.020
2050	0.138	3.433	0.125	3.151	0.112	2.938	0.099	2.796
2060	0.165	4.757	0.150	4.353	0.136	4.020	0.124	3.764
2070	0.182	6.254	0.168	5.722	0.150	5.252	0.135	4.869

deficit = D_t/Y_t and debt = $(B_t - F_t)/Y_t$.

Table 8: Extending FRA: Pension Deficits

Year	Baseline	FRA 67	FRA 69	FRA 71
2020	0.025	0.024	0.024	0.024
2030	0.026	0.024	0.016	0.016
2040	0.046	0.034	0.023	0.015
2050	0.056	0.047	0.038	0.028
2060	0.054	0.045	0.037	0.029
2070	0.052	0.043	0.034	0.025

If the FRA is raised from the current 65 to a higher age, individuals start receiving benefits later and have a shorter period of receiving benefits. As shown in table 8, the reform would improve the budget of the public pension system and reduce the pension deficit from the baseline level of 5.2% in 2070 to 4.3%, 3.4% and 2.5%, respectively, in each experiment. Lower pension deficit helps reduce total deficit further as it reduces the government debt and interest payment. We note, however, the increase in the FRA alone is hardly sufficient to achieve for fiscal sustainability.

Note that we do not allow individuals in the model to optimize given their environments. In a typical overlapping generations model, when individuals expect a reduction in benefits, they typically provide more labor and also choose to save more rather than consume and increase the capital stock over time, leading to a larger tax base. This would potentially reduce the budget deficit further and provide a more significant relief in the fiscal outcomes, which would be added to the gains that we reported above.

The increase in the FRA allows the public pension fund to survive additional years. With FRA at 67, the pension fund is now projected to be depleted in 2078 instead of the baseline year of 2057. With an FRA of 69, the fund survives past 2100 with a declining path at 47.2% in 2100. When the FRA is raised to 71, the public pension fund monotonically increases with a value of 122.1% in 2100.

Reducing Pension Benefits When pension benefits are directly reduced, the fiscal relief is immediate and significant. We simulate a reform to reduce benefits by 10%, 20% and 30% over a period of 30 years. Table 9 shows that even a modest cut of 10% in pension benefits can go deep in cutting the budget deficit. A reason for this improvement in the fiscal outlook is the fact that the pension cut affects not only the future retirees but more importantly the current pensioners. A larger pension benefit cut such as a 30% reduction would lower the deficit by about 7% of GDP compared to the baseline case, reducing the outstanding net debt by more than 180% of GDP by 2070. This finding suggests that a pension reform in the form of a reduction in benefits could produce significant gains in establishing fiscal sustainability.

Table 9: Reduction in Pension Benefits: Deficits and Debt

	Baseline		10% Cut		20% Cut		30% Cut	
Year	deficit	debt	deficit	debt	deficit	debt	deficit	debt
2020	0.032	1.310	0.031	1.301	0.030	1.304	0.029	1.301
2030	0.055	1.620	0.049	1.591	0.044	1.562	0.039	1.533
2040	0.100	2.287	0.089	2.185	0.078	2.084	0.067	1.982
2050	0.138	3.433	0.120	3.101	0.102	2.945	0.084	2.706
2060	0.165	4.757	0.145	4.338	0.124	3.918	0.103	3.500
2070	0.182	6.254	0.162	5.656	0.138	5.036	0.114	4.416

deficit = D_t/Y_t and debt = $(B_t - F_t)/Y_t$.

With benefit cuts shown in table 9, the public pension fund survives past 2070 in all the alternative cases. If the cuts are deep enough, namely 20% or 30%, the fund increases past 2070.

Raising the Consumption Tax In our model, the consumption tax rate is assumed to increase from 8% to 10% in 2019 based on the current policy plan. In alternative experiments, we consider higher consumption tax rates and let them increase to 15%, 20%, and, 25%, the levels comparable to those in many European countries. In the experiments, we let the consumption tax increase by 1 percentage point each year starting in 2020.

Table 10: Raising the Consumption Tax: Deficits and Debt

	Baseline		15%		20%		25%	
Year	deficit	debt	deficit	debt	deficit	debt	deficit	debt
2020	0.032	1.310	0.027	1.306	0.026	1.303	0.026	1.300
2030	0.055	1.620	0.028	1.417	0.004	1.340	−0.001	1.335
2040	0.100	2.287	0.072	1.824	0.046	1.502	0.021	1.311
2050	0.138	3.433	0.107	2.679	0.078	2.090	0.051	1.651
2060	0.165	4.757	0.131	3.715	0.100	2.861	0.072	2.175
2070	0.182	6.254	0.146	4.913	0.113	3.786	0.084	2.850

deficit $= D_t/Y_t$ and debt $= (B_t - F_t)/Y_t$.

According table 10, raising the consumption tax rate to 15% cuts the budget deficit in 2030 roughly in half compared to the baseline case. Higher tax rates would bring the deficit close to zero or even a surplus by 2030. Clearly, a higher consumption tax is important in helping Japan achieve fiscal sustainability.

However, as the aging-related parts of the budget continue to raise the fiscal burden, the longer run health of the government budget deteriorates and even a 20% consumption tax leads to a budget deficit of 10% of GDP or higher by 2060. This results argues that using the consumption tax as the only fiscal instrument cannot produce fiscal sustainability.

Raising Co-Pays for Health and Long-Term Care Insurance As described in the calibration section, public health insurance covers 80% of gross expenditures for individuals at age 0 to 5, 70% for age 6-69, 80% for 70-74 and 90% for those above 74. The long-term care insurance covers 90% of gross expenditures of all the insured at and above age 40.

In this subsection we consider policies that raise the copays for public health or LTC expenses, either at 20% or 30% for the older workers.

Table 11: Raising Co-Pays for Public Health and Long-Term Care Insurances: Deficits and Debt

	Baseline		Health insurance copay 20% for ≥ 70		Health insurance copay 30% for ≥ 70		Long-term care copay 20% for ≥ 40		Long-term care copay 30% for ≥ 40	
Year	deficit	debt	deficit	debt	deficit	debt	deficit	debt	deficit	debt
2020	0.032	1.310	0.028	1.305	0.022	1.301	0.029	1.304	0.025	1.298
2030	0.055	1.620	0.048	1.565	0.041	1.498	0.049	1.574	0.044	1.528
2040	0.100	2.287	0.093	2.168	0.084	2.024	0.094	2.186	0.087	2.086
2050	0.138	3.433	0.129	3.233	0.117	2.993	0.130	3.262	0.122	3.090
2060	0.165	4.757	0.153	4.464	0.140	4.116	0.155	4.507	0.145	4.257
2070	0.182	6.254	0.170	5.860	0.156	5.395	0.171	5.911	0.160	5.569

deficit $= D_t/Y_t$ and debt $= (B_t - F_t)/Y_t$.

Although the increase in copays improves the budget of health insurance and long-term care insurance programs, the results in table 11 show only mild improvements in the debt situation in the long-run.

In the experiments, we assume that a rise in copays will not affect gross expenditures for medical and long-term care services. The model with elastic expenditures would imply a lower fiscal cost of insurances and the effects shown in the table can be considered as lower bounds of a reduction in deficits and debt that the reforms can bring.

Combination of Outcomes and Policies Our numerical experiments suggest that a single policy instrument or economic outcome is unlikely to deliver fiscal sustainability. However, a combination of policies and outcomes may provide significant relief to the aging related fiscal issues facing Japan. In this experiment, we consider two combination policies as follows:

1. Combination 1
   (a) Raise FRA from 65 to 67 in 10 years starting in 2020.
   (b) Cut pension benefits by 10% in 10 years starting in 2020.
   (c) Raise health insurance copay for older workers/retirees to 20%.
   (d) Raise LTC copay to 20%.
   (e) Close the gap between males and females in the A/B/C experiments by 50% so that females are 50% closer to males in the LFP rate, fraction of regular versus contingent jobs, and, earnings.
2. Combination 2:

(a) Same as Combination 1 except the last item, which makes females exactly like their male counterparts in the LFP rate, fraction of regular versus contingent jobs, and, earnings.

3. Combination 3:

   (a) Same as Combination 1, plus consumption tax raised from 10% to 15%.

Table 12: Social Insurance Reforms and Female Earnings Changes: Deficits and Net Debt

	Baseline		Combination 1		Combination 2		Combination 3	
Year	deficit	debt	deficit	debt	deficit	debt	deficit	debt
2020	0.032	1.310	0.015	1.271	0.008	1.246	0.009	1.266
2030	0.055	1.620	0.001	1.192	−0.033	0.929	−0.025	0.993
2040	0.100	2.287	0.026	1.247	−0.013	0.636	−0.002	0.794
2050	0.138	3.433	0.049	1.610	0.004	0.589	0.018	0.868
2060	0.165	4.757	0.064	2.093	0.014	0.650	0.030	1.063
2070	0.182	6.254	0.073	2.676	0.018	0.788	0.036	1.346

deficit = D_t/Y_t, fund = F_t/Y_t, and debt = $(B_t - F_t)/Y_t$.

The effects of Combination 1 can be seen in the sharp reduction in the deficit to GDP and the net debt to GDP ratios. For example, the deficit is cut by two-thirds by 2040, relative to that in 2020, and the net debt to GDP is just a little higher in 2040 than its level in 2020. With significant reduction in the pension, public health and LTC-related parts of the deficit, combined with significant additional tax/premium collected due to the assumed increase in female earnings and employment, Japan achieves a large fiscal consolidation that lasts for decades.

If the effects of female employment are increased, Combination 2 delivers fiscal sustainability for 50 years. Indeed, the debt to GDP ratio in 2070 is lower under the Combination 2 policies relative to the level in 2020, once again emphasizing the large impact of incentivizing increases in the female employment and earnings in Japan.

In Combination 3, where a rise in consumption taxes to 15% is added to Combination 1, there will be surpluses in 2030 and 2040 and the debt level will be significantly lower than in the baseline scenario, standing at 86.8% of GDP in 2050 and 134.6% in 2070. The simulations of the combined policies and economic scenarios show that what the government needs is a comprehensive reevaluation and reform of the entire system, which consists of taxes, labor market and social insurance policies to deal with the demographic aging Japan will face over the next several decades.

5 Conclusion

Japan leads all advanced economies in terms of aging and has the highest debt to GDP ratio. While the latter may limit fiscal choices available to policymakers, the aging is projected to induce additional fiscal pressures. In this paper, we develop an accounting model populated with overlapping generations of individuals, incorporate details of the social insurance programs, use most recent estimates from Japanese micro data to discipline the earnings profiles of heterogeneous agents, and simulate future paths of fiscal and macroeconomic indicators. Our numerical results suggest that absent any change in current policies, Japan will continue to run large very large pension, public health, LTC, and total deficits and the debt to GDP ratio will reach unprecedented highs, with interest payments on the debt becoming larger and larger.

No single policy or economic outcome considered can restore the fiscal balance in Japan by itself. Among alternative scenarios analyzed, the most promising avenues to achieve fiscal sustainability are 1) higher productivity growth, 2) increases in the consumption tax rate, and 3) increases in female employment (with wage increases and employment regularization). Raising the full retirement age and increasing the co-pays in public health insurance and LTC also help. We argue that a combination of all these outcomes and policies will be needed to bring about sustained fiscal consolidation. In particular, extending FRA to 67 and cutting pension benefits by 10%, raising copays in medical and LTC expenditures to 20%, increasing the employment and earnings of females close to those of men, and raising consumption taxes to 15% achieve fiscal sustainability in the short run and lead to a lower debt to GDP ratio in 2050 than that in 2020.

Our results also suggest that reforms to consolidate the fiscal situation in Japan should be implemented sooner than later since the debt will be accumulated quickly from rising deficits of each of the social insurance programs, generating additional burdens on future generations to service them.

Of course, there are other policies that could also make a large impact which were not explicitly considered in the paper. In particular, increasing the family support programs to raise the female labor force participation or increasing work incentives of older workers within a general equilibrium model could increase the tax base and reduce fiscal burdens in a sustainable manner. How a rise in the female labor force participation interacts with fertility decisions would be important in affecting the labor force and fiscal sustainability in the long-run. Increasing the number of guest workers from abroad could also help mitigate the labor shortage and raise production and tax revenues. These policies and reforms are left for future research.

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