Japan's Aging Workforce: Determinants and Outlook *

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Abstract

This paper examines recent trends in the Japanese labor market, with a particular focus on the elderly workforce. Japan's elderly employment rates are notably high compared to other OECD countries and have increased significantly over the past two decades. To investigate the factors that affect the employment of old individuals, we develop a structural life-cycle model with consumption-saving decisions and endogenous labor supply in both intensive and extensive margins. The model is calibrated to the cohort of men born in 1936-1940. We find that social security reforms to raise the retirement age by five years and reduce the replacement rate by 20% would have increased labor force participation among men in their 60s from 58% to 69% and 67%, respectively, while also encouraging greater retirement savings. Furthermore, we find that overall labor productivity growth reduces elderly participation due to an income effect, whereas productivity growth among the elderly, driven by lower skill depreciation, motivates longer labor force participation.

Keywords: Retirement, life-cycle model, health, public pension, Japan.
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1 Introduction

Ongoing demographic aging in many countries presents a significant economic challenge, primarily due to the shrinking labor force and the rising fiscal pressures from age-related public expenditures. However, the labor supply is influenced not only by the size of the working-age population but also by the participation rates across different age groups and their labor productivity.

In the first part of this paper, we examine employment trends in Japan. Using multiple data sources, including the Basic Survey of Wage Structure (BSWS), and Labour Force Survey (LFS), we analyze the life-cycle employment and earnings patterns over time since the 1990s and across different cohorts. Employment rates of elderly men and women across age groups are high relative to other developed countries and have been on the rise since 2000. The employment rate of men in their early 60s rose from 65.1% in 2000 to 84.4% in 2023, and for women from 37.8% to 63.8%. Earnings are hump-shaped over the life-cycle and the trend differs from that of employment rates. Men's earnings at young and middle ages have declined since the 1990s and very recent cohorts of men earn less than those in earlier cohorts.

In the second part, we develop a structural life-cycle model, calibrated to the economic environment and labor market experiences of males born between 1936 and 1940. This cohort was chosen to allow us to track the full career trajectory of the same group of individuals.

We simulate the model under alternative assumptions about the social security scheme and the labor productivity of young and old workers, to analyze the factors that influence the employment of old individuals. Our findings indicate that the specifics of social security rules significantly impact individuals' labor supply decisions. Raising the retirement age from 60 to 65 and reducing the replacement rate by 20% would increase the average employment rate of men in their 60s from 58.1% to 74.9% in total. Individuals would also accumulate more wealth over the life-cycle, as a result of optimally choosing the combination of additional labor supply and more savings to prepare for later retirement.

While higher overall productivity tends to reduce elderly participation due to the income effect, an increase in the productivity of elderly workers, driven by a decrease in the rate of skill depreciation at old ages, leads to higher participation by the elderly. Although economic growth might generally lower participation rates, improving working conditions for the elderly could counteract these negative effects and enhance their employment.

This paper builds on the literature that investigates the life-cycle pattern of labor supply and its interaction with the macroeconomic environment, using a quantitative model of heterogeneous individuals. French (2005) is an early paper that estimates a life-cycle model with endogenous saving and labor supply in both intensive and extensive margins and studies the roles of the social security scheme in individuals' decisions. Blundell et al. (2016) examine retirement data from developed countries and study the roles of government and private pension schemes in shaping retirement decisions. French and Jones (2011) build a life-cycle model of older individuals with medical expenditure risks and show that Medicare plays an important role in the retirement decisions of the elderly. Fan et al. (2024) construct a model with endogenous consumption, labor supply, and human capital and emphasize the roles of human capital accumulation and depreciation in accounting for the life-cycle profiles of labor supply and wages. Borella et al. (2023) examine the effects of marriage-related tax provisions and social security benefits and demonstrate distortionary effects of these provisions on the saving and labor supply of men and women.[1]

The papers listed above parameterize their models to the U.S. economy. There are recent papers that build quantitative life-cycle models focusing on the Japanese economy and study the roles of various policies on the life-cycle decisions of households.[2] Braun and Joines (2015) analyze the medium- to long-run impact of demographic aging and fiscal sustainability in a general equilibrium life-cycle model. Kitao (2015) builds a model with endogenous labor supply in both the intensive and extensive margins, and studies the roles of demographic aging and the effects of social security reform. Some papers focus on the role of fiscal policy in affecting the labor supply decisions of women. Yamada (2011) studies the impact of tax reform in the 1990s on the labor supply decisions of married women over the life-cycle. Kitao and Mikoshiba (2024) construct a model of women's labor supply and human capital accumulation, with heterogeneity in marital status and family structure. Okada (2023) builds a life-cycle model of the elderly and studies the effects of the social security earnings test.

Our study is also related to the empirical literature on the labor supply of the elderly in Japan. Oshio et al. (2020) and Oshio et al. (2023) investigate the effects of public pension programs and implicit taxes on the work incentives of the elderly. Oshio et al. (2024) analyze old individuals' health capacity to work using data on the life expectancy and the health status of both young and old workers, and find that the elderly in Japan have significant health capacity to continue working. Kondo (2016) studies whether a rise in elderly employment crowds out young workers, finding no clear evidence of substitution, though there is some indication of a modest crowding out of middle-age female workers. Kondo and Shigeoka (2017) investigate the effects of government intervention

[1] See Perez-Arce and Prados (2021) for a survey of the literature investigating recent trends of the labor force participation rate in the U.S. There are papers that focus on the roles of health in the life-cycle behavior of households. See, for example, De Nardi et al. (2024) and Capatina (2015).

[2] For quantitative models of labor supply in other countries, see, for example, Laun and Wallenius (2015), who examine the impact of a Swedish pension reform, focusing on how the reform affects retirement behavior and the disability insurance claiming of old workers. Alonso-Ortiz (2014) uses a life-cycle model with incomplete markets to study the roles of social security features in accounting for the variation in employment rates across OECD countries.

on the employment of the elderly and demonstrate the positive impact of the policy on the employment of individuals in their early 60s. Kajitani and Kan (2023) examine the impacts of this government intervention and pension reform on elder male workers' employment, by leveraging variations on companies' mandatory retirement ages. Oshio et al. (2018) study factors related to the labor force participation of older individuals in Japan, including improved health, education levels, a shift in the composition of jobs, and social security rules.

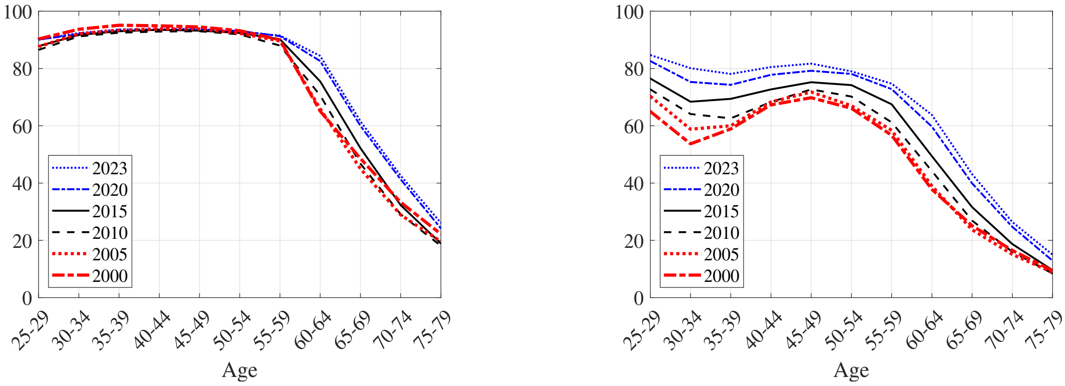
The remainder of the paper is organized as follows. Section 2 presents labor market data in Japan and reviews the recent trends. Sections 3 and 4 describe our quantitative model and parametrization of the model, respectively. Section 5 presents numerical results and section 6 concludes.

2 Labor Market Trends

In this section, we analyze labor market trends in Japan over the past few decades, focusing on employment, earnings, and work hours across the life-cycle, with particular attention to the behavior of the elderly. Employment-related statistics are drawn from the Labour Force Survey (LFS), a household survey conducted monthly since 1947 by the Statistics Bureau of the Ministry of Internal Affairs and Communications (MIC). The LFS provides comprehensive data on employment and unemployment among individuals residing in Japan.

For wage and work hour information, we rely on the Basic Survey of Wage Structure (BSWS), an annual establishment survey conducted by the Ministry of Health, Labour and Welfare (MHLW) since 1947. Both the LFS and BSWS are designated as Fundamental Statistics under the Statistics Act.

Figure 1 shows the participation rates of men and women by age between 2000 and 2020. While the participation rates for prime-aged men aged 20 to 50 have changed little, there has been a noticeable increase in labor market participation among elderly men in recent years. For women, participation rates have increased across all age groups.



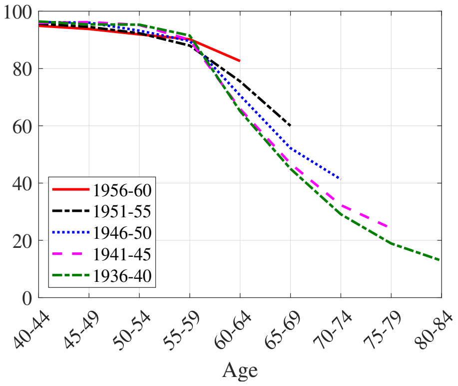
(a) Men

(b) Women

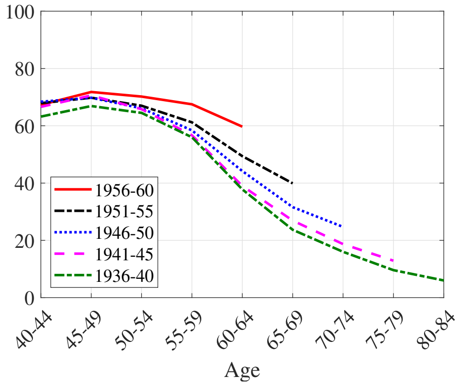
Figure 1: Employment Rates of Men and Women by Year
Source: Labour Force Survey (LFS)

Figure 2 illustrates the trend in the elderly's participation rates from a cohort perspective. Using cross-sectional data on labor force participation rates by age, we constructed life-cycle profiles for cohorts born between 1936 and 1960. More recent cohorts stay in the labor force longer, with more individuals continuing to work well into their 60s. For men aged 60-64, the participation rate exceeds 70% across all cohorts, increasing from just above 70% for the early-1940s cohort to over 85% for the late-1950s cohort. Notably, over 40% of the late-1940s cohort, now aged 70-74, are still working. Elderly women's participation rates follow a similar trend, although their participation rates are lower than those of men across all age groups.[3]

[3] Women's labor force participation, particularly the diminishing M-shaped pattern in recent decades as more women remain in the labor force through their late 20s and 30s, has attracted considerable attention in Japan. See, for example, Kawaguchi et al. (2021) for an empirical analysis of labor market dynamics during the Abenomics period in the 2010s.



(a) Men



(b) Women

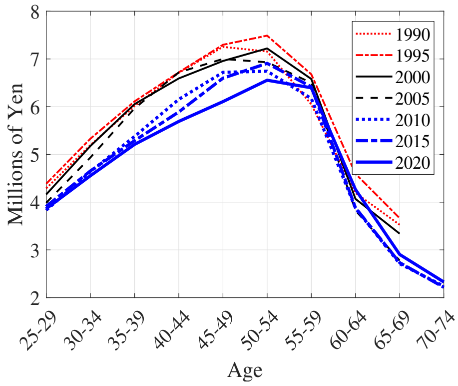
Figure 2: Employment Rates of Men and Women by Cohort
Source: Labour Force Survey (LFS)

Many quantitative models assume that individuals leave the labor force and begin collecting social security benefits at an exogenously determined age, typically set at the eligibility age for the public pension. Recently, models have been developed focusing on women's labor supply, but men's participation decisions have received relatively less attention and are often simplified by assuming that men always work and leave the labour force once they start collecting public pensions.

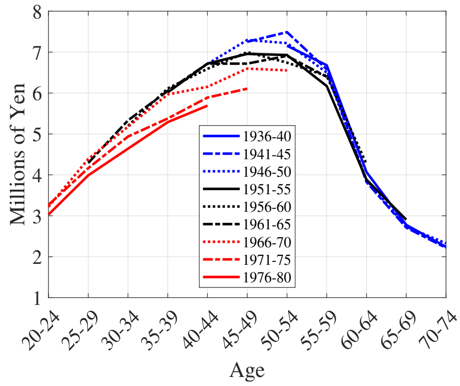
However, the figures above show that many men continue working well beyond the pension eligibility age of 65. Moreover, the labor supply of elderly men has risen significantly in recent decades. This paper examines men's life-cycle work decisions, exploring the factors influencing elderly men's labour force participation and the potential reasons behind the recent increase.

Figure 3 presents the average annual earnings of male workers by year and cohort, based on data from the BSWS. Although not entirely monotonic across age groups and years, there is a noticeable decline in earnings among prime-aged men over the last few decades, as shown in Figure 3a. For example, the average earnings of men aged 40 fell by 14% from 6.7 million yen in 1990 to 5.7 million yen in 2020.[4] Figure 3b shows the age profile of earnings by cohort, computed from cross-sectional averages with the cohort participation rates calculated in a similar way to employment rates. This figure also illustrates the decline in earnings throughout the life-cycle for more recent cohorts.

[4]Throughout our analysis, all nominal amounts are adjusted by the consumer price index (CPI) to convert them into real values in terms of 2020 yen.



(a) By Year



(b) By Cohort

Figure 3: Earnings of Male Workers

Source: Basic Survey on Wage Structure (BSWS)

Figure 4 shows the average work hours of male workers across age groups from 1990 to 2015 based on BSWS data.[5] Work hours declined sharply across all age groups during the 1990s. This decline coincides with revisions to the Labor Standards Act in the early 1990s, which reduced the standard weekly work hours from 48 to 40. In each year, average work hours remain relatively flat for workers aged 25 to 59, before declining sharply thereafter.

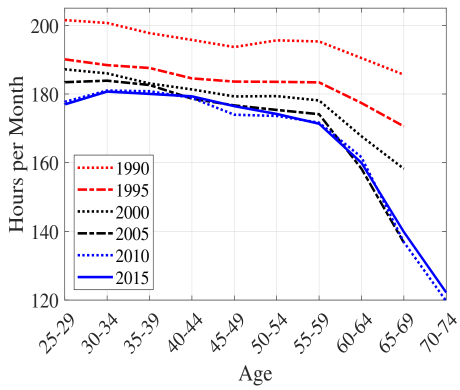


Figure 4: Work Hours of Male Workers

Source: Basic Survey on Wage Structure (BSWS)

3 Model

In this section, we present our quantitative life-cycle model of individuals with endogenous saving, consumption and labor supply on both intensive and extensive margins.

[5]We intentionally focus on this time period and do not include data after 2020 due to a change in the classification of short-term workers, which prevents us from computing average work hours on a consistent basis.

Individuals are heterogeneous in multiple dimensions: age, assets, health status, and labor productivity in both fixed and stochastic components. We also assume preference heterogeneity in patience to account for a fraction of individuals who save nothing or very little over the life-cycle. Our model is focused on male individuals and abstracts from heterogeneity in family structures and gender.

In each period, individuals choose the amount of assets to carry into the next period and decide on whether to participate in the labor market and, if so, how many hours to work. Individuals face uncertainty in three dimensions. First, their life span is uncertain, and they face survival probabilities in each period that vary by age. Second, their health status is uncertain, which we assume affects the utility cost of participating in the labor market. Third, their labor productivity includes an idiosyncratic stochastic component. We assume that individuals take macroeconomic conditions, including factor prices and fiscal policies, as given, and that there is no aggregate shock.

Individuals enter the economy at age $j = 1$ and live up to the maximum age of $j = J$. The conditional probability of survival from age j to age $j + 1$ is denoted as s_{j+1}, with $s_{J+1} = 0$. In each period, individuals are endowed with a unit of disposable time that they allocate between market work and leisure. Individuals' productivity consists of three components. First, they are born with an ability type α, which is fixed throughout their life-cycle. Second, there is an idiosyncratic stochastic component denoted by η. Third, there is an age-specific productivity component denoted by ν_j. Earnings of a working individual are given as $y = \alpha\eta\nu_j hw$, where h denotes work hours and w is the wage per efficiency unit. The interest rate r is exogenously given.

The health status of an individual is denoted as m, and $\pi_j^m(m, m')$ represents the probability that the health status will be m' in the next period, given that the current health status is m for an individual of age j.[6] Individuals derive utility from consumption c and leisure l in each period according to the following utility function.

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

where $l = L - h - (\theta_j + \phi_m)I_h$, L denotes the total time endowment of an individual, h is work hours chosen by an individual, θ_j denotes participation costs that may vary with age, ϕ_m represents participation costs that vary with health status, and I_h is an indicator that takes a value of 1 if an individual participates in the labour market, that is, $h > 0$.

[6] We assume that the health status is exogenous and affects work disutility as discussed below. The existing literature, however, suggests that retirement can cause both positive and negative effects on health and life satisfaction. See, for example, Behncke (2012), Insler (2014) and Kwak and Lee (2024). The positive effects on health are likely to provide more incentives to work, but a thorough investigation of this issue would require a model of endogenous health status, which we leave for future research.

The lifetime utility of an individual is defined as

$$E\left\{\sum_{j=1}^{J}\beta_i^{j-1}u(c_j,l_j)\right\}, \tag{2}$$

where the expectation is with respect to idiosyncratic productivity shocks, mortality risks and health shocks. We assume preference heterogeneity in discount factors and β_i in equation (2) denotes the subjective discount factor of type-i individuals. We assume the value of discount factor remains constant throughout the life-cycle.[7]

The government provides social security benefits and means-tested transfers for eligible individuals. Once an individual reaches the pension eligibility age, which we call the "normal retirement age", denoted by j_R, the individual starts to receive pension benefits $ss(p)$, and nothering otherwise. The benefits are specified as an increasing function of past earnings. The index p represents an individual's average earnings up to the normal retirement age.[8] The government provides a means-tested transfer tr to an individual to guarantee a minimum consumption level of $\underline{c}$. The transfer amount is zero if the individual's disposable assets exceed $\underline{c}$ plus consumption taxes.[9]

The government imposes taxes on consumption at rate τ^c, labor income at τ^l, and capital income at τ^a. Earnings are also subject to a proportional payroll tax denoted by τ^p. The after-tax gross interest rate, R, is specified as $R = 1 + r(1-\tau^a)$.

Individuals' Problem: The state vector of each individual is given as $(j, a, i, \alpha, \eta, m, p)$, where j denotes age, a assets, i preference type, α fixed productivity, η stochastic productivity, m health (medical) status, and p an index for past earnings. The value function of an individual in state x is given as

$$V(j,a,i,\alpha,\eta,m,p) = \max_{c,e,a'}\left\{u(c,l) + \beta_i s_{j+1}\mathbb{E}V(j+1,a',i,\alpha,\eta',m',p')\right\}, \tag{3}$$

subject to

$$(1+\tau^c)c + a' = Ra + (1-\tau^l-\tau^p)y + ss(p) + tr. \tag{4}$$

a' denotes the choice of assets for the next period. The expectation operator is with respect to the health status m' and productivity shock η' in the next period. We assume no borrowing, $a' \geq 0$.

[7]See Krusell and Smith (1998) and Hendricks (2007), for example, for papers that incorporate heterogeneity in discount factors.

[8]Note that the normal retirement age j_R is the age at which individuals start to receive publicnormal pensions benefits. The normal retirement age for the public pension does not have to be the same as the age at which individuals leave the labor force and retire from work.

[9]The transfer is defined as $tr = \max\{0, (1+\tau^c)\underline{c} - \underline{a}\}$, where $\underline{a}$ denotes the disposable assets of an individual, $\underline{a} = Ra + (1-\tau^l-\tau^p)y + ss(p)$.

4 Calibration

In this section, we present our parameterization of the model. We use various databases including LFS, BSWS, the Japan Household Panel Survey (JHPS/KHPS), and estimates from the National Institute of Population and Social Security Research (IPSS), to obtain the data counterparts of our model variables and to derive target moments for our calibration.

Our basic strategy is to calibrate parameters to match the life-cycle profiles of variables for the cohort born between 1936 and 1940, which we refer to as the 1940 cohort. This cohort is in their early 80s by 2020, so we have labor market data for most of their working ages. We also use the demographic variables and government policies that vary over time, consistently with what this cohort experienced over their life-cycle.

Individuals enter the economy at age $j = 1$ (25 years old) and live up to the maximum age of $J = 76$ (100 years old). Survival probabilities s_j for the 1940 cohort are obtained from the life tables reported by the MHLW.

An individual's earnings is given by $y = \alpha\eta\nu_j hw$ and the logarithm of the wage is given as

$$\log\alpha + \log\eta + \log\nu_j + \log w. \tag{5}$$

We calibrate the distribution of the fixed ability type α and the stochastic process of the idiosyncratic component η to match the life-cycle profile of wage dispersion estimated by Lise et al. (2014), who use the BSWS data to estimate various moments of male wages by age for different cohorts. We use their estimates of the variance for the 1940 cohort.

We assume that there are two values of α the fixed ability type, $\{0.77, 1.30\}$, to match the variance of wages at the initial age of 25. Lise et al. (2014) demonstrate that the wage variance rises monotonically and almost linearly with age. To approximate this pattern, we assume that the idiosyncratic shocks η are permanent and calibrate the variance of the error ε_η^2 to 0.091 to match the growth of the variance between ages 25 and 59.

The age-specific component ν_j is based on the average wage by age for individuals aged 25-59 obtained from the BSWS. The average wage level declines from age 60 onward in the data, and we assume that the age-specific component falls at a rate $\delta = 0.037$ from age 60 to match the decline in the average wages between from 60 to 80 in the BSWS. Note that the depreciation rate δ is set in the model so that the growth rate of the average wage of participating workers matches the data. The interest rate is exogenous in the model and is set to 2%.

For the health transition matrix, we use data from the JHPS/KHPS surveys. Based on the survey responses about individuals' subjective health status, we classify individuals into three categories: good, fair, and poor. Figure 5 shows the proportion of individuals in fair and poor health status. Health status deteriorates with age, with the share of those in fair or poor health increasing from less than 10% in their 20s to 20% in their

70s. Using this classification, we compute a 3-by-3 transition matrix, with each element representing the conditional probability of transitioning to another health status in the following period.

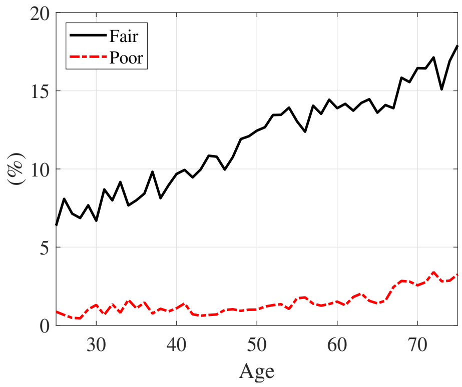


Figure 5: Shares of Individuals in Fair and Poor Health Status
Source: JHPS/KHPS

Regarding the preference, we set γ, the weight parameter on consumption relative to leisure, so that average work hours in the model align with the data.[10] The risk aversion parameter σ is set to 2.

To better capture saving patterns, we allow for heterogeneity in the discount factor β_i, assuming there are two types of individuals. A significant fraction of individuals save very little over the life-cycle. According to the JHPS/KHPS data, about 15% of individuals report having zero assets around their retirement age.[11] We classify these individuals as hand-to-mouth (type 2), setting $\beta_2 = 0$ for 15% of the individuals. For the remaining individuals (type 1), we set their discount factor $\beta_1 = 0.998$, so that the average wealth at age 60 matches the data.

Labour force participation costs are categorized into two types: age-dependent costs θ_j and health-dependent costs ϕ_m, respectively. For age-dependent costs, since participation rates start to decline only after age 60, we assume positive costs only for individuals aged 60 and above. The functional form is specified as $\theta_j = \Theta_1 + \Theta_2 j^{\Theta_3}$, where the parameters Θ_1, Θ_2, and Θ_3 are calibrated to match the participation profile for individuals aged 60 and older.[12] Among individuals aged 60-74, the average participation rate is 10 percentage points lower for those in fair health and 37 percentage points lower for those in poor health

[10] According to the BSWS, average weekly work hours for men aged 25-59 in the 1940 cohort are 199 hours. Thus, we set the target $h = 199/480 = 0.42$.

[11] This share is consistent with Kitao and Yamada (2019), who use data from the National Survey of Family Income and Expenditure (NSFIE).

[12] In the calibration algorithm, we use the average participation rates in their 60s and 70s, as well as the zero participation in their 90s as target moments. The age in the functional form represents the number of years from age 59.

compared to those in good health. We calibrate health-dependent participation costs to match these differences, by setting the values to 0.015 and 0.064 for those in fair and poor health, respectively.

For the government, we set the capital income tax rate τ^a and labor income tax rate τ^l to 0.35 and 0.18, respectively, based on the effective tax rates estimates in Gunji and Miyazaki (2011). The consumption tax, introduced in 1989 at 3%, was gradually increased to 10% by 2019. Accordingly, we allow the consumption tax rate τ^c to vary over time.

The payroll tax τ^p reflects social insurance premiums, including contributions to public pension, health insurance, and long-term care insurance programs. The total tax rate for employed workers rose from 5.9% in 1965, when the 1940 cohort was 25, to 15.0% in 2024. We model the payroll tax rate τ^p to grow over time accordingly.

The replacement rate of social security κ is set to 0.417 so that the average pension benefits of the 1940 cohort match the data. The pension retirement age is set at 60 ($j_R = 41$ in the model). Since 2001, the retirement age has been gradually raised to 65. In section 5, we simulate the model with an alternative retirement age and replacement rates.[13] For welfare transfers, we calibrate the consumption floor to match the path of the standard amount of living assistance paid to single individuals.

5 Numerical Results

5.1 Baseline Model

Figure 6 shows the employment rates of individuals in our baseline model, compared to the data for the cohort of men born in 1936-1940, constructed from the LFS data. In our model, individuals continue to work until age 60 and then gradually begin to leave the labor force, reaching nearly full retirement by age 90, as observed in the data.

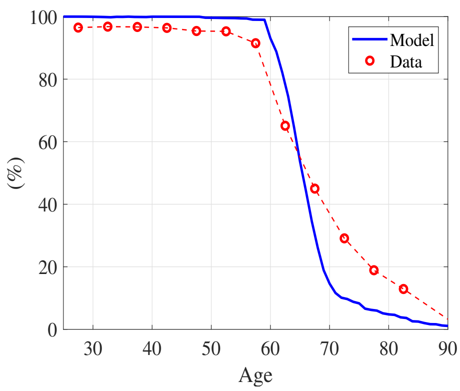


Figure 6: Employment Rates: Baseline Model

[13]Note that we assess the impact of the Employee Pension Insurance (*Koesei Nenkin*) system not the National Pension (*Kokumin Nenkin*) system.

Note that we are not able to explain the small percentage of individuals aged between 25 and 60 who do not participate in the labour market at all. This group likely includes individuals who are not working due to reasons such as unemployment, disability, hospitalization, and caring for family members which are not accounted for by the elements of our model. The main goal of our quantitative model is to approximate the pattern of gradual decline in employment for individuals above the age of 60, and we achieve this with a parsimonious set of parameters that define work and participation disutility and productivity.[14]

Figure 7 shows the participation rates by health status for individuals aged 60 and older. Note that we target the difference in participation rates across health types using the health-specific participation costs for individuals in fair and poor health status, respectively.

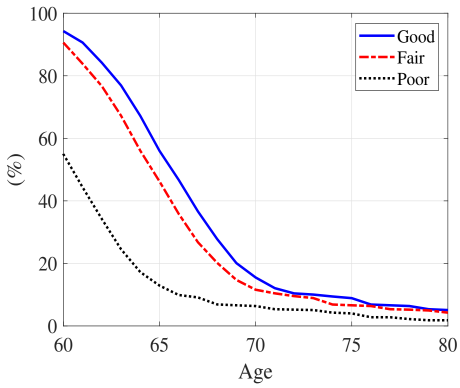
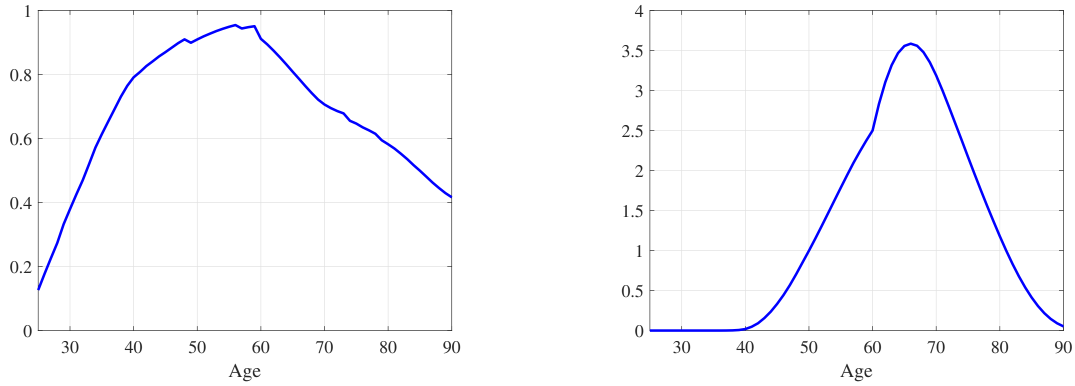


Figure 7: Employment Rates by Health (Age 60 and older): Baseline Model

Figure 8 shows the life-cycle profiles of consumption and assets. The consumption profile is hump-shaped, and in a similar shape to those reported in empirical studies, such as Kitao and Yamada (2024). The amount of assets held increases towards the retirement period and peaks when individuals are in their mid-60s.

[14]The data shows a more gradual decline in participation above age 70 compared to our model. As our discussant, Naohito Abe, noted, a large fraction of workers above age 75 are self-employed, which our model does not explicitly account for. Extending the model to distinguish between employed and self-employed individuals would be a valuable direction for future research.



(a) Consumption

(b) Assets

Figure 8: Consumption and Asset over the Life-cycle: Baseline Model (Average Earnings=1)

5.2 Factors Related to Elderly Participation

We now examine how various factors influence individuals' life-cycle behavior in our model.[15] First, we simulate two scenarios involving the public pension scheme: a lower replacement rate and a higher retirement age. Reduced pension benefits incentivize individuals to remain in the labor force longer due to the income effect. At the same time, they save more for retirement in anticipation of lower old-age income, partially offsetting the direct income effect.

In the second set of simulations, we analyze two scenarios related to individuals' labor productivity. Higher productivity at younger ages allows individuals to accumulate more savings for retirement, reducing the need to work later in life. Conversely, higher productivity among older workers, driven by slower skill depreciation, creates stronger incentives to remain in the labor force. We quantitatively explore these effects in this section.

Social Security Reform: In the baseline model calibrated to the 1940 cohort, individuals start receiving the public pension at age 60, and the replacement rate is set to match the average pension benefits of the cohort. In this sub-section, we simulate the model under alternative assumptions about the normal retirement age and the replacement rate.

Since 2001, the retirement age for the Employee Pension Insurance system has been gradually raised from 60, and it will reach 65 by 2025 for men and by 2030 for women. Moreover, to cope with the rising fiscal burden to cover age-related expenditures, the government introduced the 'macroeconomic slide' scheme in the pension reform in 2004.

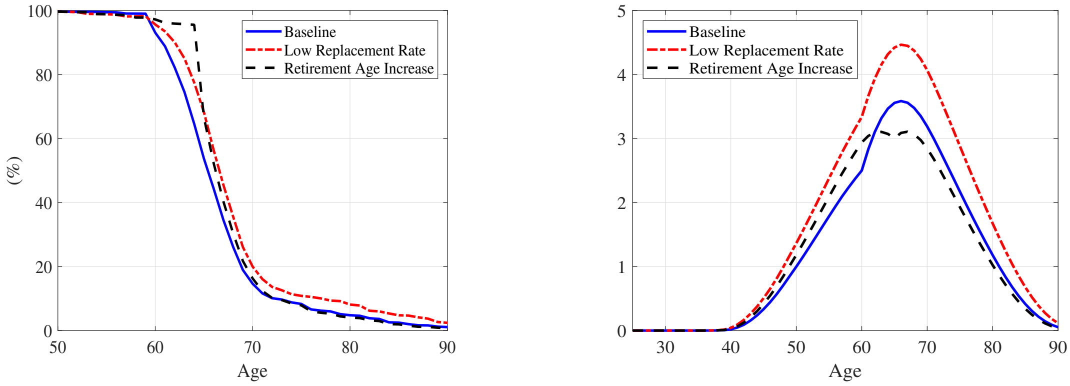
[15] In these experiments, individuals are assumed to know the path of alternative policy or productivity parameters upon entering the economy, and there is no policy uncertainty.

The scheme is designed to adjust the amount of public pensions automatically in response to demographic changes, including increases in average life expectancies, and a decline in the insured working-age population. However, the scheme includes an exemption from adjustments in a deflationary economy to prevent a decline in benefits in nominal terms. Due to this exemption and other reasons, adjustments were not made in many years, and the scheme has been implemented only several times so far. Adjustments will continue, and according to the government's 2024 Financial Projection of Pension (*zaisei kensho*), published by the MHLW, the pension replacement rate is expected to decline by approximately 20% under the baseline growth scenario.

Given these past and ongoing developments, we simulate a reform that raises the retirement age from 60 to 65, and a reform that reduces the replacement rate by 20%. Figure 9 shows the paths of employment rates and assets under these two scenarios. With a lower replacement rate, individuals have stronger incentives to save for retirement, resulting in higher asset levels throughout their life-cycle. At age 65, the average asset level is 24% above the baseline model. Individuals also stay in the labor force longer, with the average employment rate in their 60s at 67.3%, compared to 58.1% in the baseline model.

When the retirement age for receiving pension benefits is raised from 60 to 65, individuals save more than in the baseline model until their early 60s. Thereafter, they decumulate wealth faster, as they need to wait an additional five years for their pension benefits to begin. Many individuals choose to stay in the labor force longer, with the employment rate remaining particularly high until the new retirement age. The average employment rate in their 60s rises to 69.2%, about 11 percentage points above the baseline level.

These two experiments demonstrate that individuals adjust to lower expected pension benefits by increasing their savings and extending their working period. When combining the two scenarios - raising the retirement age to 65 and reducing the replacement rate by 20% - the average employment rate in their 60s increases to 74.9%, 16.8 percentage points above the baseline model. This indicates that part of the rise in elderly participation rates in recent years is likely due to changes in the social security system and a decline in the expected receipt of benefits.



(a) Employment Rates

(b) Assets

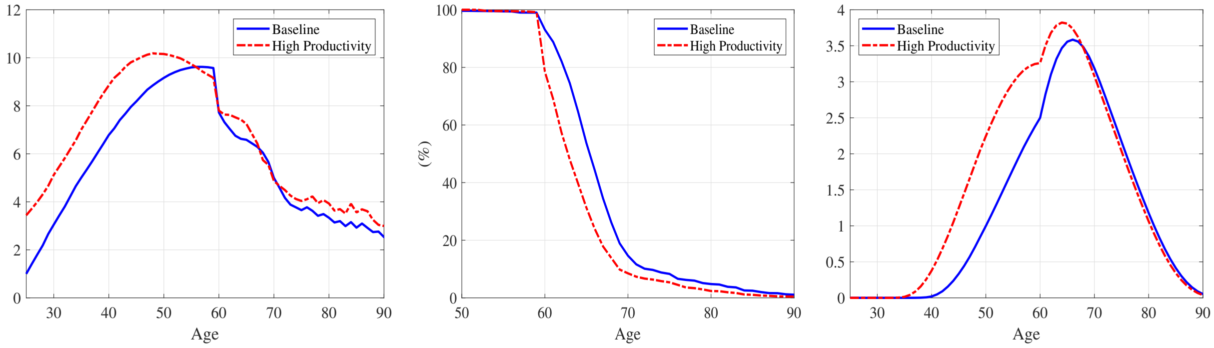
Figure 9: Social Security Reform

Note: Assets are expressed in units of average earnings in the baseline model in (b).

Productivity Growth and Depreciation: The labor productivity of workers depends on the age-dependent deterministic component ν_j, as well as idiosyncratic components. We calibrated the deterministic component for individuals aged 25 to 59 so that the wage profile by age would match the profile of the 1940 cohort. After age 60, deterministic productivity is assumed to decline at a rate δ.

In this sub-section, we simulate the model with two alternative scenarios regarding individuals' labor productivity. In the first scenario, we assume higher average productivity for prime-aged individuals aged between 25 and 59, using the wage profile of the 1960 cohort based on the BSWS data. In the second scenario, we consider a scenario with a lower depreciation rate of older individuals' productivity, setting δ at one percentage point below the baseline level.

Figure 10 shows the results for the scenario of high productivity. As shown in Figure 10a, labor income is significantly higher among young and middle-aged individuals, leading them to accumulate more wealth until their mid-60s. The asset level at age 60 is 30.3% higher than in the baseline model. Due to the strong income effect, the employment rate is lower after the retirement age, as shown in Figure 10b.

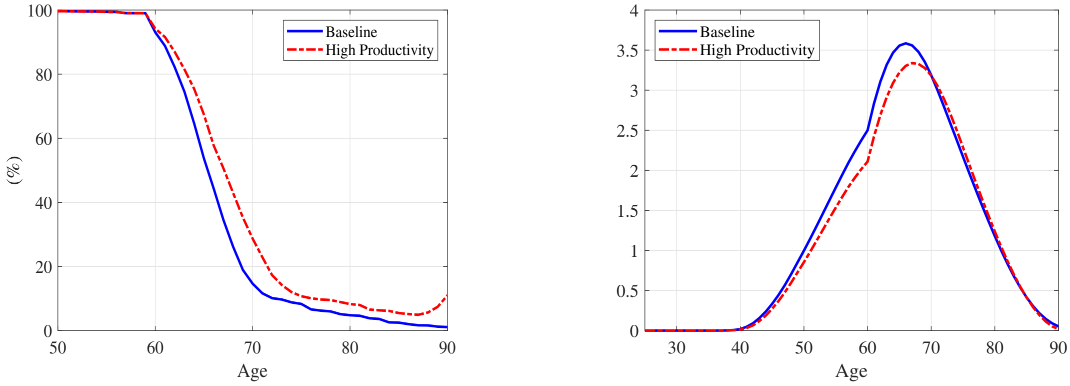


(a) Earnings (b) Employment Rates (c) Assets

Figure 10: Productivity Growth

Note: Average earnings are for workers only. Earnings at age 25 in the baseline=1 in (a). In Panel (c), assets are expressed in units of average earnings in the baseline model.

Figure 11 shows the profiles of employment rates and assets when we assume a lower depreciation rate of skills after age 60. Employment rates decline more gradually, with the average employment rate in their 60s reaching 68.4%, approximately 10 percentage points higher than in the baseline model. Anticipating higher wages and longer working years, individuals save less than in the baseline model until around age 70, as shown in Figure 11b, although their asset level is similar thereafter as their earnings are higher on average.



(a) Employment Rates (b) Assets

Figure 11: Lower Depreciation of Skills

Note: Assets are expressed in units of average earnings in the baseline model in (b).

These two experiments demonstrate that higher productivity and wages may or may not lead to more employment of the elderly, depending on how such changes occur. Economic growth and higher income generally imply income effects and tend to reduce participation, but a rise in the productivity of the elderly will induce them to work longer. Improvements in the working capacity of the elderly or changes in the labor market and working conditions for the elderly would encourage their labour market participation. Such changes could potentially be achieved in different ways, for example, by improving health conditions and their working environment, better maintenance of human capital through recurrent and life-long education, and a shift towards jobs that require less physical strength.

6 Conclusion

In this paper, we first described recent labor market trends among the elderly in Japan. Two key observations are that the employment rates for those aged 60 and older are significantly higher in Japan than in many other OECD countries, and these rates have continued to rise since 2000.

We then constructed a quantitative structural model calibrated to the life-cycle behavior of the cohort of male individuals born between 1936 and 1940. Our quantitative life-cycle model allows for heterogeneity across individuals in five key dimensions: age, labor productivity, assets, health status, preference in the discount factor, and average past earnings. The calibrated model is used to quantify the effects of factors related to elderly participation decisions. We find that pension reforms to lower the replacement rate or to raise the retirement age lead to higher participation rates among the elderly. Additionally, we show that an overall productivity increase and higher wages for young and middle-aged workers will lower the labour market participation rates of the elderly due to income effects, but higher productivity of the elderly due to lower skill depreciation provides them with more incentives to stay longer in the labor force.

Finally, we discuss several limitations of our quantitative analysis and suggest areas for future research. First, as a partial equilibrium life-cycle analysis, our model does not consider how changes in individual behavior might affect macroeconomic variables, such as factor prices, tax revenues and government expenditures. Exploring these general equilibrium effects under alternative policy scenarios would be a valuable extension. Second, our structural model focuses on men's behavior. Labor market data highlights that employment and earnings patterns differ between men and women, with women experiencing unique trajectories over the past decades. Developing a model to account for behavior of both genders, possibly considering decisions within households with heterogeneous family structures, would be a challenging but important direction for future research.

Lastly, in our computation, we assume individuals possess perfect foresight and quantify how they would have behaved under an alternative path of government policy, assuming they were aware of it upon entering the economy. Alternatively, one could model a surprise reform, quantifying how individuals would respond if they encountered an unexpected policy change at a specific age. In this case, individuals would reoptimize their consumption, saving, and labor supply paths from that point onward.

Our analysis focuses on individuals born between 1936 and 1940, who reached full retirement age of 60 by 2000, and examines their behavior under alternative policy environments. Another potential avenue of analysis could explore how later cohorts, such as those born in the 1970s or 1980s, respond to unexpected policy reforms, shedding light on shifts in labor supply patterns. For instance, one could simulate the introduction of the "macroeconomic slides," benefit adjustment mechanism introduced in 2004, or changes in social security contributions, based on the timing of individuals' awareness of these reforms. Furthermore, in a model incorporating the government budget could analyze the GPIF portfolio reform and its associated rise in portfolio returns to quantify budgetary implications. While modeling policy dynamics, uncertainty, and reactions to surprise reforms requires more detailed computation, it offers a promising direction for extended research.

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