On Financing Retirement, Health Care, and Long-Term Care in Japan

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ABSTRACT

Japan is facing the problem of how to finance retirement, health care, and long-term care expenditures as the population ages. This paper analyzes the impact of policy options intended to address this problem by employing a dynamic general equilibrium overlapping generations model, specifically parameterized to match both the macro- and microeconomic level data of Japan. We find that financing the costs of aging through gradual increases in the consumption tax rate delivers better macroeconomic performance and higher welfare for most individuals relative to other financing options, including raising social security contributions, debt financing, and a uniform increase in health care and long-term care copayments.

Keywords: retirement, health care, taxation, aging, Japan

JEL classification: H51,H55, I13, E62

1 Introduction

Many countries are facing the challenging policy issue of how to finance retirement, health care, and long-term care expenditures as the number of workers per retiree falls. In this context, Japan is the OECD front-runner: Japan's population started declining around 2009 and is expected to fall by more than 25 percent, from 126 to 94 million, between 2017 and 2060; the old-age dependency ratio—the ratio of individuals aged 65 and over to individuals aged 15 to 64—was 44 percent in 2016, more than 10 percentage points higher than the average of the next 10 highest OECD countries (see Figure 1). Population projections suggest that Japan will remain the country with the highest old-age dependency ratio, surpassing 70 percent by 2060, while the average for the next 10 highest OECD countries is forecasted to be 54 percent. These demographic trends, combined with the fact that Japan's age-related government outlays (shown in Figure 2) are among the highest in the OECD, will further increase age-related costs while putting downward pressure on both aggregate and per capita GDP. The fact that the government debt-to-GDP ratio is the highest among OECD countries (at 2.4 times GDP), while tax revenues are well below the OECD average (shown in Figure 3), only exacerbates these challenges.

In this paper, we evaluate policies discussed by Japanese policymakers and other institutions such as the International Monetary Fund to address financing problems related to these demographic trends (IMF 2016, 2017). The Japanese government has already implemented some reforms—most notably, a macro-indexing mechanism in the pension system with the aim of controlling aggregate pension spending as a percentage of GDP. Further reforms have been proposed to also buttress the universal health care and long-term care systems, which are part of the Japanese social security system. Per adult spending on health and long-term care (shown in Figure 4) rises exponentially with age, making this portion of aging costs particularly expensive in light of Japan's worsening demographic trends.[1] On the financing side, options include increasing consumption tax rates, social security contributions, and copayment rates for health care and long-term care. Other proposed policies are aimed at increasing fertility rates, improving the efficiency of health services, and raising economy-wide productivity.

We analyze the impact of these policy options by employing a dynamic general equilibrium

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[1]Nozaki et al. (2017), for instance, estimate that health care and long-term care costs could increase from roughly 9.5 percent of GDP in 2010 to a level in the range of 13 to 15.5 percent by 2030.

overlapping generations model, specifically parameterized to match both the macro- and the micro-level data of Japan. Our *baseline financing option*, which allows for debt to be stabilized, requires continual but very gradual increases in the consumption tax rate and has relatively benign effects on macroeconomic activity and welfare. This financing option results in substantial long-run gains relative to alternative financing options in terms of GDP, private investment to GDP, and welfare. To arrive at this conclusion, we compute equilibrium transition paths with the initial state calibrated to Japan in 2015, referred to later as the "current Japanese economy." We allow for within-cohort heterogeneity with differences arising from differences in productivity. This approach allows us to explore the impacts of alternative policies on different birth cohorts and income groups. The simulated data from the model we use are consistent with both Japanese national income and product accounts and the income distribution.

The transitions that we study involve changes in both demographics and fiscal policies. We model the current Japanese economy departing from the current composition of the population, and use demographic forecasts from the National Institute of Population and Social Security Research (IPSS) so that the old-age dependency ratio reaches around 75 percent by 2060. In addition to Japan's demographic transition, we introduce some of the different policies under consideration. We first study a tax-transfer system, with consumption tax rates as the only variable that adjusts over time in order to keep government debt stable at about 200 percent of GDP (the current value of gross debt minus pension fund financial assets). As the population ages, consumption taxes rise to finance the additional old-age transfers, as required by the government budget constraint to keep the debt-to-GDP ratio unchanged. The consumption tax rate in this scenario peaks at about 20 percent.

We then compare the results of the baseline scenario with other scenarios defined by the use of other policy variables that may contribute to financing the costs of retirement, health care, and long-term care. In all scenarios, consumption taxes are adjusted period by period to satisfy the government's budget constraint. The first alternative scenario considers *increases in social security contributions* to finance increasing health care and long-term care costs. This policy is implemented through gradual increases in effective tax rates on labor income over 20 years, peaking at an increase of 8 percentage points and remaining at that new higher rate indefinitely. Under this scenario, consumption tax rates would still need to increase significantly, by roughly 8

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percentage points, to keep the debt-to-GDP ratio stable. Labor income taxes are more distortive than consumption taxes and, therefore, GDP falls significantly. This would be particularly relevant for future generations, who would experience long-run GDP losses on the order of 7 percent relative to the baseline policy. Average welfare is also 5 percent lower for future generations than under the baseline policy scenario.

Higher taxes can be postponed by allowing debt to accumulate at a pace such that consumption tax rates remain unchanged. We study this case of *further inaction*, allowing for a 15-year delay in tax increases and constant growth in debt until 2040. Under this scenario, debt reaches 300 percent of GDP, causing a substantial crowding out of private investment. Government debt is held domestically and is assumed to have an unchanged rate of interest, which is lower than the rate of return for private capital. Hence, higher government debt reduces household portfolio returns. The private sector must pay a higher interest rate to motivate households to save and channel resources into the financial system. According to the model predictions, the ratio of private investment to GDP declines by up to 8 percent relative to the baseline policy scenario. Because the long-run level of debt is higher, consumption tax rates must increase to roughly 30 percent in order to stabilize the debt-to-GDP ratio. The overall effect of these changes is a long-run GDP level that is 20 percent lower than under the baseline policy. Policies with higher debt or income taxation benefit retirees and older workers as they care mostly about current consumption, and both policies either delay the increase in the consumption tax rate or require a lower level for the rate. Their relatively small gains come at the expense of current workers and all future generations across the income spectrum.

The next scenario we consider explores the effects of *increasing the health care and long-term care copayment rates* for the elderly. In particular, we allow the copayment rate paid by people over 65 to rise gradually over a 20-year period to the same level as that of the working-age population. We find that this policy results in relatively small gains, and the required adjustment in consumption taxes is only reduced by more than 2 percentage points. Data show that health care spending per adult is very similar across the income spectrum. Hence, increasing health care copayment rates is regressive, affecting poor and middle-class workers disproportionately. Welfare losses for the latter groups can reach 6 percent of lifetime welfare under this policy.

The last set of experiments considers the sensitivity of the model, and our estimates of gov-

ernment financing needs, to more favorable assumptions on demographic trends, efficiency of the health care sector, and improvements in economy-wide productivity. In the case of demographic trends, we use more favorable fertility predictions from the IPSS. In the case of efficiency improvements, we assume less spending is required for the same level of health care services. In both cases, we require a smaller increase in consumption tax rates, by roughly 3 percentage points, when compared with our baseline policy scenario. Higher productivity does not necessarily substantially reduce the fiscal burden of aging costs, given that the pension transfers are linked with real wage developments and health care transfers have grown faster than per capita GDP.

In Section 2, we discuss the related literature. Section 3 presents the model used to evaluate the alternative retirement financing systems. Section 4 discusses the model parameters that are chosen to be consistent with macro and micro data from Japan. Results of our policy experiments are reported in Sections 5 and 6. In Section 7, we conclude.

2   Related Literature

The literature concerned with financing aging costs is large and growing. The Feldstein (1998) volume is a useful collection of papers that consider saving-for-retirement systems in the United States, Chile, Australia, the United Kingdom, Mexico, and Argentina. Conesa and Garriga (2008) consider a set of social welfare functions and derive optimal policies. They are interested in designing plans that are welfare improving for transitional generations. They show that such a plan is possible but find paths for tax rates, especially tax rates on capital income, that "call into question its relevance" as an actual policy option (p. 294). For example, in their baseline economy in which the government chooses both labor and capital income tax rates, the optimal capital income tax rate oscillates between 60 percent and −60 percent. In the case of Japan, an imminent issue is how to address aging costs under its generous and well-established social security system. Therefore, we focus attention on policies that are currently being discussed by Japanese policymakers and the IMF.[2]

Based on historical data, the IMF (2010) performs a partial equilibrium accounting analysis and finds that gradual increases in the consumption tax rate—rising to a 15 percent rate in the long

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[2]For the authorities' policy discussions, see the "Basic Policy on Economic and Fiscal Management and Reform 2018." (https://www5.cao.go.jp/keizai-shimon/kaigi/cabinet/2018/2018_basicpolicies_en.pdf)

run—paired with some expenditure reforms would suffice to guarantee the sustainability of public finances. Recent quantitative general equilibrium analyses suggest that much larger adjustments are required. Kitao (2015) employs an overlapping generations model calibrated to Japan. In her baseline experiment, for debt to remain stable, the consumption tax rate must rise to 19.3 percent in the long run, with larger adjustments needed during the transition. Similar results and large fiscal adjustment needs are also reported in general equilibrium settings considered by Braun and Joines (2015) and Imrohoroglu and Sudo (2011). All of these analyses abstract from intangible capital and thus require substantially larger increases in consumption tax rates to finance aging costs. In addition, these analyses do not consider the welfare implications of reforms to the health care system, do not model within-cohort heterogeneity, and do not assume progressive income taxes. We find that all of these features are necessary to analyze potential reform options in Japan, as different types of workers are subject to different benefits and tax rates in the current system, and government authorities are interested in the distributional impact of policy changes on welfare.

Imrohoroglu et al. (2016) perform a very rich partial equilibrium analysis of pensions and pension reform. Their analysis includes key features of the pension system, heterogeneous types of workers, and a detailed matching of life cycle consumption, work, and savings patterns. These authors find that, under unchanged policies, pension and non-pension spending, which includes health care and long-term care expenditures plus other forms of government spending, would contribute more or less equally to the fiscal deficit and that debt is on an unsustainable path. They conclude that debt sustainability can be ensured by increasing consumption tax rates to about 20 percent, increasing the retirement age to 70, and cutting pension benefits by 10 percent. They do not consider the welfare impact of alternative policy options. Our analysis also includes worker-type heterogeneity, is consistent with life cycle micro data, and includes pension spending paths consistent with the data and pension system of Japan. However, we do so in a general equilibrium framework, which is necessary for estimating the joint macroeconomic and welfare implications of alternative policy scenarios under consideration. For example, the large crowding-out effects associated with the scenario of further inaction would be difficult to sort out in a partial equilibrium setting in which prices and behaviors do not respond to the policy environment.

To summarize, this paper's main contribution to the literature is performing a general equilibrium analysis of reforms being discussed by Japanese policymakers and the IMF to deal with the

costs of aging. We also take into account the important role of intangible investment for macroeconomic responses, and key sources of heterogeneity of the labor force, matching lifetime work and saving patterns, and allow for health care, long-term care, and pension paths that are consistent with the Japanese data and policy framework.

3 The Model Economy

In what follows, we adopt the modeling approach of McGrattan and Prescott (2017), with Japan-specific refinements. The model economy has an OLG structure with measure $n_t^{1,k}$ arriving as working-age households with productivity level $k \in \{1, 2, \ldots, K\}$ at the beginning of date t. The year since entry into the workforce is called *age* and is denoted by j. The measure of age j households with productivity level k at date t is $n_t^{j,k}$. The maximum possible age is J. The probability of an age $j < J$ household of any type at date t surviving to age $j+1$ is $\sigma_t^j > 0$. The $n_t^{1,k}$ are parameters that define the population dynamics. We restrict attention to

$$n_{t+1}^{1,k} = (1 + \eta_t) n_t^{1,k}$$

with $\sum_k n_0^{1,k} = 1$, where η_t is the growth rate of households entering the workforce.

3.1 State Vector

To simplify notation, we use recursive competitive equilibrium language. Given that the economy is non-stationary, t is included as an element of the aggregate state vector. All stocks are beginning-of-period stocks. The variables that define the aggregate state vector s are as follows:

(i) $t = 0, 1, 2, \ldots,$ is the time period.

(ii) $\{a^{j,k}, n^{j,k}\}$ are the assets $a^{j,k}$ (net worth) of an age j, type k household, and $n^{j,k}$ is the measure of these households.

(iii) B is government debt.

(iv) K_{T1} and K_{T2} are aggregate tangible capital stocks for two business sectors (described below).

(v) K_{I1} and K_{I2} are aggregate intangible capital stocks for two business sectors.

Two business sectors are needed because different legal categories of businesses are subject to very different tax systems and, as a consequence, the market values of their equity and debt relative to their capital stock are different. The empirical counterpart of sector 1 includes businesses that are subject to the corporate income tax. Unincorporated household businesses are categorized in sector 2, which distributes all profits to owners.

3.2 Portfolios and the return of assets

To match the Japanese data, it is important that the model can accommodate a large amount of debt held by the public, which pays a relatively low interest rate, and thus imposes a relatively small burden on the government budget, as in the actual Japanese data. To achieve this aim, we modify our model relative to that of McGrattan and Prescott (2017) by following Braun and Joines (2015) and Kitao (2015), whereby individuals are assumed to save in shares of ownership of an asset constituted by a fraction ϕ_t of government debt and a fraction $1 - \phi_t$ of claims to the flows from private firms' capital. Hence, the rate of return of the only financial asset available is a weighted average of the returns of government debt and private capital. The interest rate on government bonds is exogenously determined and given by sequence $\{i_t^d\}$. As the capital account is assumed to be closed, total asset holdings in this composite financial asset must equal government debt and private capital for equilibrium in financial markets to hold. Hence, given the exogenous stock of government debt and its interest rate, fraction ϕ_t will be computed as part of equilibrium so as to guarantee the assumed fractions of assets in the portfolio.

3.3 Prices and Policy

The relevant equilibrium *price* sequences for the households are government debt and private capital interest rates $\{i_t^d, i_t^k\}$ and wage rates $\{w_t\}$.

Policy specifies the following sequences:

(i) Tax rates $\tau = \{\tau_t^c, \tau_{1t}^d, \tau_{2t}^d, \tau_{1t}^\pi\}$, where c denotes consumption, d distributions from businesses to their owners, and π profits. Note that sector 2 businesses are not subject to the corporate profit tax and must distribute all their profits to their owners.

(ii) Effective tax schedules on labor income $\{T_t^w(\cdot)\}$.

(iii) Exogenously given transfers (constituted by pension transfers and also by health care (plus long-term care) transfers $\{T_t^{j,k,p}, T_t^{j,k,h}\}$) that are dependent on time, age, and productivity type).

(iv) Government debt $\{B_t\}$.

(v) Pure public good consumption $\{G_t\}$, defined as a fraction of GDP: $G_t = \phi_{Gt} GDP_t$.

3.4 The Household's Problem

The value function of a household of age $j \in \{1, 2, \ldots, J\}$ with productivity level $k \in \{1, 2, \ldots, K\}$ satisfies

$$v_j(a, s, k) = \max_{a', c, \ell \geq 0} \{u(c, \ell) + \beta \sigma_t^j v_{j+1}(a', s', k)\}$$

subject to

$$c + \tau_{c_t}(c - T_t^{j,k,h} - \chi_t^{j,k,h}) + a' \sigma_t^j$$

$$= \left\{\phi_t(1 + i^d) + (1 - \phi_t)(1 + i^k)\right\} a + y_t - T_t^w(y_t) + T_t^{j,k,p} + T^{j,k,h}$$

$$y_t = w_t \ell \epsilon^{j,k}$$

$$c \geq T_t^{j,k,h} + \chi_t^{j,k,h}$$

$$s' = F(s)$$

The variable ℓ denotes the labor services of a household. A household with productivity k knows with certainty its type- and age-dependent productivity profile $\epsilon^{j,k}$. The prime denotes the next-period value of a variable and $v_{J+1} = 0$. As discussed earlier, savings are in shares of ownership of an asset that makes payments to members of a cohort in their retirement years conditional on them being alive. Effectively, the return on savings depends not only on the return of the asset but also on the survival probability. As described on the right hand side of the household's budget constraint, each household is subject to labor income tax $T_t^w(\cdot)$ while receiving pension and health care transfers $(T_t^{j,k,p}, T_t^{j,k,h})$. We count corresponding health care spending as part of consumption, c, for welfare calculations. But in Japan, health care expenditures are not subject to consumption taxes, which are described as $\tau_{c_t}(c - T_t^{j,k,h} - \chi_t^{j,k,h})$ on the left-hand side of the household's budget constraint. We impose the condition that consumption must be at least equal to health care and

long term care transfers, including individual health copayments $\chi_t^{j,k,h}$.

We make the simplifying assumption that pension, health care, and long-term care are lump-sum transfers (dependent only on time, household type, and age) from the government. As we document later on, this assumption is roughly consistent with the data.

Aggregate labor supply L is

$$L = \sum_{j,k} n^{j,k} \ell^{j,k} \epsilon^{j,k}.$$

The equilibrium law of motion of the aggregate state variable, F, is taken as given by the private agents.

3.5   Technology

One sector is subject to the corporate income tax and produces intermediate good Y_{1t}, and one sector produces intermediate good Y_{2t}. The aggregate production function of the composite final good is

$$Y_t = Y_{1t}^{\theta_1} Y_{2t}^{\theta_2},$$

where the exponents are positive and sum to 1.

The aggregate sectoral production function is Cobb-Douglas with inputs of tangible capital K_{iTt}, intangible capital K_{iIt}, and labor L_{it}:

$$Y_{it} = K_{iTt}^{\theta_{iT}} K_{iIt}^{\theta_{iI}} (\Omega_t L_{it})^{1-\theta_{iT}-\theta_{iI}}$$

for $i = 1, 2$. The labor-augmenting technical level at date t in both sectors is Ω_t, which grows at rate γ, so

$$\Omega_{t+1} = (1+\gamma)\Omega_t.$$

Capital stocks depreciate at a constant rate, so

$$K_{iT,t+1} = (1 - \delta_{iT})K_{iT,t} + X_{iTt}$$

$$K_{iI,t+1} = (1 - \delta_{iI})K_{iIt} + X_{iIt}$$

for $i = 1, 2$, where T and I denote tangible and intangible capital, respectively, and X is investment.

Depreciation rates are denoted as δ and are indexed by sector and capital type. The resource balance constraint is

$$Y_t = C_t + X_{Tt} + X_{It} + G_t,$$

where $X_{Tt} = \sum_i X_{iTt}$ and $X_{It} = \sum_i X_{iIt}$.

3.6 Government Budget Constraints

Some notation must be set up before the law of motion for government debt can be specified. The prices of the intermediate good relative to the final good are p_{1t} and p_{2t}. The accounting profits of corporations are given by

$$\Pi_{1t} = p_{1t} Y_{1t} - w_t L_{1t} - X_{1It} - \delta_{1T} K_{1Tt},$$

and distributions to the corporations' owners are

$$D_{1t} = (1 - \tau_{1t}^\pi) \Pi_{1t} - K_{1T,t+1} + K_{1Tt}.$$

Other business distributions to their owners are

$$D_{2t} = \Pi_{2t} = p_{2t} Y_{2t} - w_t L_{2t} - X_{2It} - \delta_{2T} K_{2Tt}.$$

We can now specify the law of motion of government debt:

$$B_{t+1} = B_t + i_t B_t + G_t - \sum_{j,k} n_t^{j,k} (T_t^j (w_t \ell_t^{j,k} \epsilon^k) - (T_t^{j,k,p} + T_t^{j,k,h}))$$
$$- \tau_t^c (C_t - T_t^h - \chi_t^h) - \tau_{1t}^\pi \Pi_{1t} - \tau_{1t}^d D_{1t} - \tau_{2t}^d D_{2t}.$$

Thus, next period's debt is this period's debt plus interest on this period's debt, plus public consumption, minus tax revenues (net of transfers). Taxes are levied on labor income and consumption (excluding health care transfers and copayments), on profits of corporations, on corporate distributions to their owners, and on distributions of other business firms to their owners.

3.7 Equilibrium Conditions

The equilibrium conditions are as follows:

(i) Labor, capital, and goods markets clear at each point in time.

(ii) The household policy functions $\{a' = f_j(s,k)\}_j$ imply the aggregate law of motion $s' = F(s)$.

4 Model Parameters

We choose parameters of the model so that key features of equilibrium time series from our base-line model are consistent with the National Accounts of Japan (published by the Cabinet Office, henceforth referred to as the "JSNA") *and* with the distribution of individual incomes reported in the Statistical Survey of Actual Status for Salary in the Private Sector and the Sample Survey for Self-Assessment Income Tax (both published by the National Tax Agency, henceforth referred to as the "Tax Surveys"). This is done in two steps. First, we set parameters governing demographics, household preferences, firm technologies, government spending and debt shares, and capital income tax rates so that the national accounts and fixed asset tables implied by the model are consistent with aggregate data. Second, we set population weights, productivity levels, transfers, and taxes on labor income to match micro data on population shares, labor income, transfer income, and tax rates.

4.1 Macro Data

We first describe the data for national income and product accounts, and fixed assets from the JSNA, as well as adjustments to make the accounts consistent with the model economy. Then, we discuss the parameters that are consistent with these data for 2015.

4.1.1 National Account and Fixed Asset Tables

Table 1 displays the Japanese national income and product accounts, after some of the standard adjustments that make model measurements and concepts consistent with the JSNA. Adjusted GDP is equal to JSNA GDP after subtracting consumption tax as it is assumed to be levied on private consumption.

We categorize income as "labor" or "capital." *Labor income* comprises 53 percent of total adjusted income and mainly consists of compensation of employees. Seventy percent of households' mixed income (including private unincorporated enterprises) is also classified as labor income. *Capital income* includes all other categories of income, including the remaining 30 percent of households' mixed income as well as households' net operating surplus (imputed service of owner-occupied dwellings).

The product side is divided into two categories: consumption and investment. *Consumption* comprises 75 percent of total adjusted product—private consumption of 63 percent and public consumption of 12 percent. Private consumption includes health care and long-term care spending financed by the government, to be consistent with the model specification. This treatment enables us to compute household welfare in a comprehensive manner including health care and long-term care. Spending on health care and long-term care is not subject to consumption taxes, and this is taken into account by our model specification detailed above. *Investment* includes gross private domestic investment, gross government investment, changes in inventories, and net exports, with an adjustment made for the consumption tax on gross capital formation. This category is 25 percent of adjusted total product.

Capital stocks are reported in Table 2. In line with the revision of JSNA in 2016 by adopting the 2008 SNA, capital stocks include both tangible and intangible capital. Private capital amount to 229 percent of adjusted GDP, of which private corporations account for 68 percent and households and NPOs account for the remaining 32 percent. Capital stocks owned by the government amount to 112 percent of adjusted GDP. Together, private and public capital are equal to 340 percent of adjusted GDP. Our estimate for the total capital stock is about 4 times GDP.[3]

Table 3 reports the parameters used in the baseline economy—the economy with current Japanese demographics and policies. The first set of parameters governs demographics. For the baseline economy, we set the long-term growth rate of the population equal to -1 percent and the survival probabilities to match the demographic transition with population projection for Japan under the medium fertility rate (stable at around 1.4) and the medium mortality rate assumption reported by the IPSS. Preference parameters are chosen so that the model's labor input and la-

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[3]Following McGrattan and Prescott (2017), we do not include human capital owned by individuals in our measure of the capital stock because retired people do not rent their human capital to the business sector and cannot sell it to finance retirement consumption.

bor share are consistent with that of Japan. The JSNA reported that average hours worked per employee are 1,751 hours per year in 2015. If discretionary time per week is 100 hours, then the fraction of time at work is 33.7 percent. Assuming logarithmic preferences, namely,

$$u(c, \ell) = \log c + \alpha \log(1 - \ell),$$

we set α equal to 2.2 to get the same predicted hours of work for the model. In addition, we set $\beta = 0.983$, so that the model's predicted division of income into labor and capital matches that of Japan shown in Table 1.

The technology parameters in Table 3 govern technological growth, investment rates, and capital income shares across business sectors. The long-run growth rate of labor-augmenting technology is set equal to 1 percent. Together with the long-term population growth rate of -1 percent—as implied by the demographic parameters described above—this results in a long-run GDP growth rate of 0 percent. The share parameter in the aggregate production function θ_1—which determines the relative share of income to private corporations—is set equal to 64 percent. This parameter is based on the private corporations' proportion of operating surplus and mixed income.

As we noted earlier, we use data from the JSNA to determine the relative quantities of investments and fixed assets for the model's two sectors. Accordingly, the choice of tangible capital shares (θ_{1T}, θ_{2T}) and tangible depreciation rates (δ_{1T}, δ_{2T}) ensures that the model's investments and fixed assets line up with tangible investments and stocks reported by the JSNA. In doing so, we estimate tangible capital shares of $\theta_{1T} = 0.45$ and $\theta_{2T} = 0.35$ in the two sectors. The annual depreciation rates that generate investment rates consistent with Japan's data are $\delta_{1T} = 0.06$ and $\delta_{2T} = 0.05$. The high capital share and low depreciation in sector 2 follow from the fact that we have included housing.

The intangible capital shares and depreciation rates, θ_{1I}, θ_{2I}, δ_{1I}, δ_{2I}, are not uniquely identifiable with the data we have. For the baseline model, we calibrate these parameters following Arato and Yamada (2012), who derive estimates of tangible and intangible assets for the corporate sector. We assume the same ratio for the intangibles to non-land fixed assets of the non-corporate sector to obtain an intangible assets estimate for this sector.

The last set of parameters in Table 3 includes fiscal policy parameters. The term ϕ_B is defined as

gross general government debt subtracting financial assets held by public pension funds. Financial assets held by public pension funds are accumulated for future pension liabilities. However, in this model, future pension liabilities are also incorporated. We set the level of government consumption ϕ_G as a constant percentage of adjusted GDP for all periods.[4]

Capital tax rates are listed next in Table 3. The effective corporate income tax rate τ_1^π is set to 25 percent to match the model-implied corporate income tax with taxes on corporate income and other current taxes paid by corporations in the JSNA. An additional tax on distributions τ_1^d is paid by investors in these corporations, where distributions are in the form of dividends and share buybacks. This tax is set to 25 percent to adequately match capital income and the size of the corporate sector. The accounting earnings of household businesses, our second business category, are assumed to be distributed to the business owners, and these earnings are subject to ordinary labor income tax. For the tax rates on these household business distributions (τ_2^d), we use an estimate of 29 percent for the average tax rate on labor income (see below for details on labor income tax).

When we simulate the model using the parameters in Table 3, the model's national account and fixed asset statistics in 2015 are very close to those shown in Tables 1 and 2 for Japan.

4.2 Micro Data

In this section, we disaggregate labor income (captured as employee compensation in the JSNA) and estimate effective tax rates on labor income across income cohorts using the Tax Surveys published by the National Tax Agency (NTA). In addition, per capita pension and health care transfers are calibrated to match the aggregate fiscal data.

Individuals are assigned to different income brackets, and for each brackets, we construct population shares, income shares, and marginal and average tax rates. We then use estimates for these variables to set population weights, productivity levels, and the net tax schedules for workers and retirees.

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[4]In order to focus on Japan's aging costs, ϕ_G is set to stabilize the debt-to-GDP ratio at an initial period based on other parameters, rather than using the actual data. This implies that the initial primary deficit has not been incorporated in the calibration. Fiscal adjustment needs would be even larger if the initial imbalance were included.

4.2.1 Income Distribution and Tax Rates

In constructing the distribution of labor incomes and labor income tax rates, we use the Tax Surveys published by the NTA. Income distributions have some data sources, such as the National Survey of Family Income and Expenditure (hereinafter referred to as the "NSFIE"). However, the Tax Surveys have several important advantages in calibrating the model economy. First, aggregate labor income in the Tax Surveys is very close to the JSNA because of its wide coverage.[5] Second, estimating labor income tax rates corresponding to income cohorts is relatively straightforward. Although the NSFIE has merit in capturing household-based income, taxes, and government transfers collectively, it only captures monthly revenue and expenditure, making it difficult to match with aggregate annual data. In particular, given that the monthly data do not capture bonuses, which is an important factor especially in the context of Japan, estimating income distributions and corresponding tax rates using these data would require substantial adjustments. Instead, we rely on the Tax Surveys for income distributions and tax rates while using micro data for pension and health care transfers across ages.

In Table 4, we report the distribution of labor income grouped into 14 income brackets. Labor income taxes (including social security contributions) in each bracket are estimated with the following steps:

(i) The national personal income tax can be obtained directly from the Tax Surveys.

(ii) Data on local income taxes are not directly available from the Tax Surveys. Instead, taxable income is estimated from aggregate income in each income cohort, the number of workers who benefit from various income deductions (proxies for which can be obtained from national tax data), and the maximum amount of income deduction for local taxes. Then, local income taxes are estimated by multiplying the taxable income for each income by the statutory tax rate.

(iii) Social security contributions are also estimated from the Tax Surveys since they record the amount of social security contributions in each income bracket for calculating income deductions.[6]

The last column of Table 4 provides the estimates of effective income tax rates across income

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[5]The Tax Surveys and the JSNA have some differences in coverage. For example, the Tax Surveys do not cover employee compensation for public officials.

[6]Our estimates of adjusted earnings and social security contributions include corporations' contributions in line with the definition of employee compensation in the JSNA.

brackets. In spite of the progressivity of the tax structure, social security contributions are regressive, with flat rates for middle incomes. The latter highlights the importance of capturing social security contributions in addition to national and local income taxes.

4.2.2 Parameters Based on Income Distribution and Tax Data

The next step is to set the parameters relevant for the model's predicted distributions of income and taxes. Specifically, we show how we use the data from Table 4 to estimate the productivity levels, ϵ^k, and the initial tax schedules $T_0^j(\cdot)$.

For our baseline parameterization, we assume that there are four types of labor that differ in terms of their productivity levels; we refer to the types as *low, medium, high,* and *top 1 percent.* The value of ϵ^k for the low types is chosen so that the share of their lifetime labor income (average over ages 18 to 65) in the model matches the share of labor income in brackets covering under ¥2 million. This type comprises 32 percent of the population over 18 years old. Similarly, the values of ϵ^k for the medium, high, and top 1 percent types are chosen so that there is a match between the group's lifetime labor income share in the model and that of ¥2 million to ¥4 million, ¥4 million to ¥15 million, and over ¥15 million, respectively. The population shares for the medium and high types are 31 and 36 percent, respectively. Per capita earnings in each productivity type are normalized relative to the average earnings. This gives us shares in total labor income from the lowest to highest types equal to 8, 25, 61, and 6 percent, respectively.

It is also important to note that labor income typically increases up to 50 years old, then decreases until retirement, as illustrated in the Basic Survey on Wage Structure published by the Ministry of Health, Labor, and Welfare (MHLW). In the data, non-regular workers' earnings paths do not grow much with age (which some attribute to the lack of incentives for firms to provide training to workers), and we assume flat profiles. For regular workers, productivity paths fed into the model correspond to quadratic interpolations of the data from the Basic Survey on Wage Structure (see Figure 5).

To parameterize the initial tax schedule, $T_0^j(\cdot)$, we use data shown in the last column of Table 4. We assume that the tax schedule only depends on labor income, $T_0^j(y) = T^w(y)$, where $T^w(y) = \beta_i y$ on each income interval $[\underline{y}_i, \bar{y}_i]$, $i = 1, \ldots, 14$. As noted earlier, we assume uniform tax rates on distributions from corporations and household business.

4.2.3 Pension Benefits, Health Care, and Long-Term Care

The final step is the estimation of pension and health care transfers, T^p and T^h. In the transition period of 20 years up to 2038, we treat these age-related transfers separately since they have different dynamics: pension transfers are expected to be controlled by the government's macro indexing, whereas health care transfers are projected to evolve along with aging. After the transition period, per capita pension and health care transfers are assumed to grow at the rate of 1 percent, in line with per capita GDP growth.

In the model economy, pension transfers are categorized into two types: basic pension and employee pension. Per capita basic pension at the initial period is assumed to be the same amount for all retirees over age 65, regardless of their productivity. Per capita employee pension, however, is linked with lifetime labor income described above. At the initial period, per capita transfers are calibrated to match the aggregate benefit in 2015. Under the current Japanese pension system, in principle, both basic and employee pension transfers for those aged 65-67 are set to increase along with real wage growth. At the same time, transfers are also adjusted following the macro-indexing mechanism with the aim of containing the growth of aggregate pension transfers in percentage of GDP. In the model, real wage growth can be proxied by labor-augmenting technology growth of 1 percent. Hence, in terms of the size of the macro-indexing adjustment and adjustment period, we follow one of the official scenarios in the 2014 Actuarial Valuation (published by the Ministry of Health, Labor, and Welfare) with real wage growth of 1 percent ("Scenario G").[7] Henceforth, we will refer to the above adjustments to pension payments simply as the "macroeconomic slide" in model simulations.

The trajectory of per capita pension transfers can then be described as

$$T_{t+1}^{j,k,p} = T_t^{j-1,b}(1+\gamma)M_t^b + T_t^{j-1,k,e}(1+\gamma)M_t^e$$

for $j = 65, \ldots, 67$, where $T_t^{j,b}$ and $T_t^{j,e}$ are basic and employee pension benefits, respectively,

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[7]See the appendix for details.

and M_t is the macro-indexing adjustment factor. On the other hand, for $j = 68, \ldots,$

$$T_{t+1}^{j,k,p} = max(T_t^{j-1,b} M_t^b, 0.8 T_{t+1}^{65,b}) + max(T_t^{j-1,k,e} M_t^e, 0.8 T_{t+1}^{65,k,e}).$$

Pension benefits for those aged 68 or above are no longer adjusted along with real wage growth. But, with the aim of preserving equity among retirees, the lower bound for benefits is set to 80 percent of the benefits for those aged 65.

Figure 6 shows age-specific per capita health care transfers and effective copayment rates in real terms at the initial period. These rates are estimated based on per capita spending for health and long-term care and effective copayment rates in FY2015 published by the MHLW. Health care transfers for those aged 65 or above are about 6.8 times higher than for those aged 18-64. Moreover, transfers for those aged 85 or above are 4.4 times higher relative to those aged 65-69. The elderly also benefit from low copayment rates. Per capita health care transfers are assumed to evolve at the rate of long-run per capita GDP growth (1 percent) plus the excess cost growth of 0.7 percent over 20 years.[8]

5 Evaluation of Alternative Financing Options

Next, we turn to our policy experiments.[9] Our baseline will be the case in which the debt-to-GDP ratio is stabilized at its current level of two times GDP, and consumption taxes (labeled as "VAT" in the figures) adjust to satisfy the government constraint. Because the number of workers per retiree is falling, and because spending per capita increases exponentially with age, the resulting sequence of consumption tax increases over time. We then consider other policy packages that finance the costs of aging (at least partly) in different ways. In all cases, consumption taxes will adjust period by period to guarantee that the government budget constraint is satisfied.

To compute the transition paths and welfare consequences for alternative policy reforms, we hold fixed over time the ratios of government consumption (excluding aging costs) to GDP and the

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[8] The excess cost growth rate of 0.7 percent is in line with the ex post excess cost growth over the past five years. This assumption could overestimate the excess cost growth in the model, as ex post excess cost growth could turn out to be higher than 0.7 percent because of the negative impact of fiscal adjustments on the economy.

[9] McGrattan and Prescott (2016) provide details of the algorithm used to compute equilibria. The only modification required for our version of the model is an external loop that computes the equilibrium portfolio composition of the economy, given a debt-to-GDP target.

fraction of the population with a particular productivity type. The initial state is summarized by the level of government debt and the distribution of household asset holdings. The initial distribution of ages is determined so that the model matches Japan in 2015. We then use Japan's demographic projections and feed into the model the forecast growth rate of the 18-year-old population over time, as well as forecast values for age-specific survival probabilities. At time $t = 0$, households learn about the policy packages that will be used to finance the transition, and we determine the welfare consequences for people of all ages and productivity levels that are alive, and for all new cohorts entering the workforce in future years.

5.1 Baseline: Financing the Costs of Aging through Consumption Taxes

The first transition path that we compute as our baseline assumes that the debt-to-GDP ratio is stabilized at its current level and adjusts consumption taxes, and only consumption taxes, to finance the changing costs of retirement, long-term care and health care (what we call the costs of aging) as the population ages. The consumption tax rate required to finance the costs of aging rises from a baseline rate of 8 percent to about 20 percent. The net tax schedules for workers and retirees do not change, but revenues and transfers change in response to the demographic transition.

Figures 6-9 summarize the key trends that emerge in this economy. Aging costs are the sum of pension transfers, plus health care and long-term care costs. Total aging costs (Figure 6) go up slowly from 18 percent of GDP and peak at about 24 percent of GDP by 2057. The impact of the macroeconomic slide resulting from the recent pension reform in Japan (embedded in our calculations) is reflected in the fact that most of the increase in aging costs is driven by increases in health care spending, up to 2030. Demographic changes eventually dominate, and by 2057 pensions and health contribute about equally to expected government outlays on aging costs (the latter is consistent with Imrohoroglu et al. (2016)).

Financing the costs of aging exclusively through consumption taxes requires continuous, but very gradual, increases in the consumption tax rate (see Figure 7 for VAT (baseline)). Half of the required adjustment (the consumption tax rate reaching 14 percent) occurs by 2030.

Demographics and the needed fiscal adjustment exert an important influence on GDP (Figure 8) and other key macroeconomic variables. Because of the shrinking population and the continuous increases in the dependency ratio, GDP is only 5 percent higher in 2040 than it is today (see Figure

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8 for GDP (baseline)). If the labor force remained constant, given the underlying 1 percent growth in total factor productivity, GDP would be 30 percent higher by 2040. Instead, hours worked per person go down, which reduces the marginal product of capital. Because this is a closed economy, this translates into lower interest rates and a lower investment-to-GDP ratio. The ratio of private consumption to GDP goes up (even excluding health care and long-term care consumption).

Labor income tax and business tax revenues (as shares of GDP) are essentially unchanged with the demographic transition (Figure 9). Current workers know that taxes will increase and incomes will decrease and respond by increasing their labor supply, preventing labor income taxes from falling faster than GDP.

The peak rate of consumption taxes needed to finance the costs of aging found here is smaller than those in Kitao (2015), Braun and Joines (2015), and Imrohoroglu and Sudo (2011). All these analyses abstract from the role of intangible investment. McGrattan and Prescott (2017) also find that including intangibles when studying the costs of aging in the United States yields results that are substantially different from analyses that abstract from intangibles. To consider this issue, we rerun the baseline and the present experiment, changing only the share of intangible investment to a very low number (less than 1 percent). In this case, the peak rate of consumption taxes needed to finance the costs of aging is much higher at 32 percent. This can be explained by the fact that the total amount of capital available is lower in this economy in which intangibles are shutdown, and this provides lower sources of tax revenues, results in a larger negative impact on GDP, and thus requires larger increases in consumption tax rates to finance comparable spending amounts.

5.2   Increasing Social Security Contributions

Under the current health care and long-term care system, about half of total spending is financed through social security contributions, which will be adjusted across all income brackets. To analyze the implications of increases in personal contributions, we assume that the labor income tax rate is gradually increased by 8 percentage points over 20 years (Figure 10). This scenario is labeled "SSC" in the figures. This increase is what is required to finance expected increases in the cost of aging that are from health care spending. The first important result is that consumption taxes still need to increase gradually but continuously, by up to 8 percentage points if the ratio of debt to GDP is going to remain stable (see Figure 8 for GDP (SSC)). This is roughly half of the increase

necessary under the preferred policy scenario. Second, increasing social security contributions raises the effective labor income tax rate. Progressive labor income tax rates are well known to have more of a distortive effect than consumption taxes on the macroeconomy.[10] After 25 years, GDP is about 4 percent lower than under the preferred policy, and the difference becomes as large as 7 percent in a longer horizon (see Figure 8 for GDP(SSC)). Interestingly, in the short run, GDP differences are barely noticeable. This happens because young workers know they will face higher future income taxes, and they respond by increasing their labor supply in the short run and by saving more.

In terms of welfare (Figure 11), retirees and older workers gain since they care mostly about consumption, and this policy scenario allows consumption taxes to remain lower than in the preferred policy case. Young workers and all generations thereafter suffer very large losses, however, averaging about 5 percent of lifetime welfare. Labor income taxes are progressive, and thus higher personal contributions have a more negative effect on higher-income individuals. The top 1 percent of earners on average lose about 8 percent of lifetime welfare, whereas the bottom 30 percent loses close to 4 percent.

5.3   Debt Financing

To analyze the costs of delaying adjustment, we assume continuous deficit financing (and debt accumulation), and debt is stabilized after 2040 (the resulting debt-to-GDP ratio is 3; see Figure 12). This scenario is labeled "debt" in the figures. We assume that the interest rate on government debt remains unchanged at 1 percent in real terms. Stabilizing debt under this scenario requires even higher future consumption tax rates to finance the government budget, peaking at about 29 percent (see Figure 7 for VAT (debt)).

In equilibrium, this policy causes a large crowding out of private sector investment (Figure 14) because households must be compelled to save enough to hold a much larger stock of government debt, and this can happen only by increasing the cost of capital for the private sector (Figure 13). The macroeconomic cost of delaying adjustment, arising from the crowding-out effects, are large and quickly set in. Indeed, after 10 years, GDP is 4 percent lower than in the preferred policy scenario but more than 15 percent lower after 20 years (see Figure 8 for GDP (debt)).

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[10]Both the consumption tax and the labor income tax incentivize workers to reduce hours worked and increase hours for leisure. Consumption taxes, however, have a flat rate and are imposed on a broader base including retirees.

In terms of welfare (Figure 15), delaying adjustment is very costly. Most individuals lose from this strategy. Older individuals could benefit from lower consumption taxes. However, lower aggregate growth arising from the crowding-out effect outweighs the potential benefits for the most elderly. Losses are in excess of 16 percent of lifetime welfare on average.

5.4 Increasing Health Care Copayment Rates

Under the current system, adults between 20 and 64 years old pay on average an effective copayment rate on health care expenditures of 17.3 percent, and adults aged 65 and older pay an average effective copayment rate of 9.5 percent (the rate is 15.3 percent for those between 65 and 69, 9.3 percent for those between 70 and 74, and about 8.5 percent for older individuals). Here, we consider a scenario in which health care copayments for those aged 65 and older are increased to the average level paid by those between 20 and 64 years of age. We do this gradually (at a constant rate of increase) over a 20-year period. The effects of this change result in a permanent reduction in net health care and long-term care transfers of about 8 percentage points for those in the relevant groups. As in the baseline, we assume that the debt-to-GDP ratio remains constant, and we adjust only consumption taxes to guarantee that the government budget constraint is satisfied every period.

This option could help to mitigate tax increases for future generations who are expected to be most affected by the effects of demographic transition. On the other hand, net health transfers do not vary much (conditional on age) by income levels. Hence, an increase in copayment rates of equal magnitude across the income spectrum should be regressive. Indeed, we find that the bottom third of the population would experience large welfare losses under this policy, as large as 6 percent of lifetime utility. Most of the population (the bottom 99 percent in terms of income) currently between 18 and 90 years old would experience welfare losses (Figure 16), with disproportionately negative effects on young and lower-income workers.

The relatively large welfare losses for the bottom third of the income distribution highlight the importance of due consideration of safeguards for low-income households in this kind of reform. Moreover, this policy alone yields only modest gains in terms of the needed fiscal adjustment. Consumption taxes still increase gradually but substantially, peaking at a rate of about 17 percent.

6 Evaluation of Other Reform Options

This section considers the sensitivity of the model, and of our estimates of government financing needs, to more favorable assumptions on demographic trends, improvements in the efficiency of the health sector, and improvements in economy-wide productivity. While our findings suggest none of these options alone can fully address Japan's aging costs, they can be useful complements to the preferred policy option of gradually increasing consumption taxes. Our results highlight the importance of a policy package that includes a government financing plan that minimizes distortions on the economy, as well as broader reforms.

6.1 Alternative Demographic Pattern with Higher Fertility Rate

The IPSS presents a range of possible scenarios for long-run trends in fertility and mortality. As described in Section 4, the above experiments are based on the IPSS's medium fertility rate and medium mortality rate scenario. Here, we study the sensitivity of our results to alternatives. For this, we employ what the IPSS considers a favorable demographic scenario of a high fertility rate (involving a gradual improvement by the mid-2020s to the range of 1.6-1.7 live births per woman in her lifetime) and medium mortality. This scenario is labeled "demographics" in the figures. Baseline and favorable scenarios imply very similar patterns for population dynamics in the medium term (up to 2030). The favorable scenario embeds an important recovery of the growth rate of the population entering the workforce in the mid-2030s and implies a long-run growth rate for the population of -0.85 percent (instead of -1 percent in the baseline). Because of the macro-indexing mechanism in Japan's pension system, different demographics also imply different future flows of pension transfers. The 2014 Actuarial Valuation provides estimates for the implied changes, which we introduce in our simulations.

Figures 17 and 18 summarize the results. Since demographic trends are essentially the same until 2030 under the two scenarios, and since the impact of population changes permeates slowly through the economic system, the differences in the VAT rates required under this alternative demographic scenario are not very noticeable before 2040. By 2065 the difference becomes more material as the required consumption tax to keep the debt-to-GDP ratio constant is about 3 percentage points lower than in the baseline. A more noticeable impact occurs in GDP, which by 2065 is 8 percent

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higher under the favorable demographic scenario than in the baseline. This difference is mostly attributable to the fact that in the long run, the growth rate of TFP under the two scenarios is assumed to be the same, but the population shrinks at a slower pace in the new scenario. Since GDP growth in the long run is the product of the change of TFP growth and population growth, larger GDP naturally takes place.

6.2 Improving Efficiency of Health Care Services

Miake et al. (2018) evaluate options for health care system reform. Their findings suggest that improvements in the efficiency of the health care system could potentially yield a reduction in total health care spending by up to 10 percent (reductions that materialize gradually but remain into the future). Because the savings are derived through improvements in efficiency, the expected impact on the quality of services is assumed to be negligible. We thus allow for the costs of savings to decline continuously over a 12-year period but assume that the real consumption of health care services is unchanged. This scenario is labeled "health care efficiency" in the figures. Under these assumptions and under the baseline demographic projections, the required increases in consumption taxes are smaller than in the baseline (Figure 17). Quantitatively, the impact is noticeable, reaching a maximum and essentially permanent reduction of more than 2 percentage points in the consumption taxes required to stabilize the debt. The effects on GDP are positive but moderate (Figure 18).

6.3 Improving Economy-Wide Productivity

We conclude this section by considering the implications of faster productivity growth. In principle, faster growth could provide an opportunity to contain government expenditures as a share of GDP. In the case of Japan, however, some expenditures are naturally linked to growth. Expenditure on the pension system, for example, is determined by a government formula linked directly to the growth rate of the economy (see appendix on pension transfers). Furthermore, the number of periods over which the macroeconomic slide operates (and thus pension payments grow at a rate lower than GDP) decreases as economic growth improves. Hence, faster growth does not necessarily reduce government pension outlays as a ratio to GDP.

As the effects of faster growth on overall financing needs are difficult to sort out, we consider

two alternative scenarios. Both scenarios assume a permanent acceleration of TFP growth from 1.0 percent (as assumed in the baseline) to 1.5 percent. This size of TFP improvement is within the range of effects that credible structural reforms (including labor market reforms, product market reforms, and reforms to open further to international trade) could bring to Japan, according to previous IMF work (see Colacelli and Fernandez-Corugedo, 2018). Both scenarios also assume that consumption taxes are the only tax that adjusts to ensure that the debt-to-GDP ratio remains constant, and assume that government outlays on pensions are dictated by the spending rules of the Japanese pension system.

In the first scenario, we assume government consumption (which excludes pensions, health care and long-term care) grows at par with GDP, while per-person government outlays on health care and long-term care grow at 1.7 percent per year for 20 years (as in the baseline case of earlier sections). This scenario is labeled "TFP" in the figures. The second scenario instead assumes that both government consumption spending and government outlays on health and long term care grow at 1 percent (the long-run growth rate of all scenarios prior to this section) for 20 years. This scenario is labeled "TFP, G, and health care grow at 1 pct" in Figures 19 and 20.

Figures 19 and 20 summarize the results. A key observation is that faster TFP growth has very positive implications for levels of GDP, as should be expected. Under both scenarios, the level of GDP increases by about 17 percent by 2047 and keeps rising to reach a level that is 23 percent larger than 2017 output by 2067 (Figure 19). In terms of the financing needs of the government, under the first scenario we find that the reduction in fiscal adjustment generated by faster productivity growth is very modest. It peaks at a temporary 2 percentage point reduction in the consumption tax rate by the mid-2030s and yields a less than 1 percentage point reduction in the rate in the long run. The reasoning is that the gains from faster growth in reducing the ratio of health care costs to GDP are compensated by the reduction in years of the macroeconomic slide. In sharp contrast, in the second scenario in which growth in government consumption and outlays on health care and long-term care are contained, substantial savings are realized. The reduced financing needs peak at about a 5 percentage point reduction in the consumption tax rate by the mid-2030s and stay at about that level in the long run. In this case, the consumption tax rate still needs to rise but peaks at a more modest 15 percent rate (Figure 20).

7   Conclusions

A challenging economic policy issue facing Japan and many other nations is the financing of retirement and other age-related government spending as the population ages and the number of workers per retiree declines. We find that the fall in the number of workers per retiree requires major fiscal adjustments, which can nevertheless be done at a gradual pace. Different ways of performing the fiscal adjustment have dramatically different effects on welfare. We find that among the policy options, a continuous and gradual adjustment of consumption taxes dominates all of the other policy options such as increasing social security contributions, delaying adjustment (with an implied prolonged period of debt financing), and increased health care copayment rates, by having a relatively smaller adverse effect on long-run GDP and welfare. Financing higher health care costs through increases in labor income tax rates is highly distortive and results in a 7 percent lower long-run GDP and significantly lower welfare for young workers and future generations. Postponing adjustment through debt financing results in a large crowding out of private sector investment—by up to 8 percent—with detrimental effects on long-run GDP and welfare. Finally, a uniform increase in health care copayment rates for the elderly implies shifting a part of aging costs to current generations, but with regressive consequences. More benign demographic patterns improve the long run outlook slightly, whereas expected efficiency gains in the health care sector reduce the required increase in consumption taxes by more than 2 percentage points. Comparable savings can be attained with reforms that improve overall productivity growth, but only when government outlays are also contained. These policies certainly exhibit intergenerational tensions, as increasing social security contributions or delaying adjustment benefits current retirees and old workers at the expense of all future generations.

Table 1. Adjusted national income and product accounts, 2015

Total adjusted income	1.000
Labor income	0.530
Compensation of employees	0.513
Wages and salaries	0.436
Employer social contributions	0.077
Household business (70 % labor income)	0.017
Capital income	0.470
Corporate profits	0.134
Household business (30 % labor income)	0.007
Household operating surplus	0.051
Taxes on production and imports	0.088
Less: consumption tax	0.042
Less: subsidies	0.006
Consumption of fixed capital	0.235
Statistical discrepancy	0.003
Total adjusted product	1.000
Consumption	0.754
Private consumption	0.675
Less: consumption tax	0.042
Government consumption	0.121
Investment	0.246
Gross private investment	0.209
of which corporations	0.172
of which households and NPOs	0.037
Gross government investment	0.039
Changes in inventories	0.002
Net exports	-0.004
Sources: Cabinet Office and IMF staff estimates.	

Table 2. End-of-period adjusted capital stocks, 2015

Tangible capital	3.13
Corporations	1.33
Households and NPOs	0.72
Government	1.08
Intangible capital	0.27
Corporations	0.23
Households and NPOs	0.01
Government	0.03
Total	3.40

Sources: Cabinet Office and IMF staff estimates.

Table 3. Parameters of the model economy calibrated to Japan's data

Demographics	
Population growth rate	-1
Maximum work life in years	63
Preferences	
Disutility of work (α)	2.2
Discount factor (β)	0.983
Government consumption	0.115 GDP
Technology	
Growth rate of TFP	1 %
Income share of corporates	0.5
Capital shares	
Tangible, corporate (θ_{1T})	0.45
Intangible, corporate (θ_{1I})	0.15
Tangible, household bus. (θ_{2T})	0.35
Intangible, household bus. (θ_{2I})	0.05
Fiscal	
Government debt	2.0
Corporate income tax	25 %
Tax on corporate distributions	25 %
Tax on household bus. distributions	29 %
Source: IMF staff estimates	

Table 4. Tax rates and incomes (in ¥ million for average earnings and ¥ trillion for aggregate earnings and tax revenues)

Labor earnings	# workers	Share (%)	Adjusted avg. earnings	Adjusted agg. earnings	Agg. nat. tax rev.	Agg. local tax rev.	Agg. soc. sec.	Tax rate
1. under 1	9.8	17.3	0.6	5.4	0.0	0.0	0.1	2.7
2. 1-2	8.5	15.0	1.6	13.4	0.1	0.4	2.0	19.1
3. 2-3	8.8	15.5	2.8	24.7	0.4	0.8	5.6	27.2
4. 3-4	8.7	15.4	3.9	34.5	0.6	1.2	8.0	28.5
5. 4-5	6.9	12.2	5.0	34.9	0.6	1.4	8.3	29.4
6. 5-6	4.7	8.3	6.2	29.1	0.6	1.2	6.9	30.2
7. 6-7	2.9	5.1	7.3	20.8	0.5	0.9	5.0	30.6
8. 7-8	2.0	3.5	8.4	16.5	0.6	0.7	3.9	31.5
9. 8-9	1.3	2.4	9.5	13.2	0.6	0.6	2.9	32.4
10. 9-10	0.9	1.5	10.6	12.7	0.5	0.5	2.0	32.8
11. 10-15	1.6	2.8	13.0	20.2	1.7	1.2	3.9	33.3
12. 15-20	0.3	0.6	18.5	6.3	0.9	0.4	0.9	35.8
13. 20-25	0.1	0.2	23.8	2.4	0.5	0.2	0.3	38.7
14. 25-over	0.1	0.2	42.6	5.0	1.5	0.5	0.3	44.7
Total	56.6	100.0	4.2	235.3	9.1	9.9	50.2	29.4

Sources: National Tax Agency and IMF staff estimates

Note: Adjusted earnings and social security contributions include corporations' contributions

Figure 1. Old-age Dependency Ratios, Japan and The Next 10 Highest OECD Countries
(In percent)
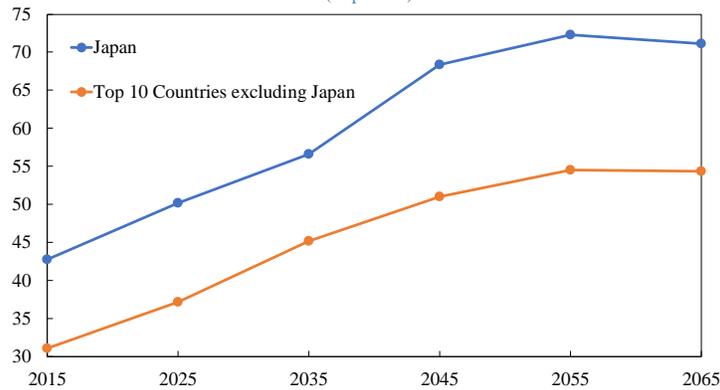
Source: United Nations, Department of Economic and Social Affairs, Population Division, *World Population Prospects: The 2017 Revision.*

Figure 2. Old-age-related Spending, Japan and OECD Countries
(In percent of GDP)
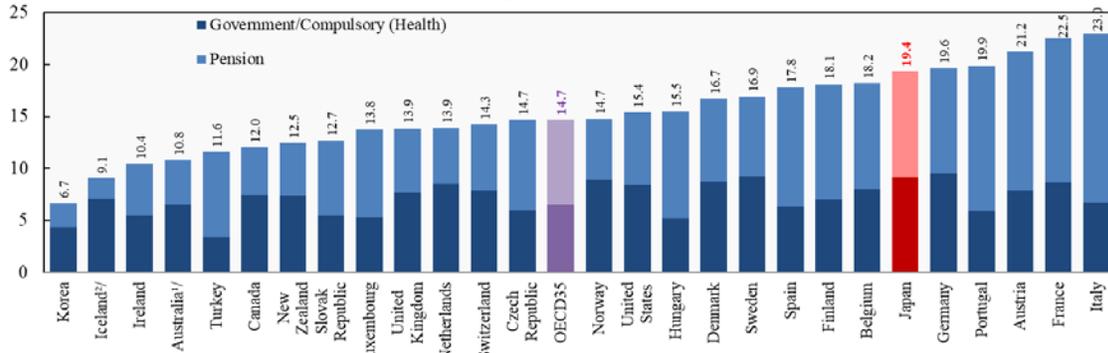
Source: OECD Health Statistics 2017, WHO Global Health Expenditure Database.
1/ Australian expenditure estimates exclude all expenditure for residential aged care facilities in welfare (social) services.
2/ Includes investments.

Figure 3. OECD Countries: Tax Revenues to GDP
(In percent of GDP, 2018)
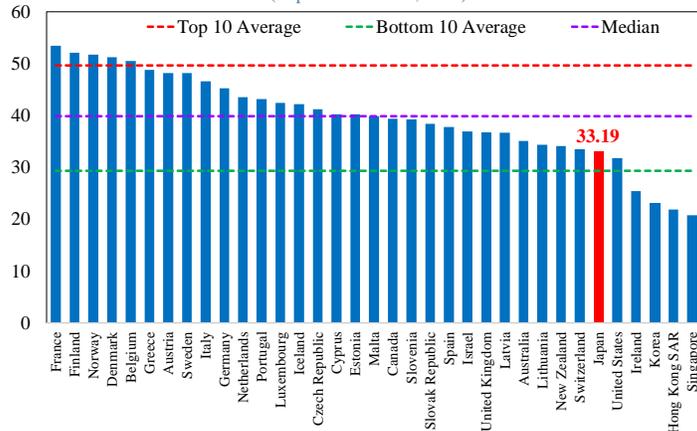
Source: OECD, Tax Statistics.

Figure 4. Health Care Transfers and Copayments by Age
(In constant ¥, thousand)
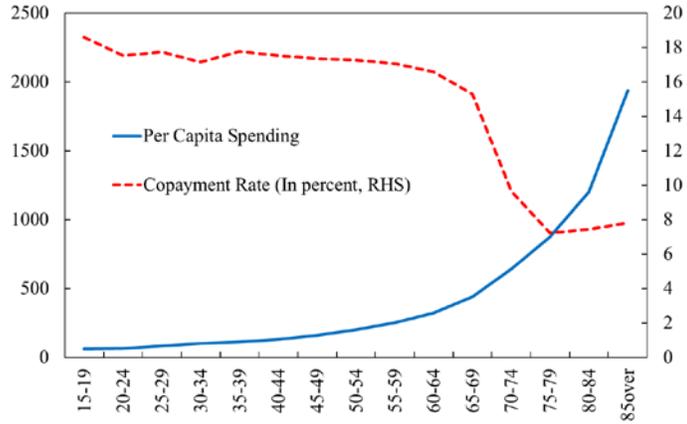
Source: Ministry of Health, Labor, and Welfare; IMF staff estimates.

Figure 5. Earnings Patterns by Productivity Type and Age
Labor Income Across Age (Normalized, Mean Income = 1)

$y = -0.0055x^2 + 0.5252x - 5.2982$

$y = -0.0016x^2 + 0.1522x - 1.5356$

$y = -0.0008x^2 + 0.0721x - 0.7274$
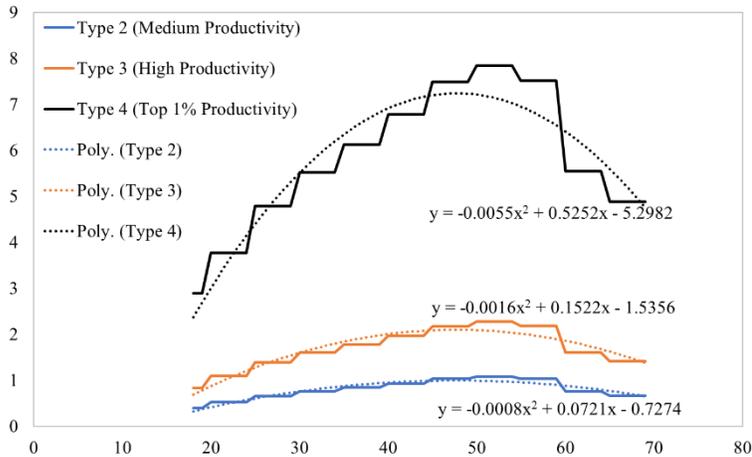
Sources: Basic Survey on Wage Structure; Ministry of Health, Labour and Welfare; IMF staff calculations.

Figure 6. Aging Costs: Total and Health Care plus Long-term Care
Total Transfers and Health Transfers - Baseline Scenario (In percent of GDP)
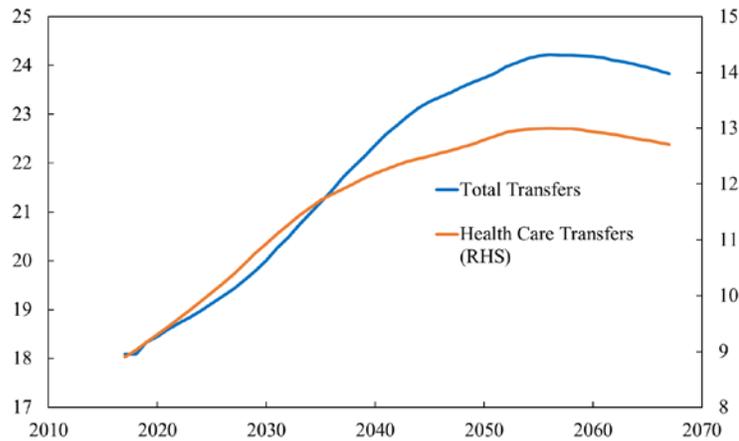
Source: IMF staff simulations.

Figure 7. Consumption Taxes Under Different Scenarios
(In percent)
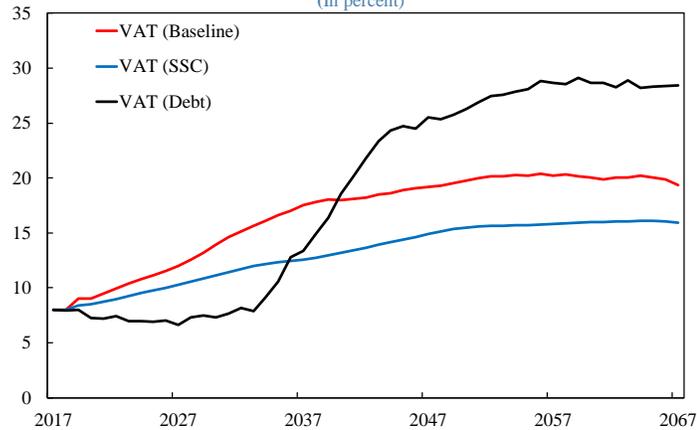
Source: IMF staff simulations.

Figure 8. GDP Under Different Scenarios
(Index, 2018=100)
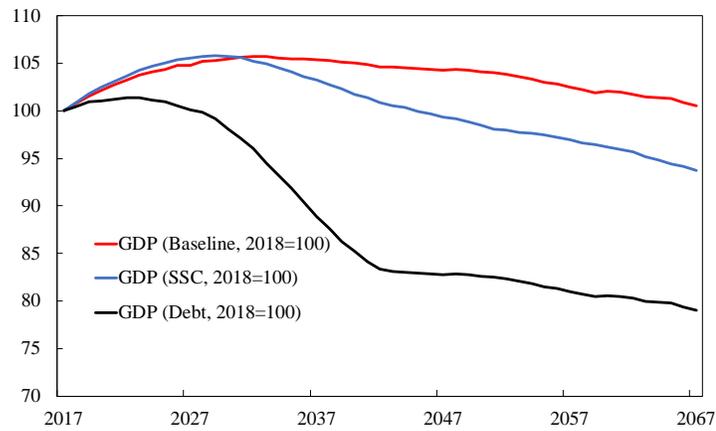
Source: IMF staff simulations.

Figure 9. Sources of Government Revenue Under Preferred Policy Scenario
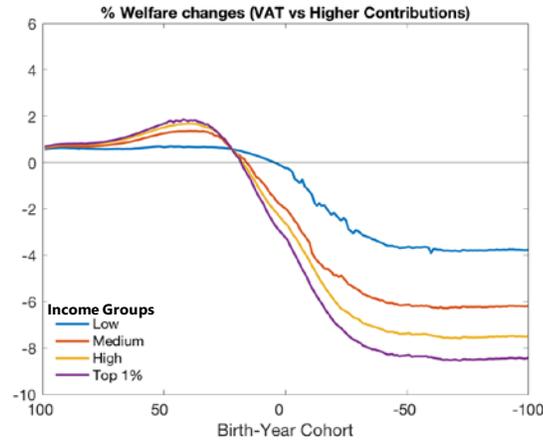(In percent of GDP)
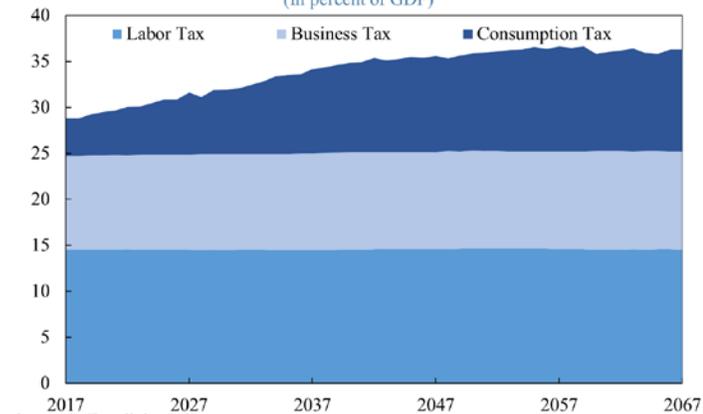
Source: IMF staff simulations.

Figure 10. Financing Aging Costs Through Increases in Contributions[1]

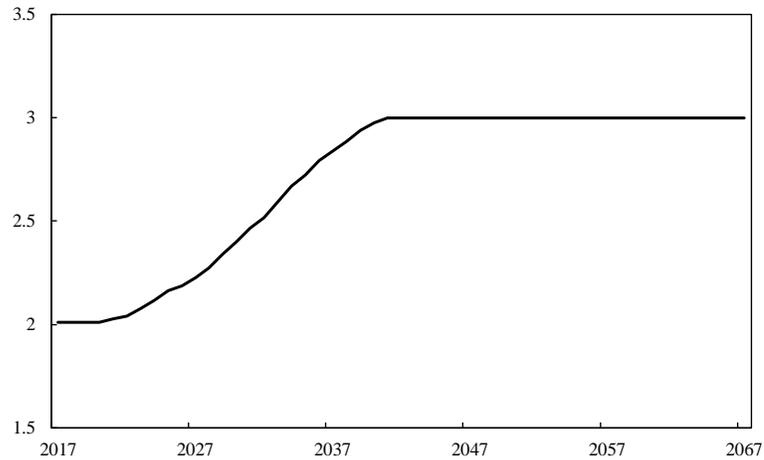Change in Labor Income Tax (For All Income Brackets)
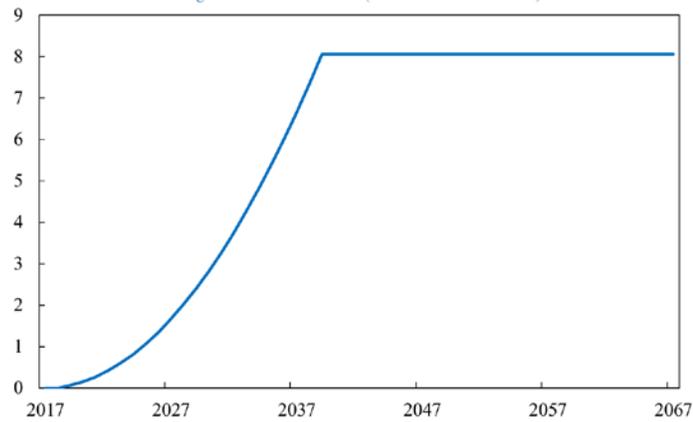
Source: IMF staff simulations.
1/ Note that increased contributions cover higher health care and long-term care costs.

Figure 11. Welfare Effects of Financing Aging Costs Through Increases in Contributions (Relative to Preferred Policy Scenario)
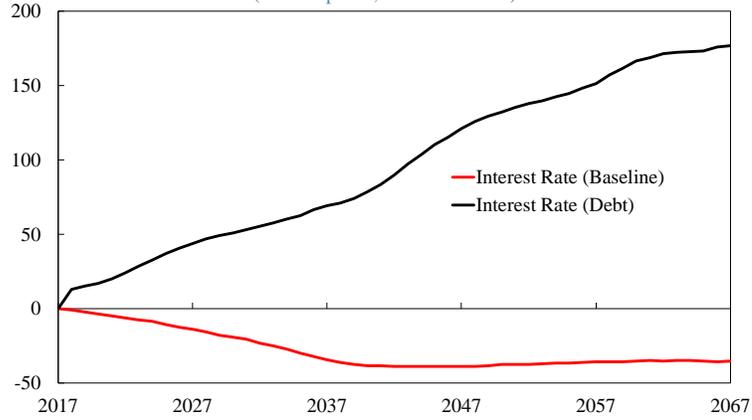
% Welfare changes (VAT vs Higher Contributions)

Income Groups
— Low
— Medium
— High
— Top 1%

Birth-Year Cohort

Source: IMF staff simulations.

Figure 12. Debt Financing Scenario

Debt-to-GDP Ratio

Source: IMF staff simulations.

Figure 13. Changes in Interest Rates Under Baseline and Debt Financing Scenario
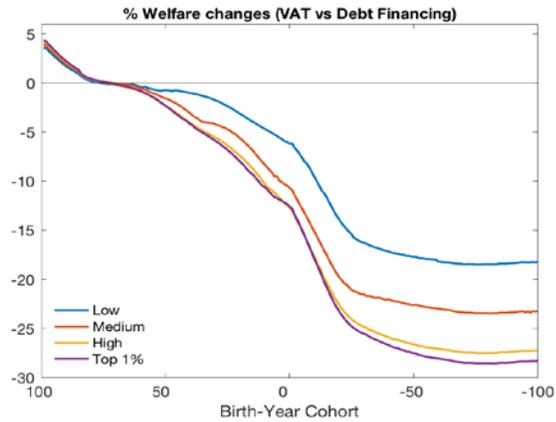(In basis points, relative to 2017)

Source: IMF staff simulations.

Figure 14. Crowding Out of Private Sector Investment in Debt Financing Scenario
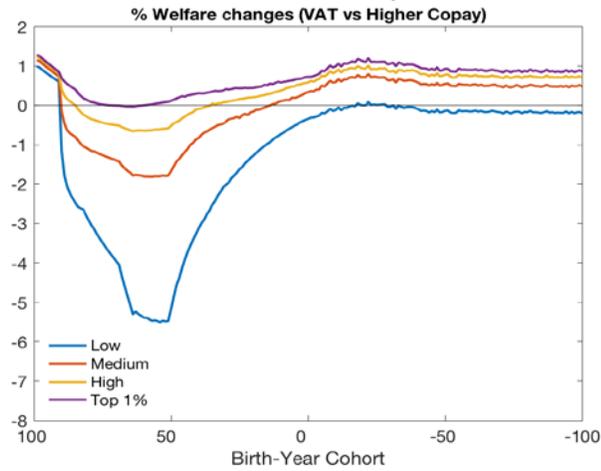Investment to GDP (In percent)
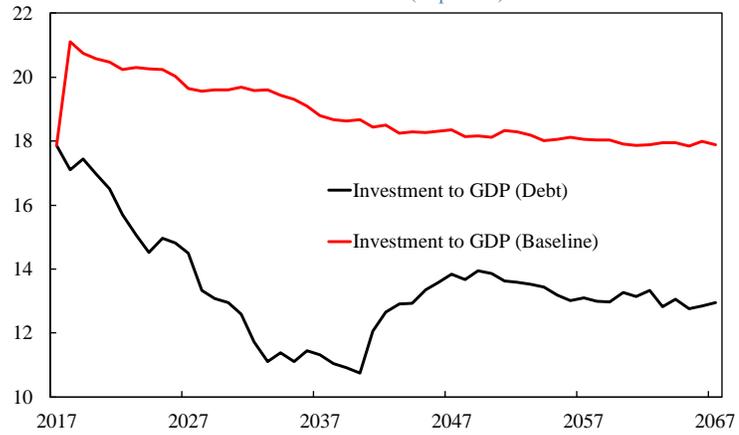
Source: IMF staff simulations.

**Figure 15. Welfare Effects of Debt Financing Scenario (Relative to Preferred Policy Scenario)**

% Welfare changes (VAT vs Debt Financing)

Source: IMF staff simulations.

Figure 16. Welfare Effects of Increasing Copayment Rates
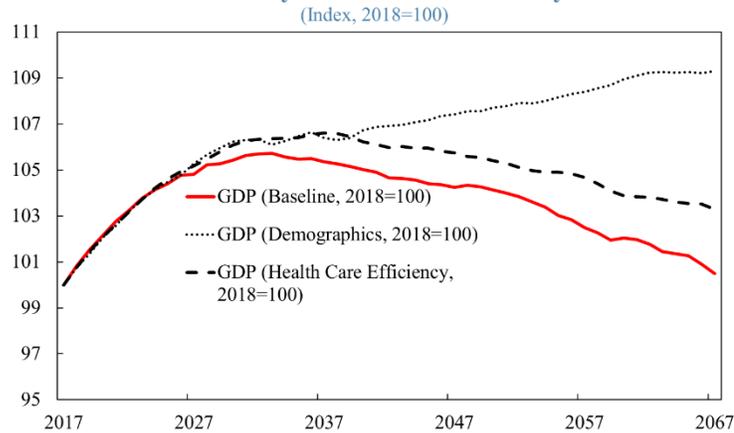**(Relative to Preferred Policy Scenario)**

Source: IMF staff simulations.

Figure 17. VAT Adjustment Under Favorable Demographics, or Improved Efficiency in Health Care Delivery
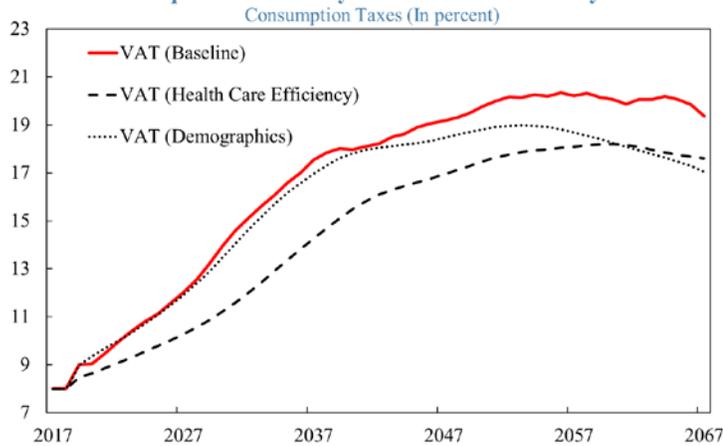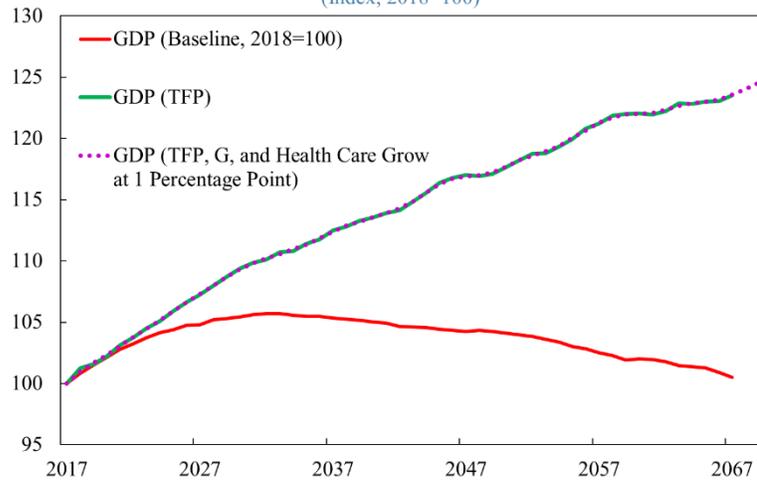

Source: IMF staff simulations.

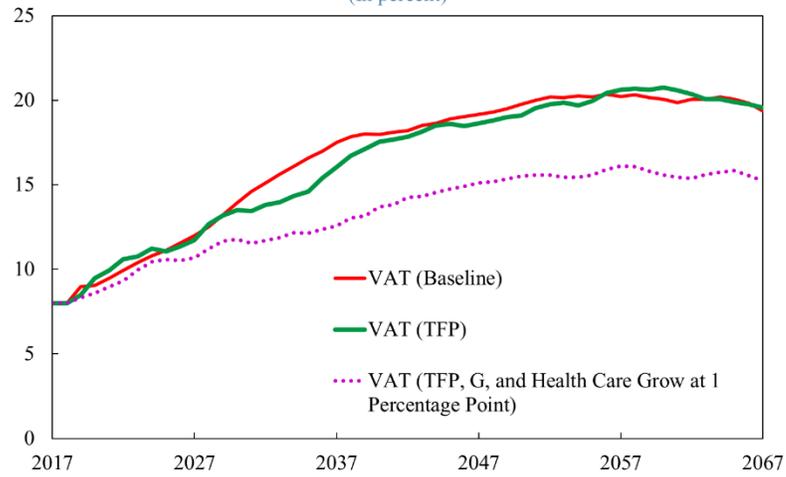**Figure 18. GDP Under Favorable Demographics, or Improved Efficiency in Health Care Delivery**

Source: IMF staff simulations.

Figure 19. GDP when TFP Growth Accelerates
(Index, 2018=100)

Legend:
- GDP (Baseline, 2018=100)
- GDP (TFP)
- GDP (TFP, G, and Health Care Grow at 1 Percentage Point)

Source: IMF staff simulations.

Figure 20. Consumption Taxes When TFP Growth Accelerates
(In percent)

Legend:
- VAT (Baseline)
- VAT (TFP)
- VAT (TFP, G, and Health Care Grow at 1 Percentage Point)

Source: IMF staff simulations.

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Appendix: Assumptions on Pension Transfers

Under the current Japanese pension system, pension transfers are adjusted for inflation and real wage growth (as explained in Section 4, the latter adjustment only applies to those aged 65-67). At the same time, with the aim of containing the growth of aggregate pension spending in percentage of GDP, a macro-indexing mechanism was introduced by the government in 2004, which allows for reduced per capita transfers in real terms. The size of the annual adjustment reflects the projected decreases in the number of insured and projected increases in life expectancy. In reality, the adjustment period depends on the projected trajectory of financial reserves held by pension funds and therefore has an endogenous nature. For simplicity, however, we follow the assumptions in corresponding scenarios in the 2014 Actuarial Valuation rather than calculating the size and period of adjustment endogenously. In our model, real wage growth can be proxied by labor-augmenting productivity growth of 1 percent for the baseline scenario and the alternative demographic scenario.[11] This broadly corresponds to Scenario G in the 2014 Actuarial Valuation (see Table A.1 for key assumptions).

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[11]Since our model is described in real terms, inflation only matters to the extent that the annual macro-indexing adjustment factor cannot exceed the inflation rate for those aged 68 and above.

Table A.1. Key Pension Payment Assumptions.

Scenario model economy	Reference scenario in 2014 Actuarial Valuation (all with medium mortality rate)	Real wage growth (%)	Inflation (%)	Adjustment period years (basic, employee)	Macro-indexing factor (%) (avg. annual adjustment over 30 years)
5.1 Baseline	Scenario G with medium fertility	1.0	0.9	2038, 2031	-1.37
6.1 Favorable demog.	Scenario G with high fertility	1.0	0.9	2042, 2025	-1.28
6.3 Improving TFP	Scenario D with medium fertility	1.5 (1.6 in Actuarial Valuation)	1.4	2043, 2019	-1.30