RIETI Discussion Paper Series 16-E-077

When Do We Start? Pension reform in aging Japan

KITAO Sagiri
RIETI

Research Institute of Economy, Trade & Industry, IAA

The Research Institute of Economy, Trade and Industry
http://www.rieti.go.jp/en/

RIETI Discussion Paper Series 16-E-077

July 2016

When Do We Start? Pension reform in aging Japan*

KITAO Sagiri

Keio University/RIETI

Abstract

Japan is going through rapid and significant demographic aging. Fertility rates have been below replacement level for four decades, and life expectancy has increased by 30 years since the 1950s. The pension reform of 2004 is expected to reduce the replacement rate, but there is much uncertainty as to when and whether the adjustment will be complete. The normal retirement age of 65 will be the lowest among major developed countries. This paper simulates pension reform to reduce the replacement rate by 20% and raise the retirement age by three years gradually over a 30-year period. We consider three scenarios that differ in timing to initiate reform and let the consolidation start in 2020, 2030, and 2040, respectively. A delay would suppress economic activities, lowering output by up to 4% and raising the tax burden by more than eight percentage points of total consumption. Delaying reform also implies a major tradeoff across generations and deteriorates the welfare of future generations by up to 3% in consumption equivalence.

Keywords: Social security reform, Demographic transition, Retirement age, Reform timing, Japanese economy.

JEL classification: E2, E6, H3, J1

*This study is conducted as a part of the Project "Fiscal and Social Security Policy under a Low Birth Rate and Aging Demographics" undertaken at Research Institute of Economy, Trade and Industry (RIETI).

1 Introduction

Japan is going through dramatic demographic aging at an unprecedented speed and will be faced with a significant rise in government expenditures. Sustainability of social security system is a major concern of the Japanese government and this paper studies effects of pension reform, focusing on the timing of a policy change. Total pension expenditures exceed 10% of GDP in 2014 and they are expected to rise quickly as the old-age dependency ratio will double during the several decades. The Japanese government implemented major pension reform in 2004 in an effort to keep benefit expenditures under control. Pension premium imposed on earnings was also set to gradually increase until it reaches the cap at 18.3% in 2017.

The pillar of 2004 reform was a scheme known as "macroeconomic slide," which would adjust benefits downwards automatically with a rise in average life expectancy and a decline in the number of the insured. The adjustment, however, is subject to enough inflation as downward adjustment is restricted in nominal terms and the slide has been triggered only once in 2015 since the reform was implemented in 2004. Although the macroeconomic slide, if successfully executed, is supposed to reduce replacement rates by about 20%, how fast the adjustment will occur and when and whether it will be completed are unknown.

Average life expectancy of the Japanese is the longest among major developed countries. Normal retirement age is 65 and one of the lowest, which implies that Japan has the longest expected duration of receiving public pension benefits compared to other developed economies. Although raising normal retirement age beyond 65 has not been very seriously debated in Japan, it is the policy that Japan should start considering immediately and do so before old-age dependency ratio will rise to an unprecedented level, as discussed in section 2. The replacement rate, especially once macroeconomic slide is complete, is fairly low relative to other developed countries with pay-as-you-go pension systems and a further adjustment in replacement rate alone might be a challenge. Combination of the adjustment in both extensive margin (retirement age and duration) and intensive margins (replacement rate) seems to be sensible and worth analyzing.

We will therefore consider reform that will reduce benefits by 20% as embedded in the pension reform of 2004 and raise the retirement age by 3 years gradually, increasing by 1 year every 10 years, from 65 to 68. We will also assume that benefits will decline over a period of 30 years and the change will occur only slowly so that it will not force a sudden and large change in income and consumption of any generation.

We will focus on effects of reform timing and compare outcomes of scenarios under which reform begins in different years. We build a quantitative general equilibrium model populated by overlapping generations, calibrated to micro and macro data of the Japanese economy with time-varying demographics as projected over the coming decades. We consider three timings to initiate reform, 2020, 2030 and 2040, respectively. Although the paths under each scenario will converge to a common transition path eventually, economic consequences at both macro and micro levels look very different during the transition.

Compared to the economy without reform at all, individuals have stronger saving motives for retirement and aggregate capital will be higher. The difference is as much as 8.7% when the reform begins in 2020, while it is 6.3% and 3.4% when reform starts in 2030 and 2040, respectively. Labor supply also differs across three scenarios and so does welfare of different generations. Current retirees and middle-aged individuals would prefer a scenario of delaying reform as long as possible since the loss from lower benefits would outweigh gains from lower taxes and other general equilibrium effects. Younger and future generations would be better off if they would start their economic life under scenarios where reform is already in progress for a longer period. For instance, individuals born in 2000 and who will become adult in 2020 would be better off by more than 2% in consumption equivalence if reform begins in 2020, rather than 2040.

In terms of the structure of the model, the paper builds on a growing literature that studies effects of aging demographics on fiscal sustainability in Japan using a dynamic general equilibrium model populated by overlapping generations.

Ihori et al. (2005) build a life-cycle model with public pension and health insurance programs and study effects of aging demographics and public debt policy. Braun and Joines (2014) model details of medical expenditures and health insurance system and study effects of public pension and health insurance reform in a general equilibrium life-cycle model. Kitao (2015) distinguishes between health and long-term care insurance programs and quantitatively evaluates effects of aging demographics on fiscal sustainability in a model with endogenous participation in the labor market. Kitao (2015) simulates alternative pension reforms that will reduce pension benefits through a reduction in replacement rates or an increase in retirement age.[1] Adjustments will be made gradually over a given period but in all experiments reforms are assumed to begin immediately in a given year. In this paper, as mentioned above we focus on effects of different timings to initiate reform.

The rest of the paper is organized as follows. Section 2 summarizes current and projected demographics of Japan, reviews main features of the pension system and compares them to those in other countries. The theoretical model is presented in section 3 and section 4 discusses parametrization. Section 5 presents numerical results and section 6 concludes.

2 Demographics and pension policy in Japan

In this section we review current state of demographics in Japan and issues that will arise over the coming decades as we extrapolate population distribution based on official projections. We will then summarize pension policy in Japan and compare that to other major developed countries. The review will be used as a basis in choosing particular

[1]Other papers in the literature include Doi (2008), Doi, Hoshi, and Okimoto (2011), Ihori et al. (2011), Yamada (2011), Okamoto (2013), Hoshi and Ito (2014), Hsu and Yamada (2015) and Hansen and İmrohoroğlu (2016).

reform that we simulate in the numerical analysis that follows.

2.1 Demographics in Japan

Figure 1 shows the population data and projections of the National Institute of Population and Social Security Research (IPSS) through the end of the century.[2]

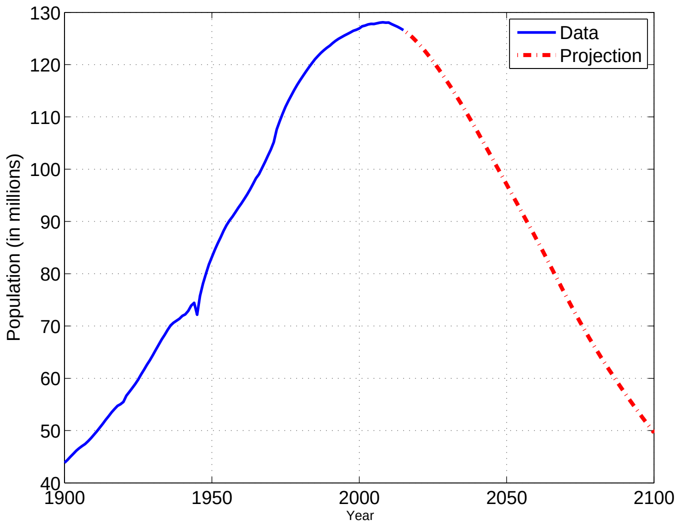


Figure 1: Japanese population. Data and projection. Source: IPSS (2012)

The population increased monotonically during the last century except for the war period. The trend, however, has reversed since 2008, when the number of deaths surpassed that of births, and the decline in population is projected to continue throughout the rest of the century. According to the official projection, by 2100 the population will reach 50 millions, 60% below the level in 2015, or back to the level in 1910s.

The ongoing decline in Japanese population is attributable to low fertility rates and rising longevity. Figure 2 shows historical and projected total fertility rates since 1950. Total fertility rates declined sharply in 1950s after the first baby boom in late 1940s following the World War II. Fertility rates somewhat recovered in 1960s and early 1970s, which generated the second baby boom generations.[3] Since mid-1970s, fertility rates have trended down and fallen well below the replacement rate that is needed to keep the population from declining. They even stayed below 1.5 for over two decades since early 1990s. The IPSS projects that total fertility rate will stay at around 1.35 through 2060, the last year of projections.

[2]The projections are based on IPSS's "medium" assumptions on fertility rates, released in 2012.

[3]There is a major drop in the number of births in 1966, which is the year of "Hinoe-uma," the fire horse, which occurs every 60 years, and associated superstition.

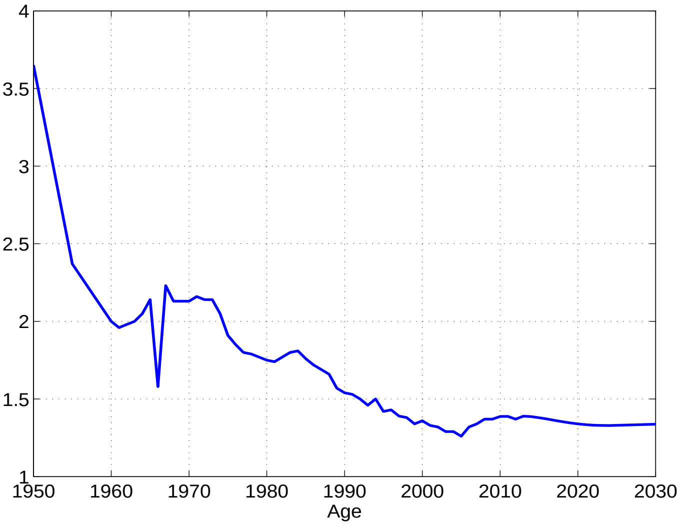


Figure 2: Total Fertility Rate. Data and projection. Source: IPSS (2012)

While the number of newborns declined, life expectancy has increased with continued improvement in health care and advancement in medical technology. Figure 3 shows life expectancy at birth, based on the data and projections of the IPSS. Life expectancy increased by about 30 years for both male and female since 1950. It is projected to rise further, reaching almost 85 for male and above 90 for female by 2060.

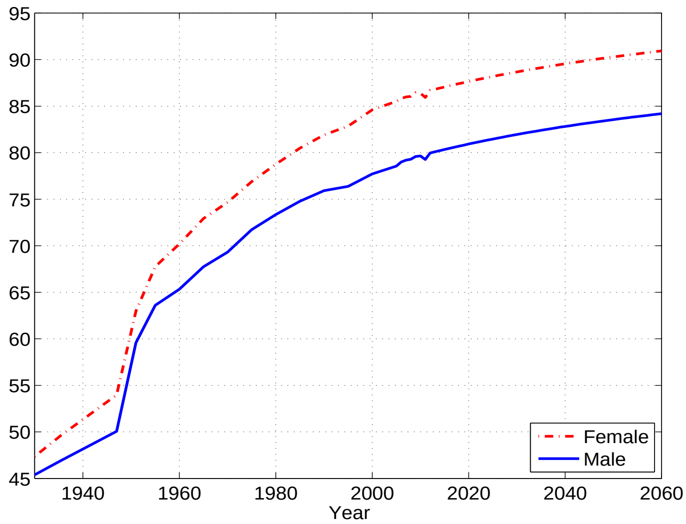


Figure 3: Life expectancy at birth. Data and projection. Source: IPSS (2012)

A decline in fertility rates and a rise in longevity changed age distribution and made the shape of demographic pyramid unusually unstable. Figure 4 shows age distribution of Japanese population in 2014. The 40-year long stagnation of fertility rates can be seen in the monotonic decline in the population from age 40 to 0, falling by half, from 2 million to about 1 million. Those in the first baby boom generation are now in mid-60s and already started to reach the retirement age. The second baby boomers will follow the wave in about 20 years. At the same time, the number of working-age population will decline monotonically during the coming decades.

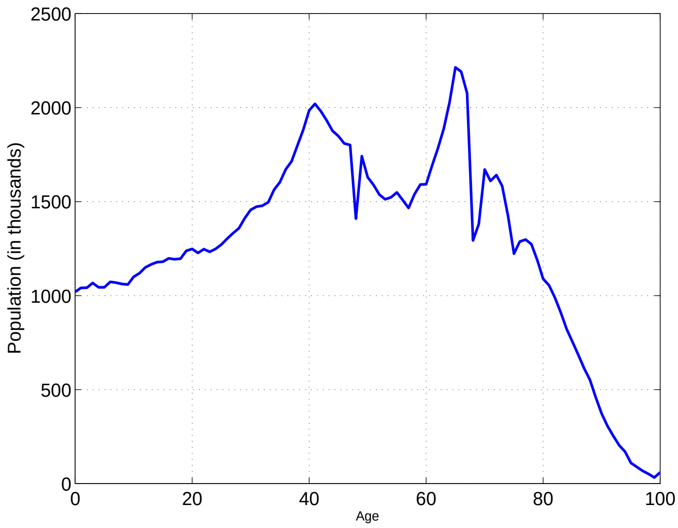


Figure 4: Population by age 2014. Source: IPSS

The dependency ratio shown in Figure 5, representing the ratio of population aged 65 and above to that aged 20-64, summarizes economic and fiscal challenge that Japan will have to deal with over the next decades. The ratio, which was around 10% in 1950s rose sharply in the following decades mainly due to dramatic improvement in longevity and a decline in mortality risks at younger ages. Low fertility rates below replacement rate since 1970s exacerbated the rise after 1990s and will continue to keep the dependency ratio rising sharply, which will reach 60% by early 2030s and 80% before 2050. It will remain above 80% throughout the century according to the official demographic projection. Compared to other developed countries that will experience a similar trend, the rise in the dependency ratio in Japan clearly stands out. The U.S., for example, will also see a rise in the number of retirees from baby boom generations, but the dependency ratio will not exceed 50% at least until 2080s thanks to fertility rates that are much higher than in Japan.

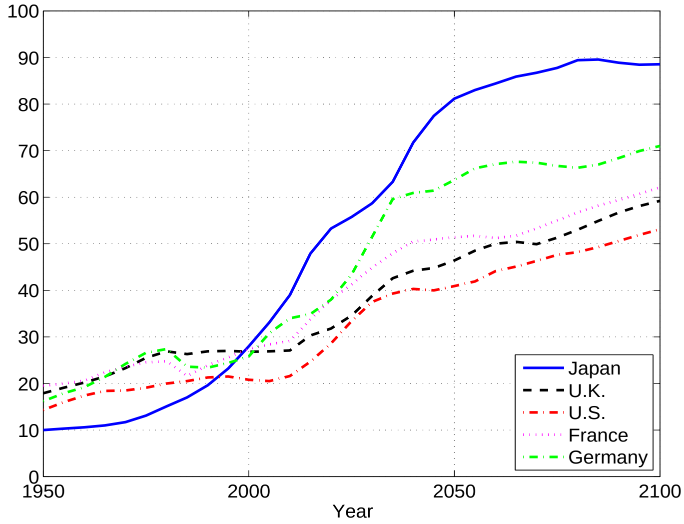


Figure 5: Dependency ratio. Data and projection. Source: IPSS and UN Population Revision

2.2 Pension policy and reform

Demographic trends described above will pose a major challenge in fiscal management in Japan. Expenditures towards the elderly through public pension and health insurance programs will soar at the same time as the size of working-age population continues to shrink and tax revenues decline.

In particular, there will be a rapid increase in not only the number of pension recipients but also the number of years of receiving public pensions as life expectancy continues to rise. The pension reform of 2004 had set the timeline to increase the contribution rate gradually and by 0.354 percentage points every year, from 13.58% of earnings to 18.3% in 2017 but it will be fixed thereafter. Revenues will keep falling with a decline in the number of workers, unless there is a dramatic rise in total earnings per worker.

As mentioned in section 1, the pension reform of 2004 was a comprehensive reform aimed at making the public pension system sustainable in the long-run. It introduced a mechanism, called macroeconomic slide, that would review both benefit payment to retirees and contribution from the insured and limit a rise in pension benefits relative to contributions in future automatically. The adjustment, however, is restricted so that the adjustment rate does not go negative when the inflation rate is positive, or below the (negative) inflation rate under deflation. When prices decline, for example, there is no adjustment in real terms even if the demographic change calls for a slide adjustment. Given the low and negative inflation as well as special exceptions made during the last decade, the slide was triggered only once in 2015, first time in 12 years since the reform was implemented in 2004. The replacement rate is expected to decline by about 20% when the slide adjustment is complete and after that the benefit schedule is to be fixed.

Table 1 compares total pension expenditures relative to output and pension replacement rates in major developed countries, based on the estimates of the OECD (2015). Total pension expenditures in Japan are about 10% of GDP, which is well above the level of U.S., U.K., Canada and Australia, but close to Germany and Spain and below France and Italy. The Japanese number, however, is expected to rise rapidly as dependency ratio increases and exceeds that of many, if not all, of these countries. For that reason, although the replacement rate is not very high compared to other countries as shown in the table, benefit adjustment through formal mechanisms such as autonomous macroeconomic slide set in real terms would be necessary to keep expenditures under control throughout the century.

Table 1: Pension expenditures and replacement rate. Source: OECD (2015)

Country	Expenditures % of GDP	Replacement rate Gross	Net
Japan	10.2	35.1	40.4
Australia	3.5	44.5	58.0
Canada	4.3	36.7	47.9
France	13.8	55.4	67.7
Germany	10.6	37.5	50.0
Italy	15.8	69.5	79.7
Spain	10.5	82.1	89.5
United Kingdom	5.6	21.6	28.5
United States	6.7	35.2	44.8

In terms of the "extensive margin" of the Japanese pension system, table 2 compares retirement age and life expectancy in the same group of major developed countries. Japanese public pension consists of two parts, basic pension (*kiso nenkin*), which is provided for all retirees conditional on required premium payment, and the employment-based part (*kosei nenkin*), whose benefits are based on and proportional to contribution made by each individual throughout his career. Normal retirement age for basic pension has been fixed at 65, ever since the national pension system was established in 1961. For employment-based part, retirement age originally was 55, but has been raised through series of reform and will be 65 by 2018.

Many other countries have the same retirement age of 65 as of now, but in all except for Japan retirement age is set to rise under current regulations in place. As shown in Table 2, in the long-run, Japan will have the lowest retirement age among the countries in the absence of new regulation. Given the life-expectancy today across these countries (United Nations, 2015), Japan has the longest expected duration of receiving public pension at 18.3 years except for Italy. In the long-run, if life-expectancy were to remain constant (counter-factually), the duration of the pension in Japan would remain 18.3 years, which is by far the longest of all and about four years longer than the average across these countries which stands at 14.3 years.

Table 2: Pension retirement age and life expectancy. Source: OECD (2015) and United Nations

Country	Retirement age Current	Retirement age Long-run	Life Expectancy	Difference Current	Difference Long-run
Japan	65	65	83.3	18.3	18.3
Australia	65	67	82.1	17.1	15.1
Canada	65	67	81.8	16.8	14.8
France	65	67	81.9	16.9	14.9
Germany	65	67	80.7	15.7	13.7
Italy	64	67	82.8	18.8	15.8
Spain	67	67	82.3	17.3	15.3
U.K.	65*	67	80.5	15.5	13.5
U.S.	66	67	78.9	12.9	11.9
Average (ex Japan)	65	67	81.4	16.4	14.4

(*) The retirement age in U.K. was 65 for men and 62.5 for women in 2014.

Given these observations about current and projected status of Japanese demographics and comparison of pension policies across countries, in the numerical simulations, we consider reform to reduce benefits by a downward shift of the schedule by 20%, which is equivalent to what successful macroeconomic slide is expected to do, and to simultaneously raise normal retirement age by three years from 65 to 68. We let the adjustment take place slowly so as to mitigate costs of the transition. Once reform begins, we let it take 30 years for adjustments to complete. We will describe the details of policy experiments in section 5.

3 Model

3.1 Economic environment

Demographics: Individuals of the economy start making economic decisions at age $j = 1$ and can live up to the maximum age J subject to mortality risks. Age-j individuals at time t survive until the next period $t+1$ with probability $s_{j,t}$. We assume that accidental bequests left by the deceased are distributed as a lump-sum transfer denoted as b_t to all surviving individuals. The size of a new cohort grows at rate n_t.

Endowment and preferences: Individuals choose hours of work h out of a unit of disposable time and the rest $(1 - h)$ is enjoyed as leisure. Earnings of an individual are given as $y_t = z\psi_j hw_t$. z represents idiosyncratic and stochastic labor productivity and ψ_j

is age-specific deterministic productivity. w_t denotes market wage rate per efficiency unit at time t.

$u(c, h)$ denotes utility from consumption and leisure and individuals maximize the sum of discounted utility expected over the lifetime, $E\left\{\sum_{j=1}^{J} \beta^{j-1} u(c_j, h_j)\right\}$. The expectation is with respect to the distribution of idiosyncratic labor productivity shocks and timing of death. β denotes the subjective discount factor.

Technology: Goods are produced according to constant returns to scale technology, $Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$, where Y_t denotes aggregate output, K_t aggregate capital, L_t total labor supply and A_t technology. α is capital's share of output and $\delta \in (0, 1)$ denotes capital's depreciation rate. Factor prices, denoted as r_t^k and w_t, are equated to marginal products of capital and labor, respectively.

Medical expenditures and health insurance: Medical expenditures of an individual consist of health care and long-term care expenditures, denoted by $m_{j,t}^h$ and $m_{j,t}^l$, respectively. Individuals pay a fraction μ_j^h and μ_j^l of each type of expenditures as copay and the government covers the rest of the bill through public health care and long-term care insurance programs, respectively. Each individual's total out-of-pocket expenditures are given as $m_{j,t}^o = \mu_j^h m_{j,t}^h + \mu_j^l m_{j,t}^l$. The sum of expenditures paid by the government M_t^g and those paid by individuals M_t^o equals total national medical expenditures denoted as M_t, that is, $M_t = M_t^o + M_t^g$.

$$M_t^o = \sum_j m_{j,t}^o \lambda_{j,t}$$

$$M_t^g = \sum_j \left[(1-\mu_j^h) m_{j,t}^h + (1-\mu_t^l) m_j^l\right] \lambda_{j,t}$$

where $\lambda_{j,t}$ denotes the number of individuals of age j at time t.

Public pension system: The government operates a pay-as-you-go public pension system. Once reaching normal retirement age, denoted as j_R, each individual starts to receive pension benefits $ss_t(e)$, which are determined as a function of an index e that summarizes an individual's average lifetime earnings. Note that j_R is the age at which individuals start to receive public pensions, but they can continue to work until they choose to leave the labor force or they may stop working before reaching age j_R.

Government debt and interest: The government issues one-period riskless debt D_t and pays interest r_t^d. The interest rate on the government debt is assumed to be different from that paid on capital rented to firms so that the model matches the level of interest rate that the government pays on debt. As in Braun and Joines (2014) and Kitao (2015), we assume that individuals allocate an exogenous fraction ϕ_t of savings to government debt and a fraction $(1-\phi_t)$ to firms' capital. After-tax gross return on each unit of individuals' savings net of taxes is given as $R_t = 1 + (1-\tau_t^k)r_t^k(1-\phi_t) + (1-\tau_t^d)r_t^d\phi_t$.

Government budget: The government raises revenues through taxes on earnings at rate τ_t^l, income from capital rented to firms at τ_t^k, interest rate earned on government debt at τ_t^d, and consumption at τ_t^c, and newly issued government debt D_{t+1}. Revenues are used to cover expenditures that consist of G_t, government consumption, debt services, public pension benefits, and health and long-term care insurance benefits. The government must satisfy the budget constraint

$$\begin{aligned} & G_t + (1+r_t)D_t + \sum_x ss_t(x)\lambda_t(x) + M_t^g \\ &= \sum_x \left\{\tau_t^l y(x) + [\tau_t^k r_t^k \phi_t + \tau_t^d r_t^d (1-\phi_t)](a_t(x)+b_t) + \tau_t^c c_t(x)\right\} \lambda_t(x) + D_{t+1}, \end{aligned} \tag{1}$$

where $\lambda_t(x)$ denotes the measure of individuals in an individual's state x at time t as explained below. We will discuss fiscal adjustment needed to satisfy the government budget constraint in more details in section 5.

3.2 Individuals' problem

Individuals can purchase and accumulate one-period riskless asset a_t, which is a composite of an investment in firms' capital and holdings of government bonds. Individuals cannot borrow against future income and asset must be non-negative, that is, $a_t \geq 0$. Markets are incomplete and there is no state contingent assets that can be used to insure away idiosyncratic productivity shocks and mortality risks.

Individuals choose a sequence of consumption, saving and labor supply over the life-cycle to maximize discounted life-time utility. A state vector of each individual is given as $x = \{j, a, z, e\}$, where j denotes age, a assets saved and carried from the previous period, z idiosyncratic labor productivity, and e an index of cumulated labor earnings that determines each individual's social security benefits. The value function $V(x) = V(j, a, z, e)$ of an individual in state x is given as follows.

$$V(j,a,z,e) = \max_{c,h,a'} \{u(c,h) + \beta s_j EV(j+1, a', z', e')\}$$

subject to

$$(1+\tau^c)c + a' + m_j^o = R(a+b) + (1-\tau^l)y + ss(e)$$

where $y = z\psi_j hw$ denotes labor earnings. The index for cumulated earnings is updated according to a function $e' = f(e, y)$ until individuals reach normal retirement age j_R, after which $e' = e$.

The competitive equilibrium is defined in Appendix A.

4 Calibration

The model period is annual and the decision-making unit is an individual, who represents a household as head. We will first compute the economy in the initial year of the transition, which we call as "initial steady state," that represents and approximates the economy of 2010. As discussed in section 2, population is currently far from stationary and it is important to capture actual age distribution so the model can assess the impact of demographic transition from the current state. Therefore we impose actual age distribution of 2010 in the initial steady state in computing aggregate statistics. We then compute final steady state that represents the economy in the long-run when demographic transition is complete and population becomes stationary. Finally we derive transition dynamics between 2010 and final steady state by computing an equilibrium in each period.

Demographics: We assume that individuals enter the economy at age 25 and can live up to the maximum age of 110. Survival rates $s_{j,t}$ and growth rates of new cohort n_t are calibrated to the estimates of the National Institute of Population and Social Security Research (IPSS). Official projections by the IPSS are available up to 2060 and we use them during the transition. We assume that age-specific survival rates will stay constant after 2060 and that growth rate of new-born individuals will gradually rise after 2060 and reach 0% by 2150.

Endowment, preferences and technology: We assume that idiosyncratic labor productivity in log, $\widetilde{z}_t = \log z_t$, follows a process

$$\begin{aligned} \widetilde{z}_t &= \omega_t + \varepsilon_t, \\ \omega_t &= \omega_{t-1} + \nu_t. \end{aligned} \tag{2}$$

where errors ε_t and ν_t are uncorrelated and iid across individuals, with mean zero and variances $\sigma^2_{\varepsilon t}$ and $\sigma^2_{\nu t}$. We use the study of Lise et al. (2014) for estimates of transitory and permanent productivity shocks.[4] The Basic Survey on Wage Structure (BSWS) is used to calibrate age-specific deterministic productivity ψ_j.

Individuals derive utility from consumption and leisure based on non-separable preference given as

$$u(c,h) = \frac{\left[c^{\gamma}(1-h-\theta_j)^{1-\gamma}\right]^{1-\sigma}}{1-\sigma}.$$

θ_j represents disutility of participation measured in terms of lost leisure time. It varies by age and takes a value of 0 when an individuals do not participate, that is, $h = 0$. For those who participate, we assume a functional form $\theta_j = \kappa_1 j^{\kappa_2}$ to capture age-dependent utility cost of participation. In order to approximate the pattern of life-cycle labor force participation in the data, we assume that θ_j is zero before 60 and set the two parameters

[4]We set variance of permanent shock σ^2_{ν} at 0.0078 and transitory shock σ^2_{ε} at 0.03.

of the function κ_1 and κ_2 at 0.3 and 7.0, respectively, so that the model matches average work years above 60 and the fact that participation rates fall gradually to reach zero in mid-80s in initial steady state.

γ represents preference weight on consumption and it is set to 0.37 so that individuals on average spend 40% of disposable time at market work. σ is set at 3.0, which implies relative risk aversion of about 1.7, in line with estimates in the literature. We set discount factor β at 1.029 so the model generates capital-output ratio of 2.5.

Firms produce output according to the production function, $Y_t = A_t K_t^{\alpha} L_t^{1-\alpha}$. Capital share α is set at 0.362 and capital depreciation δ at 0.089 based on Hayashi and Prescott (2002). Based on estimates for the past decade, we assume that total factor productivity A_t grows at $g_t = 1\%$.[5]

Social security: Individuals start to receive pension benefits once they reach normal retirement age j_R of 41 (65 years old). The benefit ss consists of a fixed basic pension $\overline{ss}$ and a part that is proportional to an individual's career earnings according to a formula $ss = \overline{ss} + \rho \cdot e$. e denotes an index that summarizes an individual's past earnings and it is updated recursively as

$$e_{t+1} = \frac{e_t \times (j-1) + \min(y_t, \overline{y})}{j}. \tag{3}$$

$\overline{y}$ denotes the cap for counted earnings and is set to the level of maximum annual earnings of about 10 million yen, used for the earnings index in the Japanese pension system. The basic pension $\overline{ss}$ is set so it corresponds to the actual average payment of about 655,000 yen per year in 2010. For the earnings-related part, the replacement rate ρ is set to 0.30 so that the model matches total expenditures for pension benefits in 2010, which stood at approximately 10% of output.

Medical expenditures and health insurance: Health and long-term care expenditures are based on the administrative data of the Ministry of Health, Labour and Welfare (MHLW). The copay rate of health insurance is 30% for individuals aged below 70, 20% at 70-74 and 10% at 75 and above. Long-term care is provided for individuals above age 40 and copay rate is 10% for all recipients.

Government expenditures, public debt and taxes: Government expenditures including spending for health and long-term care insurance are 20% of aggregate output in 2010 according to the National Accounts of Japan (SNA). G_t/Y_t is set to match this data. The government debt D_t is set at 100% of GDP, based on the SNA's net debt data at the beginning of 2010. Interest rate r_t^d on government debt is set to 1.0% based on the average real interest rate paid on outstanding government bonds in 2000s. The fraction

[5]The initial level of productivity A_0 is set so that average earnings is 1.0 in initial steady state.

ϕ_t of individuals' saving allocated to government debt is determined endogenously in each period to guarantee net debt ratio D_t/Y_t, which we assume is constant at 100%.

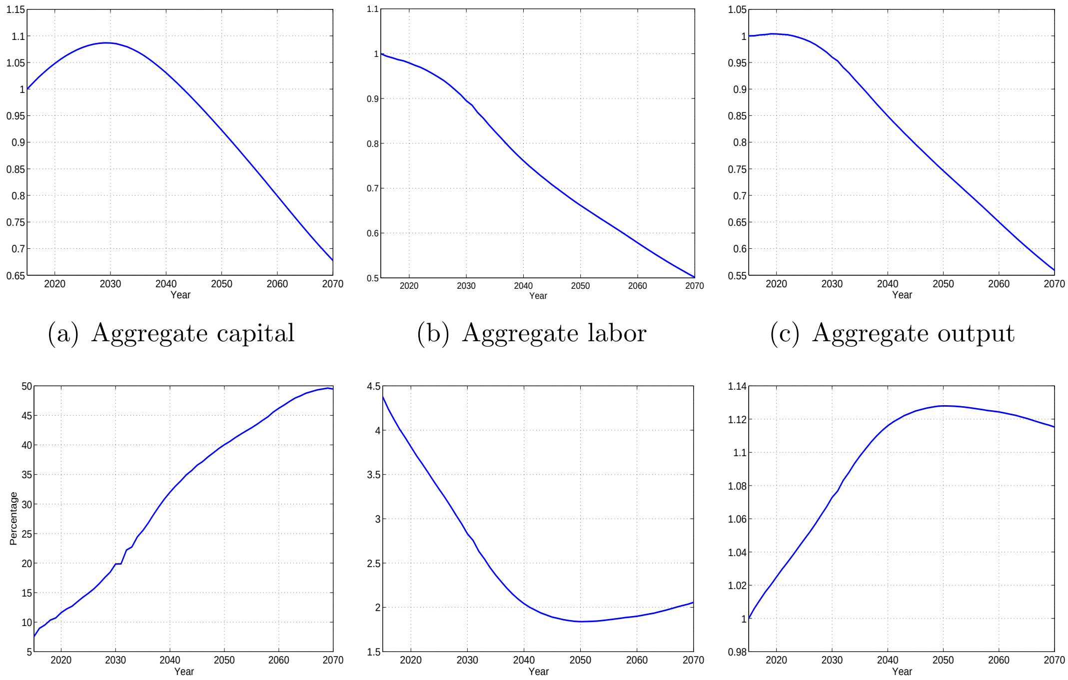
We set capital income tax at 40%, which is in the range of estimates of effective tax rates, and interest income from the government debt is taxed at 20%. Consumption tax is set at 5% in initial steady state of 2010. Labor income tax rate is determined in initial steady state and set at 35.3% so that it satisfies the government budget constraint. In section 5, when we compute the transition dynamics, we will adjust consumption tax rates to balance the government budget in each period. We will keep the labor income tax rate and other fiscal variables at the level of initial steady state to facilitate the analysis and comparison over time and across different policies.

5 Numerical results

As described in the previous two sections, we will first compute an equilibrium in initial steady state that represents the economy of 2010. We then let the economy make a transition, in which demographics will evolve as projected by the IPSS and converge to a stationary distribution eventually. During the transition, we adjust consumption tax rates to balance the government budget in each period and dynamics of the tax rates highlight the evolution of fiscal cost associated with demographic aging during coming decades. Full convergence of all economic variables will take more years after demographics converge but the focus of our analysis is on the economy over the next several decades.

As mentioned in section 2, we consider pension reform that will be needed and reasonable in light of rapidly rising expenditures and in comparison to pension policies in other countries as discussed in section 2. More precisely, reform will shift down benefit schedule by 20% and increase retirement age from 65 to 68. We consider three scenarios that differ in the timing of starting reform. In the first scenario, we assume that the reform begins in 2020 and pension replacement rates will decline gradually for a total of 20% over 30 years and retirement age will increase by 1 year every decade for a total increase of 3 years over a 30-year period. Therefore reform, once started, will complete in 30 years. In the other two scenarios, we let the same reform start in 2030 and 2040, respectively.

As a basis of comparison, we also compute a transition path in which there is no change in the pension policy and the status quo is maintained. The benefit schedule will remain unchanged and retirement age is fixed at 65. Transition dynamics of key variables under this no-reform scenario are shown in Figure 6. Although a rise in longevity gives incentives to save more for retirement, effects of declining population and a number of savers will dominate and aggregate capital starts to decline after 2030s. Aggregate labor supply declines throughout the transition and reaches about 50% of the level in 2015 by 2070. The rise in capital while labor supply falls during the first few decades of the transition implies a rapid decline in interest rate. Labor supply becomes increasingly scarce and wage rate will rise by more than 10% in 20 years from 2015 to 2035 and stay at a high level during the following decades. Consumption taxes will rise monotonically as the rapid increase in dependency ratio raises expenditures for retirees and tax revenues decline. The magnitude of the rise in fiscal burden and the scale of changes in aggregate variables observed in this baseline simulation without reform are in line with findings of other studies such as Braun and Joines (2014) and Hansen and İmrohoroğlu (2013).



(a) Aggregate capital (b) Aggregate labor (c) Aggregate output

(d) Consumption tax (e) Interest rate (f) Wage rate

Figure 6: Baseline transition without reform

We now consider reform and introduce it in three different timings. In order to highlight effects of reform and changes in outcomes associated with the timing difference, we express dynamics of macro variables as a ratio or difference to those in the baseline economy without reform, as shown in Figure 7.

Paths of aggregate capital relative to the economy without reform are shown in Figure 7(a). Given the decrease in expected pension benefits, individuals need to rely much more heavily on own savings and capital will be higher with reform. In the scenario with an early implementation of reform starting in 2020, capital will exceed the level in the baseline simulation immediately and by 2030, it is 6% higher than the level without reform and more than 10% by 2050. The rise in aggregate capital is more gradual when reform is postponed until 2030 or 2040. Under all scenarios, however, capital will be higher by more than 12% by 2070.

Another way to make up for reduced retirement income due to reform is by working longer hours and postponing an exit from the labor market. Figure 7(b) shows changes in labor supply. Although reform generates more work incentives to accumulate enough savings for retirement, it also generates disincentives since insurance benefit of working so they earn more annuity payment through added pension will be reduced. The negative effect manifests as an initial decline in labor supply that occurs in all reform scenarios, even before reduction in replacement rates begins since it is earnings before reaching retirement age that determines the annuity level. Once reform begins and retirement age rises, positive effects start to dominate and eventually labor supply is about 4% higher than in the baseline transition without reform.[6]

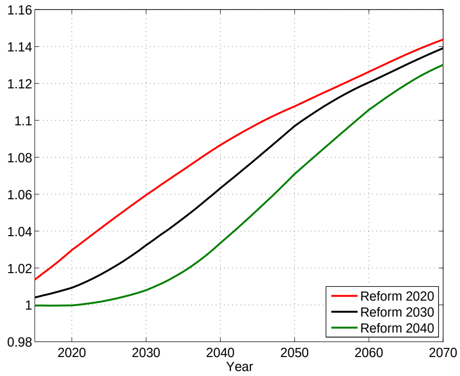
Given that individuals increase savings aggressively and even more intensively than working longer hours in order to supplement retirement consumption, capital-labor ratio will be higher with reform, implying lower interest rate and higher wages.

Consumption tax rates immediately fall relative to the baseline economy when reform starts and especially when retirement age is raised.[7] The peak tax rate in all cases will be around 32%, about 18 percentage points lower than in the baseline case without reform. There is also a significant variation in consumption tax rates across three scenarios during transition years. If reform begins sooner in 2020, consumption tax rates are 5 to 10 percentage points lower until around 2050, compared to the case of starting reform in 2040. Generations that would live through these years will face much lower taxes on consumption if reform begins sooner than later.

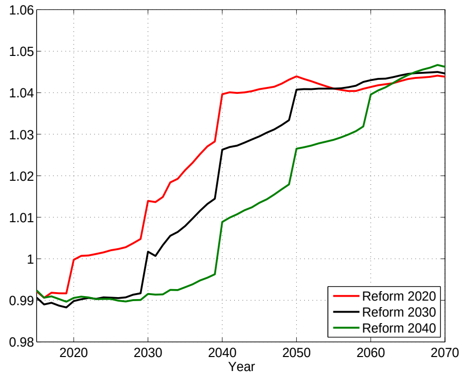
With earlier reform, wages are higher during transition periods as shown in Figure 7(d). In the transition path with reform starting in 2020, workers that enter the labor market in 2020, for example, would enjoy wages that are 0.5 to 1.2% higher throughout their career compared to the case of reform delayed by 20 years.

[6] In the year when retirement age is raised, there is a discrete increase in labor supply. If retirement age is raised more gradually, say by one month each month, labor supply will rise more smoothly, but that is difficult to implement in a model with annual frequency.

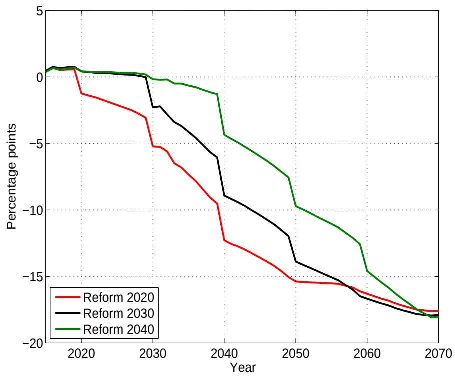
[7] There will be no new retiree in periods of raising retirement age, while the number of retirees will decline due to deaths of existing retirees, which allows consumption tax rate to drop further. This is seen as discrete declines in budget-balancing consumption taxes in Figure 7(c), in 2020, 2030, etc.



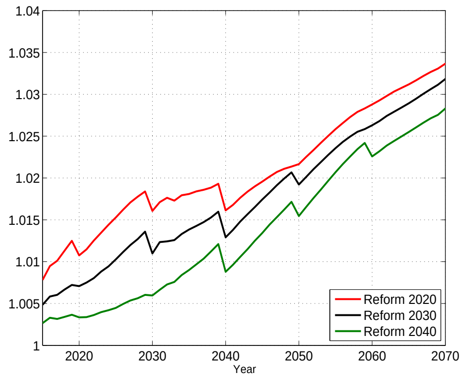
(a) Aggregate capital



(b) Aggregate labor



(c) Consumption tax



(d) Wage rate

Figure 7: Reform starting in 2020, 2030 and 2040. For (a), (b) and (d), levels are expressed as ratios to those in the baseline simulation. For (c), difference in consumption taxes in percentage points is plotted.

Table 3: Consumption taxes under three reform scenarios, R2020, R2030 and R2040: difference in percentage points relative to the baseline transition without reform.

	Consumption tax (%-pt difference)		
	R2020	R2030	R2040
2020	−1.2	+0.4	+0.4
2030	−5.2	−2.3	−0.2
2040	−12.3	−8.9	−4.4
2050	−15.4	−13.9	−9.7
2060	−16.3	−16.7	−14.6
2070	−17.6	−17.9	−18.0

Table 4: Aggregate capital and labor under reform: difference in percentage relative to the baseline transition without reform.

	Aggregate capital (% difference)			Aggregate labor (% difference)		
	R2020	R2030	R2040	R2020	R2030	R2040
2020	+3.0	+0.9	+0.0	−0.0	−1.0	−0.9
2030	+6.0	+3.2	+0.8	+1.4	+0.2	−0.9
2040	+8.7	+6.3	+3.4	+4.0	+2.6	+0.9
2050	+10.8	+9.7	+7.1	+4.4	+4.1	+2.7
2060	+12.6	+12.1	+10.6	+4.1	+4.3	+4.0
2070	+14.4	+13.9	+13.0	+4.4	+4.5	+4.6

Welfare effects: Welfare effects of starting reform at different timings are displayed in Figure 8. The left plot shows welfare effects on generations that are currently alive, indexed by age in 2010. We evaluate changes in welfare in terms of consumption equivalence. More precisely, we ask individuals of different ages whether they would prefer a transition with status-quo pension system or a transition with pension reform starting in a particular year. We then ask what is the percentage increase in consumption that is needed so that individuals will be indifferent between economies with and without reform. A positive number implies that the individual will be better off with reform and magnitude represents the size of welfare gain in terms of consumption changes in percentage for the remainder of their life. For individuals that will enter economy in future, welfare effects indicate a value expressed as a percentage change in consumption in all periods of their life.[8]

Reform will generate changes in individuals' welfare through four channels and net effect depends on the strength of each factor in the remainder of their life. The first and direct effect comes from a gradual decline in pension benefit through reduction in the replacement rate and from an increase in retirement age. Controlling for everything else, this effect deteriorates welfare as it reduces life-time income. The second and third effects are through a rise in wage rate and a decrease in interest rate, respectively. The former will be a positive effect and the latter will have a negative impact on welfare. Higher wages will improve welfare of those who have many more years to work. Lastly, consumption taxes will be lower with reform and this will benefit all individuals though at different magnitudes as the tax rates vary over time and so does the number of years each individual enjoys lower taxes.

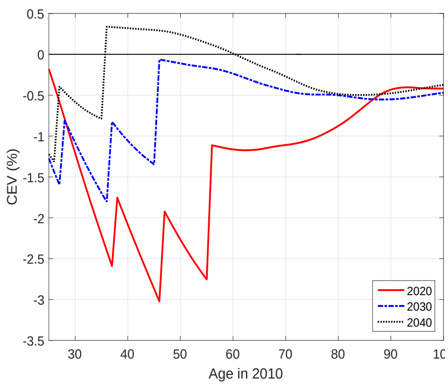
Current retirees will not benefit much from higher wages since few of them work and

[8]We note that welfare evaluation is based on the objective function of an individual, that is, discounted sum of expected utility from the individual's own consumption and leisure and that it does not take into account preference weight that he may place on welfare of descendants. Under alternative preference specification, in which individuals explicitly value welfare of children, for example, ordering over policies and corresponding transition paths of course will differ. The topic is left for ongoing research.

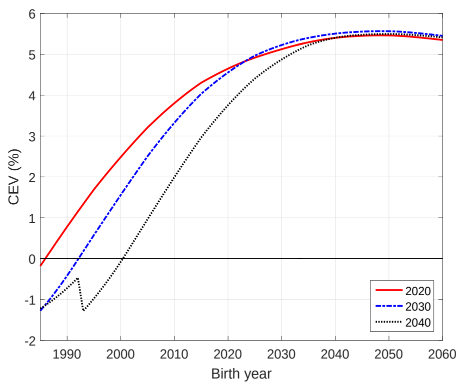
not many workable years, if any, remain. They will be worse off by a reduction in benefits and especially if reform happens sooner than later. As shown in Figure 8(a), retirees will be worse off with reform and the welfare loss is greater if it starts sooner. Middle-aged individuals before reaching retirement age are also worse off with earlier reform. For an individual at age 40 in 2010, for example, if reform begins in 2040, benefits won't start going down until they are 70 years old and the 20% reduction will not be complete until they (ever) reach age 100. If, however, the reform starts in 2020, benefits are already lower by the time they reach retirement age.

Future generations will be much better off with reform and the one that starts sooner as they gain more from higher wages and lower consumption taxes for many more years to come. They also have enough time to accumulate sufficient savings and prepare for retirement when they expect lower retirement transfers from the government. They benefit more from the strength of the economy and lower distortions through taxation. Timing of reform makes a significant difference in the welfare of future generations as well. For example, individuals born in 2000, who turn 20 in 2020, will be better off if reform starts in 2020 by 2.5% in terms of consumption equivalence, compared to the baseline transition without reform or a scenario of reform starting in 2040. The sizeable difference in welfare remains for many future generations to come. All future cohorts up to those to be born in around 2030 have higher welfare if they were born in an economy that has already implemented reform in an earlier year.

Postponing reform for as long as possible will come at a large cost of higher taxes, lower capital, labor and economic activities for many years during the transition, and leave large welfare costs that future generations will have to bear.



(a) On current generations



(b) On future generations (by the birth year)

Figure 8: Welfare effect of reform

6 Conclusion

A review of ongoing demographic transition in Japan and current pay-as-you-go pension system reveals that aggressive reform is needed either now or in future that is not too far away. The paper simulated reform that reduces replacement rates of public pension by 20%, as embedded in pension reform of 2004, and raises normal retirement age from the current 65 years old to 68 gradually over a 30-year period. We considered three scenarios that differ in the timing of initiating reform in 2020, 2030 and 2040, respectively.

Waiting for a decade or two to start reform will generate a sizeable and prolonged decline in capital, labor and economic activities, together with significantly higher taxes during the transition imposed on young and future generations. Of course, however, an earlier reform comes at the cost of retirees for whom losses from lower benefits outweigh gains from positive general equilibrium effects.

Whether reform brings welfare gain or loss depends on what we consider as the benchmark. Perhaps a proper point of reference is not the current system, but the one in which fiscal burden of demographic transition is shared equally across generations. A delay in reform will preserve generous transfers to existing retirees, making future generation face both higher tax burden to pay off the debt and much lower pension benefits than any of current retirees. The analysis of the paper also implies that current retirees and younger generations both would have gained from reform had it been implemented years ago. It does not appear to be a sensible decision of a benevolent policy maker who would care about welfare of both current and future generations to wait to consolidate the system.

References

Braun, A. R. and D. H. Joines (2014). The implications of a graying Japan for government policy. Working paper.

Doi, T. (2008). Simulation analysis of policies to ensure Japans fiscal sustainability. *Mita Journal of Economics 100*(4), 131–60.

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

Hansen, G. D. and S. İmrohoroğlu (2013). Fiscal reform and government debt in Japan: A neoclassical perspective. NBER Working Paper 19431.

Hansen, G. D. and S. İmrohoroğlu (2016). Fiscal reform and government debt in japan: A neoclassical perspective. *Review of Economic Dynamics 21*, 201–224.

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

Hoshi, T. and T. Ito (2014). Defying gravity: Can the Japanese soveriegn debt continue to increase without a crisis? *Economic Policy 29*(77), 5–44.

Hsu, M. and T. Yamada (2015). Population aging, health care and fiscal policy reform: The challenges for japan. Working paper.

Ihori, T., R. R. Kato, M. Kawade, and S. Bessho (2005). Public debt and economic growth in an aging Japan. Working paper.

Ihori, T., R. R. Kato, M. Kawade, and S. Bessho (2011). Health insurance reform and economic growth: Simulation analysis in Japan. *Japan and the World Economy 23*, 227–239.

Kitao, S. (2015). Fiscal cost of demographic transition in japan. *Journal of Economic Dynamics and Control 54*, 37–58.

Lise, J., N. Sudo, M. Suzuki, K. Yamada, and T. Yamada (2014). Wage, income and consumption inequality in Japan, 1981 - 2008: From boom to lost decades. *Review of Economic Dynamics 17*(4), 582–612.

OECD (2015). Pensions at a glance 2015: Retirement-income systems in OECD and G20 countries.

Okamoto, A. (2013). Welfare analysis of pension reforms in an ageing Japan. *Japanese Economic Review 64*(4), 452–483.

United Nations (2015). World population prospects.

Yamada, T. (2011). A politically feasible Social Security reform with a two-tier structure. *Journal of the Japanese and International Economies 25*(3), 199–224.

A Definition of competitive equilibrium

A competitive equilibrium in each period t consists of individuals' decision rules $\{c_t(x), h_t(x), a_{t+1}(x)\}$ for each state vector $x = \{j, a, z, e\}$, factor prices $\{r_t^k, w_t\}$, consumption tax $\{\tau_t^c\}$, accidental bequests transfer $\{b_t\}$, and the measure of individuals over the state space $\{\lambda_t(x)\}$ that satisfy the following conditions.

1. Individuals solve optimization problems defined in section 3.2.

2. Factor prices are determined competitively and equated to marginal product of each factor.

$$\begin{aligned} r_t^k &= \alpha A_t \left(\frac{K_t}{L_t}\right)^{\alpha-1} - \delta \\ w_t &= (1-\alpha) A_t \left(\frac{K_t}{L_t}\right)^{\alpha} \end{aligned}$$

3. The lump-sum transfer of accidental bequests equals the amount of assets left by the deceased.

$$b_t = \sum_x a_t(x)(1 - s_{j,t-1})\lambda_{t-1}(x)$$

4. The labor and capital markets clear.

$$\begin{aligned} K_t &= \sum_x \left[a_t(x) + b_t\right] \lambda_t(x) - D_t \\ L_t &= \sum_x z\psi_j h_t(x)\lambda_t(x) \end{aligned}$$

5. The consumption tax τ_t^c satisfies the government budget constraint (1).[9]

6. The goods market clears.

$$\sum_x c_t(x)\lambda_t(x) + K_{t+1} + G_t + M_t = Y_t + (1-\delta)K_t$$

[9]Here we define a competitive equilibrium based on the scenario where consumption tax τ_t^c is adjusted to balance the government budget.