# Fiscal Reform and Government Debt in Japan: A Neoclassical Perspective

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**Abstract**

Past government spending in Japan is currently imposing a significant fiscal burden that is reflected in a net debt to GNP ratio above 100 percent. In addition, the aging of Japanese society implies that public expenditures and transfers payments relative to GNP are projected to continue to rise until at least 2050. In this paper we use a standard growth model to measure the size of this burden in the form of additional taxes required to meet these obligations that maintain current promised levels of per capita public pension and health services. The fiscal adjustment needed is about a 30 percentage point increase in taxes, using either the consumption tax rate or the labor income tax rate. The latter is far more distorting than the former, leading to a significant loss in welfare. Our results highlight the importance of containing the projected increases in public spending and exploring policies designed to enlarge the tax base.

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# 1 Introduction

Due to large government stimulus in response to low economic growth in 1990s and 2000s, Japan accumulated the highest debt to GDP ratio among developed economies. In addition, this ratio is rising rapidly due to projected increases in public pensions and health expenditures. Figure 1 shows that net debt to GDP has risen from around 15% of GDP in the early 1990s to about 110% in 2010, with further increases projected.

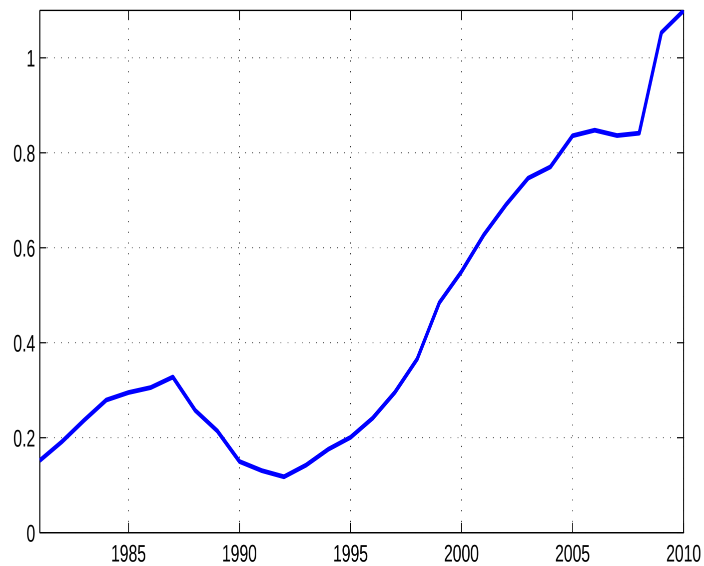


Figure 1: Net Debt to GNP Ratio

We do not fully understand how Japan can have such a high debt to output ratio and yet enjoy very low interest rates on its debt. It seems as if bond holders view Japanese debt as riskless assets. Nearly all of Japanese government debt, about 95%, is held domestically and bond holders may be expecting sufficient future tax increases so that the government may be able to support high debt or ultimately reduce it to sustainable levels.

At the same time, Japan is facing a severe demographic transition.

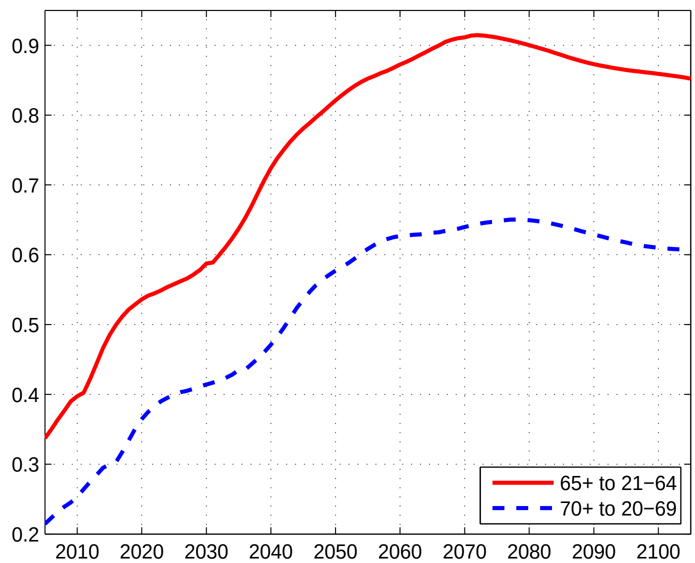


Figure 2: Dependency Ratios

Figure 2 above shows two dependency ratios; one commonly used as the ratio of the number of 65 and older individuals to the number of 21 to 64 year old individuals, and a second one that may be more relevant in the future as retirement ages are expected to be raised. The former shows that about 3 workers are currently supporting 1 retiree. In about 60 years, this ratio is projected to rise to about just over 1 worker paying taxes to support 1 retiree. A back of the envelope calculation would suggest tremendous increases in taxes if benefits are to remain at current levels. Even when we consider a more realistic scenario and assume that Japanese individuals work late into their 60s, the ratio of 70 and older individuals to the number of 20 to 69 year old workers is expected to rise from its current value of just over 20% to about 65% before stabilizing at 60% in the distant future. This is equivalent to having about 5 workers to support 1 retiree in 2005 but looking to have less than 2 workers to support a retiree in less than 40 years.

These demographic projections imply drastic increases in public pension payments and health expenditures.

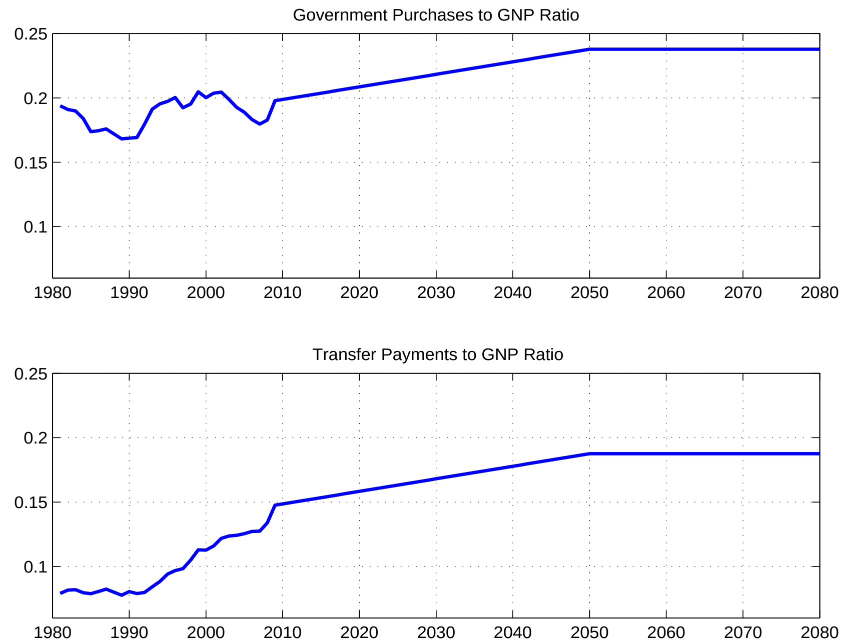


Figure 3: Government Expenditures to GNP Ratios

Figure 3 shows the projected increases, estimated by Fukawa and Sato (2009), in government purchases to GNP driven by health expenditures and aging, and in transfer payments to GNP driven by expected increases in total pension payments. Not only are there going to be far fewer workers paying taxes, but there will be many more retirees requiring huge outlays for health expenditures and old age pensions. Can Japan still finance these large expenditures with domestic loans from the private sector? Or will large tax increases inevitable?

İmrohoroğlu and Sudo (2010) address this question in the context of the standard growth model. Following Hayashi and Prescott (2002), they measure the impact of raising the consumption tax rate in Japan from its current level of 5% to 15%. They find that despite the temporary improvement in government revenues that produces primary surpluses for several years, eventually primary deficits re-emerge and the fiscal situation worsens. To see if a growth miracle may increase the tax base sufficiently to allow for fiscal balance, İmrohoroğlu and Sudo (2011) try several scenarios under which exogenous growth in total factor productivity reduces the fiscal burden by lowering the projected increases in the government expenditures to GDP ratio on one hand and by raising the tax base on the other hand. Their main finding is that a decade of productivity growth of 6% of more is needed to restore fiscal balance in Japan. This type of growth experience has not been achieved in any advanced economy over the last 35 years. Therefore, the size of tax adjustments that will deliver fiscal balance in Japan is an open question.

In this paper, we build a simple growth model following Hayashi and Prescott (2002) that incorporates a strong domestic demand for government bonds and explore alternative ways of financing the projected increases in government expenditures. In addition, we allow for an eventual reduction in the debt to GNP ratio to lower levels than experienced in more recent years. In particular, we ask "What are the revenue requirements and new taxes needed to finance future government expenditures and at the same time reduce the level of indebtedness to 60% of GNP?"

The model is a one sector deterministic growth model in which the private sector has perfect foresight about the demographic transition, government policy and factor prices. The representative household values consumption, leisure, and government bonds and markets are complete. The inclusion of bonds in the utility function is a way to capture the idea that there is very strong domestic demand for government bonds in Japan. This feature of the model allows for both the quantity and the price of bonds to be endogenous. A stand-in firm hires labor and rents capital from households. There is a government that faces exogenously given streams of purchases of goods and services and transfer payments. It taxes factor incomes, interest income and consumption to finance these expenditures. In addition, it can issue one-period, real bonds to the households, and raise additional revenues by managing its debt.

After calibrating the model to the Japanese economy, we compute a transition path from given initial conditions in Japan in 1981 to a steady-state in the distant future that allows for a different level of debt to GDP. The benchmark exercise assumes that the projected increase in social security and health expenditures will be financed by additional issues of debt and lump sum taxes. In addition, we compute two alternative transition paths, one equilibrium path in which the government uses a new consumption tax to restore fiscal balance, and a second path in which a labor income tax is used.

There is a large number of ways the Japanese government can deal with the fiscal burden that is in the horizon. They can use one or more tax rates, reduce spending, or borrow some more, and decide on the timing of these policies in infinite ways. Therefore we would like to motivate our choice of policies in the model. The first line of motivation is the fact that the Japanese government came close to raising the consumption tax recently. Prior to the 2008-2009 recession in Japan, the Japanese government planned to raise the consumption tax rate from 5% to 10% in order to achieve a primary surplus by 2011 and to reduce debt to GDP ratio to "sustainable" levels by mid 2010s. However, the 2008-2009 recession postponed these plans. The positive growth in 2010 rekindled the discussions but the the March 2011 triple disaster once again shelved any tax increase for a while. Given the 6% growth in real GDP in the 3rd quarter of 2011, the consumption tax increase in once again on the table.

Our main finding is that the projected increases in government expenditures due to aging will necessitate very large additional revenues, in the order of about 20-30% of aggregate consumption each year. If the government uses the consumption tax to finance the expected burden due to aging, then the consumption tax rate needs to increase from its current level of 5% to about 35%. If the labor income tax is used, then the tax rate will nearly double from its current level of 30% to about 60%. Also, the welfare cost of using the labor income tax is 3.22% of consumption, which is more than twice that of using the consumption tax to restore fiscal balance.

The paper is organized as follows. Section 2 describes the model economy and calibration is discussed in Section 3. Section 4 presents our quantitative results. Section 5 concludes.

# 2 Model

The fiscal analysis in this paper takes as given time series on tax rates, government spending ($G_t$), transfer payments ($TR_t$), the working age population ($N_t$), and total factor productivity ($A_t$), where actual time series are used from 1981-2008. Forecasts and assumptions are used to extend these series to 2050 and beyond. In addition, we assume that the tax rates, $G_t/Y_t, TR_t/Y_t$, and the growth rates of $N_t$ and $A_t$ are all eventually constant and the economy converges to a balanced growth path. A one sector neoclassical growth model is used to endogenously determine hours worked ($h_t$), consumption ($C_t$), output ($Y_t$), the stock of capital ($K_t$), tax revenues, government debt ($B_t$), and the price of government bonds, ($q_t$), from 1981 into the infinite future.

In this section we describe the details of our model. Upper case variables are per capita values that grow along a balanced growth path. Lower case variables are stationary along a balanced growth path. Ultimately, we will transform all variables so that they are stationary.

The economy is populated by a representative household with perfect foresight that has $N_t$ members at time $t$. The size of the household is assumed to grow at a time-varying growth factor $\eta_t$ so that $N_{t+1} = \eta_t N_t$.

## 2.1 Government

We begin by describing the government's budget constraint. The government is assumed to collect revenue from taxing household consumption at the rate $\tau_{c,t}$, labor income at the rate $\tau_{h,t}$, capital income at the rate $\tau_{k,t}$, and interest on government bonds at the rate $\tau_{b,t}$. Given time series for $G_t$ and $TR_t$, the quantity of one-period discount bonds ($B_{t+1}$) that are issued by the government is determined by the following budget constraint (where all quantities are in per capita terms):

$$\begin{aligned} G_t + TR_t + B_t &= \eta_t q_t B_{t+1} + \tau_{c,t} C_t + \tau_{h,t} W_t h_t \\ &\quad + \tau_{k,t}(r_t - \delta) K_t + \tau_{b,t}(1 - q_{t-1}) B_t. \end{aligned} \tag{1}$$

Here, in addition to variables already defined, $W_t$ and $r_t$ denote the wage rate and the return to capital, and $\delta$ is the depreciation rate of capital. In order to guarantee that the government obeys its intertemporal budget constraint, we assume a "debt sustainability" rule that forces the government to retire a fraction $\kappa$ of its debt that is in excess of what we assume the government will hold along its balanced growth path. In particular, we assume that the debt to output ratio along the balanced growth path is equal to $\overline{b}$.

This rule is triggered once the debt to output ratio exceeds some value $b_{\max}$.

$$\iota_t = \begin{cases} 1 & \text{if } B_s/Y_s \geq b_{\max} \text{ for some } s \leq t, \\ 0 & \text{otherwise} \end{cases}$$

Once the sustainability rule is triggered, the government must generate revenue equal to $D_t$ that can be used to retire debt.

$$D_t = \kappa \iota_t (B_t - \overline{B}_t),$$

where $\overline{B}_t$ is the level of bonds along the balanced growth path to which the economy ultimately converges.

We will experiment with alternative ways to raise $D_t$ along the transition path to the steady state. One way is to replace $TR_t$ with $TR_t^* = TR_t - D_t$. This is equivalent to $D_t$ being a lump sum tax. Alternatively, we will consider rules that replace $\tau_{c,t}$ or $\tau_{h,t}$ with larger tax rates $\tau_{c,t}^*$ or $\tau_{h,t}^*$ that are sufficient to bring $B_t/Y_t$ to its steady state level $\overline{b}$.

## 2.2 Household's Problem

The household at time 0 is endowed with initial holdings of per capita physical capital $K_0 > 0$ , and real, one-period, zero-coupon, discount bonds $B_0 > 0$. In addition, each member of the household is endowed with one unit of time each period that can be used for market activities $h_t$ or leisure $1 - h_t$. Given a sequence of wages, rental rates for capital, and government bond prices $\{W_t, r_t, q_t\}_{t=0}^{\infty}$, and tax rates on consumption, and labor, capital and bond income, and per-capita transfer payments $\{\tau_{c,t}, \tau_{h,t}, \tau_{k,t}, \tau_{b,t}, TR_t\}_{t=0}^{\infty}$, the household chooses a sequence of per member consumption, hours worked, capital, and real bond holdings $\{C_t, h_t, K_{t+1}, B_{t+1}\}_{t=0}^{\infty}$ to solve the following problem:

$$\max \sum_{t=0}^{\infty} \beta^t N_t [\log C_t + \alpha \log(1 - h_t) + \phi \log(\mu_t + B_{t+1})]$$

subject to

$$\begin{aligned}(1 + \tau_{c,t})C_t + \eta_t K_{t+1} + q_t \eta_t B_{t+1} &= (1 - \tau_{h,t})W_t h_t + [(1 + (1 - \tau_{k,t})(r_t - \delta)] K_t \\ &\quad + [1 - (1 - q_{t-1})\tau_{b,t}]B_t + TR_t,\end{aligned}$$

where $K_0 > 0$ and $B_0 > 0$ are given initial conditions. Here $K_{t+1}$ is per member holdings of capital at time $t + 1$. $\eta_t K_{t+1}$ expresses the same quantity of capital per member at time $t$. The individual's maximization is subject to a budget constraint where after-tax consumption expenditures and resources allocated to wealth accumulation in the form of capital and bond holdings are financed by after-tax labor income, after-tax capital income and holdings of capital, after-tax proceeds of bond holdings chosen in the previous period, and transfer payments from the government. The parameters $\alpha > 0$ and $\phi > 0$ describe the household's preferences for leisure and government bonds.

Since about 95% of the Japanese government bonds are held domestically, we assume that Japan is a closed economy where all debt is held by Japanese citizens, i.e. the Japanese household in our model. In addition, Japanese government bonds historically have had yields less than the return to physical capital. As a result, we introduce government debt in the utility function, with $\phi > 0$.[1]

[1]For example, consider a simplified version of the model in which the representative household solves $\max \sum_{t=0}^{\infty} \beta^t \{\log c_t + \phi \log b_{t+1}\}$ subject to $c_t + k_{t+1} + q_t b_{t+1} = w_t + r_{k,t} k_t + (1 - \delta) k_t$. The first order conditions are given by $\frac{1}{c_t} = \beta \frac{R_t}{c_{t+1}}$, $\frac{\phi}{b_{t+1}} - \frac{q_t}{c_t} + \frac{\beta}{c_{t+1}} = 0$, and $R_t = r_t + 1 - \delta$.

Steady-state implies $q - \frac{1}{R} = \frac{\phi c}{b} > 0$, which means that the return on $k$, denoted by $R$, dominates that on $b$ which is equal to $1/q$.

Finally, $\mu_t$ is a parameter that limits the curvature of the period utility function over bonds. Essentially, it represents assets that might be perfect substitutes to Japanese government issued bonds in generating utility to households.[2] We allow this parameter to move at the same rate of balanced growth as the rest of the economy so that the detrended version is a constant. In particular, $\mu_t = \mu A_t^{1/(1-\theta)}$.

## 2.3 Firm's Problem

A stand-in firm operates a constant returns to scale Cobb-Douglas production technology

$$\begin{aligned} N_t Y_t &= A_t (N_t K_t)^\theta (N_t h_t)^{1-\theta} \\ N_{t+1} K_{t+1} &= (1-\delta) N_t K_t + N_t X_t. \end{aligned}$$

Capital depreciates at the rate $\delta$. The income share of capital is given by $\theta$. $A_t$ is total factor productivity which grows exogenously at the rate $\gamma_t$, so we have $A_{t+1} = \gamma_t A_t$. Per capita gross investment is denoted by $X_t$.

## 2.4 Equilibrium

Given a government fiscal policy $\{G_t, TR_t, D_t, B_t, \tau_{h,t}, \tau_{k,t}, \tau_{c,t}, \tau_{b,t}\}_{t=0}^\infty$, debt sustainability rule $\{\kappa, \overline{b}, b_{\max}\}$, and the paths of working age population $\{N_t\}_{t=0}^\infty$ and technology $\{A_t\}_{t=0}^\infty$, a competitive equilibrium consists of an allocation $\{C_t, h_t, K_{t+1}, B_{t+1}\}_{t=0}^\infty$, factor prices $\{W_t, r_t\}_{t=0}^\infty$ and the bond price $\{q_t\}_{t=0}^\infty$ such that

- the allocation solves the household's problem,
- the allocation solves the firm's profit maximization problem with factor prices given by: $W_t = (1-\theta) A_t K_t^\theta h_t{}^{-\theta}$, and $r_t = \theta A_t K_t^{\theta-1} h_t{}^{1-\theta}$,
- the government budget is satisfied,
- the market for bonds clears,
- and the goods market clears: $C_t + [\eta_t K_{t+1} - (1-\delta) K_t] + G_t = Y_t$.

## 2.5 Detrended Equilibrium Conditions

In this subsection we derive the detrended equilibrium conditions to use in solving the model numerically. Given a trending per capita variable $Z_t$ we obtain its detrended per capita counterpart by

$$z_t = \frac{Z_t}{A_t^{1/(1-\theta)}}.$$

[2]Without this parameter, the price of bonds turns out to be too volatile to resemble the observed bonds prices in Japan.

The first set of detrended equilibrium conditions is given below.

$$\frac{(1+\tau_{c,t+1})\gamma_t^{1/(1-\theta)}c_{t+1}}{(1+\tau_{c,t})c_t} = \beta[1+(1-\tau_{k,t+1})(r_{t+1}-\delta)], \quad (2)$$

$$\frac{\phi}{\mu+b_{t+1}} + \frac{\beta\eta_t[1-(1-q_t)\tau_{b,t+1}]}{(1+\tau_{c,t+1})c_{t+1}} = \frac{q_t\eta_t\gamma_t^{1/(1-\theta)}}{(1+\tau_{c,t})c_t}, \quad (3)$$

$$\frac{\alpha}{1-h_t} = \frac{(1-\tau_{h,t})w_t}{(1+\tau_{c,t})c_t}, \quad (4)$$

$$y_t = k_t^{\theta}h_t^{1-\theta}, \quad (5)$$

$$\eta_t\gamma_t^{1/(1-\theta)}k_{t+1} = (1-\delta)k_t + x_t. \quad (6)$$

Equation (2) is the typical Euler equation arising from the choice of capital stock at time $t$. The bond Euler equation is given by (3). The first order condition for hours worked is shown below as equation (4). The production function and the law of motion for capital are given in equations (5) and (6), respectively. The budget constraint for the household is given below in equation (7)

$$\begin{aligned}(1+\tau_{c,t})c_t + \eta_t\gamma_t^{1/(1-\theta)}k_{t+1} + q_t\eta_t\gamma_t^{1/(1-\theta)}b_{t+1} \\ = (1-\tau_{h,t})w_th_t + b_t + tr_t - d_t + [1+(1-\tau_{k,t})(r_t-\delta)]k_t.\end{aligned} \quad (7)$$

The government budget equation is given by equation (8)

$$\begin{aligned}g_t + tr_t + b_t = {} & q_t\eta_t\gamma_t^{1/(1-\theta)}b_{t+1} + \tau_{c,t}c_t + \tau_{h,t}w_th_t \\ & + \tau_{k,t}(r_t-\delta)k_t + \tau_{b,t}(1-q_t)b_t + d_t.\end{aligned} \quad (8)$$

Equation (9) is the detrended fiscal rule

$$d_t = \kappa\iota_t(b_t - \overline{b}\,\overline{y}), \quad (9)$$

where $\overline{y}$ is value of $y_t$ along the balanced growth path. Recall that $\overline{b}$ is the targeted debt to output ratio along the balanced growth path.

Finally, the market clearing conditions are given below in equations (10), (11) and (12)

$$r_t = \theta k_t^{\theta-1}h_t^{1-\theta}, \quad (10)$$

$$w_t = (1-\theta)k_t^{\theta}h_t^{-\theta}, \quad (11)$$

$$c_t + x_t + g_t = y_t. \quad (12)$$

# 3 Calibration

Our calibration strategy involves several steps. First, we assume that the Japanese economy reaches a steady state far into the future. Second, parameters are calibrated based on information from the sample period, which is annual data from 1981 to 2008. We take the capital stock and bond to output ratios in 1981 as initial conditions. We take exogenous technology, population growth, and policy parameters as given and make assumptions about values beyond the sample period. We then calculate transition paths from 1981 toward the eventual steady state.

Following Hayashi and Prescott (2002) we define the model's capital stock as consisting of private fixed capital, held domestically and in foreign countries. We add net exports and net factor payments from abroad to measured private investment. We consider government investment to be expensed and therefore treat it as part of government consumption and subtract depreciation of government capital from government consumption. We summarize these choices in Table 3 below:

| **Table 1. Adjustments to National Account Measurements** | |
|---|---|
| $C =$ | Private Consumption Expenditures |
| $I =$ | Private Gross Investment |
| | + Change in Inventories |
| | + Net Exports |
| | + Net Factor Payments from Abroad |
| $G =$ | Government Final Consumption Expenditures |
| | + General Government Gross Capital Formation |
| | − Book Value Depreciation of Government Capital |
| $Y =$ | $C + I + G$ |

## 3.1 Time Invariant Structural Parameters

There are five parameters that are held constant throughout our analysis; two technology parameters, $\theta$ and $\delta$, and four preference parameters, $\beta, \alpha, \phi$, and $\mu$. For the technology parameters $\theta$ and $\delta$, we follow Hayashi and Prescott (2002) and calculate time series for capital share of income and the depreciation rate for each of the years in the sample 1981-2008 using Japanese national accounts, and then take sample averages. For the two preference parameters $\beta$ and $\alpha$, we use the equilibrium conditions given below in equations (13) and (14) for the sample period to obtain a value for each year, and then average them over the sample. For $\phi$, the preference for government bonds, we take the average of the values implied by the equation (15) over the period 1981-1998, since the bond to output ratio is monotonically rising after 1998.

$$\beta_t = \frac{(1+\tau_{c,t+1})\gamma_t^{1/(1-\theta)} c_{t+1}}{(1+\tau_{c,t})c_t\left[1+(1-\tau_{k,t+1})\left(\theta\frac{y_{t+1}}{k_{t+1}}-\delta\right)\right]} \tag{13}$$

$$\alpha_t = \frac{(1-h_t)(1-\tau_{h,t})(1-\theta)y_t}{(1+\tau_{c,t})c_t h_t} \tag{14}$$

$$\phi_t = \eta_t(\mu+b_{t+1})\left[\frac{q_t\gamma_t^{1/(1-\theta)}}{(1+\tau_{c,t})c_t} - \frac{\beta_t\left[1-(1-q_t)\tau_{b,t+1}\right]}{(1+\tau_{c,t+1})c_{t+1}}\right] \tag{15}$$

Note, however, that the equilibrium condition given in equation (15) contains the equilibrium price of government bonds, $q_t$. The empirical counterpart to $q_t$ that we compute reflects the fact that government debt in actual economies is comprised of bond holdings of varying maturities while our model economy includes only one period discount bonds. In particular, let $B_t$ be beginning of period debt and $P_t$ be interest payments made in period $t$, both measured in current Yen. In addition, let $F_t$ be the GNP deflator. We compute the price of bonds in period $t$ as follows:

$$q_t = \frac{B_{t+1}/F_t}{(B_{t+1} + P_{t+1})/F_{t+1}}. \tag{16}$$

Figure 4 shows the effect on bond prices of including bonds in the utility function. In the case where $\phi = 0$, bonds earn the same rate as capital. With $\phi > 0$, households are willing to hold government debt at a higher bond price and lower return than in the $\phi = 0$ case. In Figure 5, we compare the rates of return on capital and bonds in our model, both before and after tax. The rate of return dominance of capital over bonds is apparent in this figure.

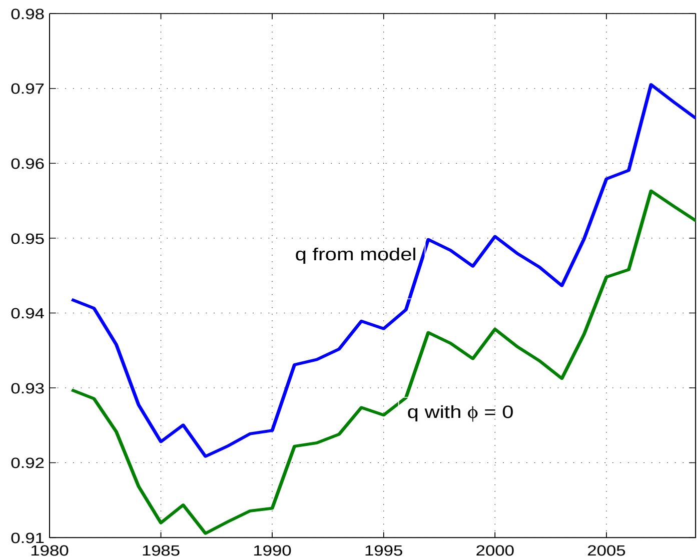


Figure 4: Bond Prices

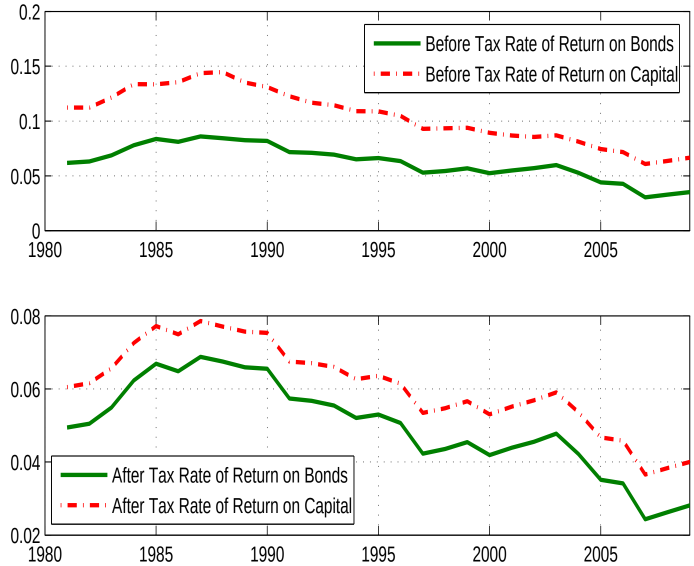


Figure 5: Returns on Capital and Bonds

The remaining preference parameter $\mu$, which is the detrended value of $\mu_t$, is chosen to minimize the sum of squared differences between the bond price implied by our model and its data counterpart. Table 3.1 reports the values for the structural parameters.

**Table 2. Calibration of Structural Parameters**

| Parameter | Value | |
|---|---|---|
| $\theta$ | 0.377 | Data Average |
| $\delta$ | 0.085 | Data Average |
| $\beta$ | 0.9747 | FOC, 1981-2008 |
| $\alpha$ | 1.6083 | FOC, 1981-2008 |
| $\phi$ | 0.0215 | FOC, 1981-1998 |
| $\mu$ | 10 | fit $q_t$ for 1981-1998 |

## 3.2 Time Varying Policy and Technology Parameters

After calibrating the structural parameters, we rely on the actual time-variation in policy and technology parameters to drive the model's simulations. In particular, for 1981-2009, we use the observed values for the tax rates $\tau_{k,t}, \tau_{b,t}, \tau_{h,t}, \tau_{c,t}$, TFP growth rate $\gamma_t$, rate of growth of working age population $\eta_t$, the ratio of government purchases to output $G_t/Y_t$, and the ratio of transfer payments to output $TR_t/Y_t$. Figure 6 below shows these tax rates except for the tax rate on interest from government bonds, which is constant at 20% at all times.

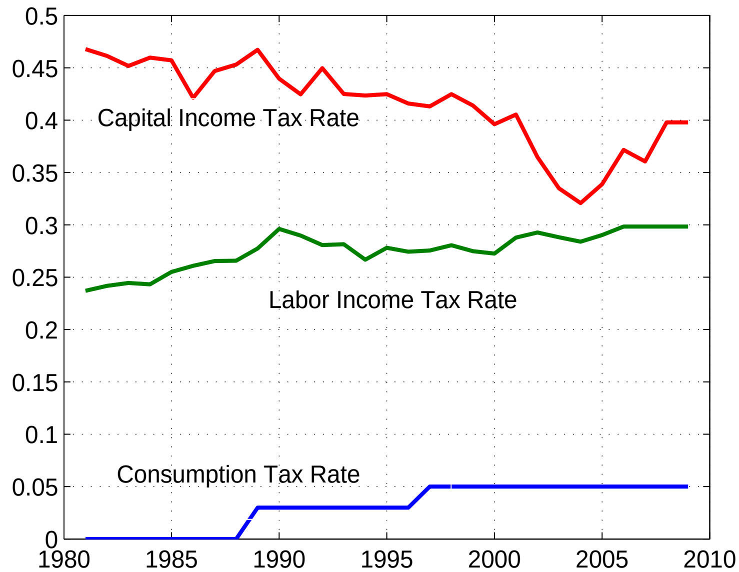


Figure 6: Tax Rates

Our labor income tax rate series is an updated version of that calculated by Mendoza, Razin, and Tesar (1994). They use national accounts and government revenue statistics for large industrial countries to compute annual time series of effective tax rates on factor incomes. The last year for which this tax data set is updated is 2006, and we assume that this value of 0.298 persists forever. Our capital income tax rate is constructed following the methodology in Hayashi and Prescott (2002). Our last calculation for this tax rate is 2008 and we assume that this value of 0.398 remains unchanged forever. A consumption tax rate of 3% was introduced in Japan in 1989, and it was raised to its current value of 5% in 1997.

Our measure of population is working age population between the ages of 16 and 69. We use the actual values between 1981 and 2009 and rely on official projections for 2010-2050. We assume that the population stabilizes after 2050. For the rate of growth of TFP, we take the estimated values (from our Cobb-Douglas production function, $\theta = 0.377$, and actual data for capital and labor) for 1981-2009. For 2010 and beyond, we assume that $\gamma = 1.02^{(1-\theta)}$. Table 3.2 summarizes these choices.

**Table 3. Calibration of TFP and Population Growth Rates**

| | $1981-2009$ | $2010-2050$ | $2051-\infty$ |
|---|---|---|---|
| $\gamma_t$ | Actual Values | $1.02^{(1-\theta)}$ | $1.02^{(1-\theta)}$ |
| $\eta_t$ | Actual Values | Government Projections | 1.0 |

For government purchases and transfer payments, we also use actual values for 1981-2009. Then we rely on projections by Fukawa and Sato (2009) that suggest an increase of about 4 percentage points in the ratio of both expenditure items to GNP by

2050.[3] We assume that the increases in $G/Y$ and $TR/Y$ are linear. Table 3.2 displays these values.

**Table 4. Calibration of $G/Y$ and $TR/Y$**

| | $1981-2009$ | $2010-2050$ | $2051-\infty$ |
|---|---|---|---|
| $G/Y$ | Actual Values | linear increase from 0.198 to 0.238 | 0.238 |
| $TR/Y$ | Actual Values | linear increase from 0.148 to 0.188 | 0.188 |

Figure 7 shows the actual values and projections of some of the key inputs between 1981-2050.

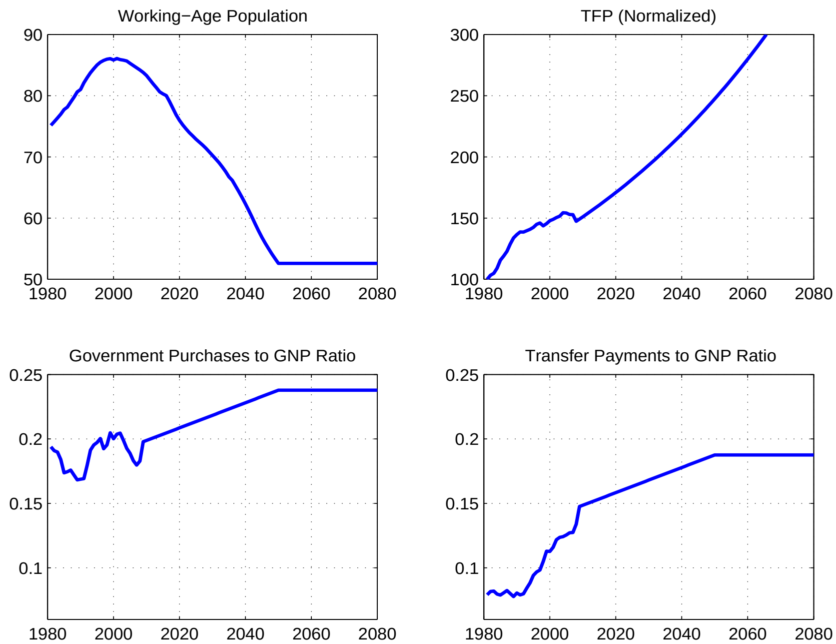


Figure 7: Projections of Key Inputs

## 3.3 Parameters for Fiscal Balance

In our benchmark exercise, the government imposes lump sum taxes (or, equivalently, reduces transfers) when the bond to output ratio reaches some critical value. Later, we will consider alternative fiscal policies that impose distorting taxes to retire debt. As discussed previously, the following equations describe the benchmark fiscal policy.

[3]The projections in Fukawa and Sato (2009) are based on the financial projections produced in Sato and Kato (2007). These projections come from a system of equations that form their accounting model. Some of the equations, such as the consumption of fixed capital, production function, pension benefits, medical expenditures, etc., are estimated from Japanese data, using age brackets when appropriate. Other inputs to the equations are taken from population projections and government's long-term care expenditure estimates. For mortality projections, the medium variant is used. The rate of growth of real GDP is assumed to be 2%. The income share of labor is estimated to be 57%.

$$
d_t = \kappa \iota_t (b_t - \overline{b}\ \overline{y}),
$$

$$
\iota_t = \begin{cases} 1 & \text{if } B_s/Y_s \geq b_{\max} \text{ for some } s \leq t, \\ 0 & \text{otherwise.} \end{cases}
$$

We need to assign values for the three parameters, $\kappa$, $b_{\max}$, and $\overline{b}$, that characterize this policy. For $b_{\max}$, the maximum net debt to output ratio beyond which fiscal austerity kicks in, we used two values, 150% and 200%. For most countries, these values may seem too high. For Japan, however, these may be more reasonable. Indeed, the (net) debt to output ratio predicted for 2012 is near 150%. For the debt to output ratio along the balanced growth path, $\overline{b}$, we use a value of 60%. This is loosely motivated by the upper bound on the debt to output ratio that was viewed as an upper bound for European Union countries that are also a part of European Monetary Union before the recent Euro debt problems.

Figures 8 and 9 below illustrate how we chose $\kappa$ for each value of $b_{\max}$. The upper panel of these figures shows $d_t/c_t$, the revenue required to retire debt as a fraction of consumption expenditures, for different values of $\kappa$. We refer to this as the "consumption tax equivalent revenue requirement." The bottom panel shows the transition path for the debt to GNP ratio for the same set of values for $\kappa$.

We chose the smallest value of $\kappa$ that is sufficient to cause the the debt to output ratio to fall once the trigger is activated. For example, for $b_{\max}$ equal to 150%, $\kappa = 0.15$ is insufficient as the debt to output ratio eventually rises above the maximal value. But $\kappa = 0.2$ works to achieve our targeted fiscal balance. A value of $\kappa = 0.25$ would allow the debt to output ratio to fall more quickly, but, as can be seen from top panel of Figure 8, this value would involve collecting more revenue than necessary in the initial periods after the trigger is activated.

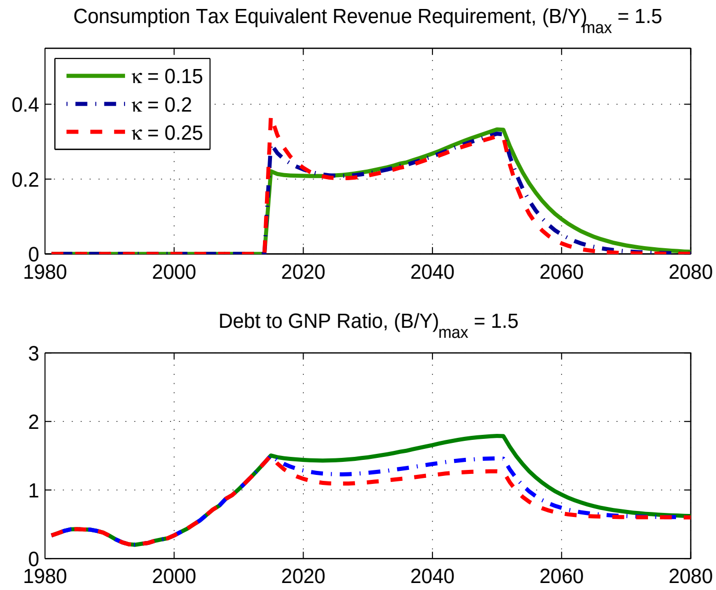


Figure 8: Revenue Requirement

For $b_{\max} = 200\%$, we chose $\kappa = 0.15$ for the same reason outlined above.

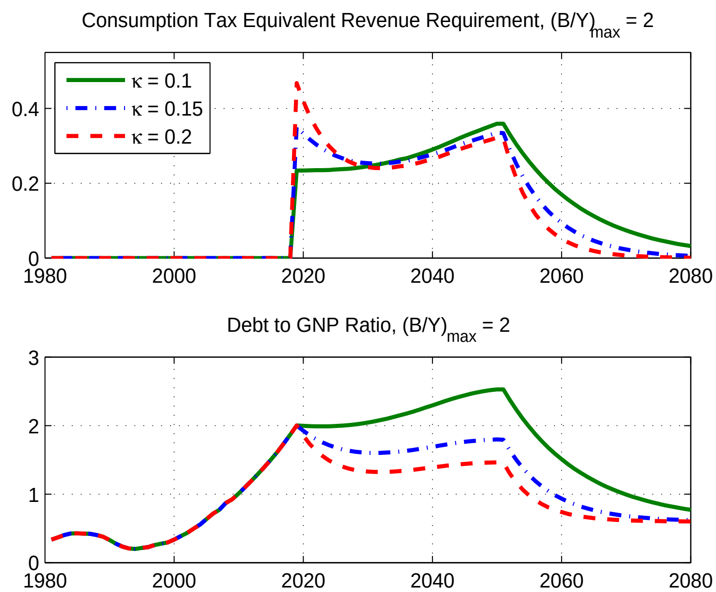


Figure 9: Revenue Requirement

# 4 Quantitative Findings

## 4.1 Benchmark Model: Comparison with Japanese Data

Although our primary interest is in predicting the path for endogenous variables beyond our sample period, we first report the time paths over the sample period 1981-2008 generated by our calibrated model and their counterparts from Japanese data. This allows us to evaluate similarities and differences between actual data and that generated by the model. Figure 10 shows observed and model hours worked (normalized), capital stock and output.

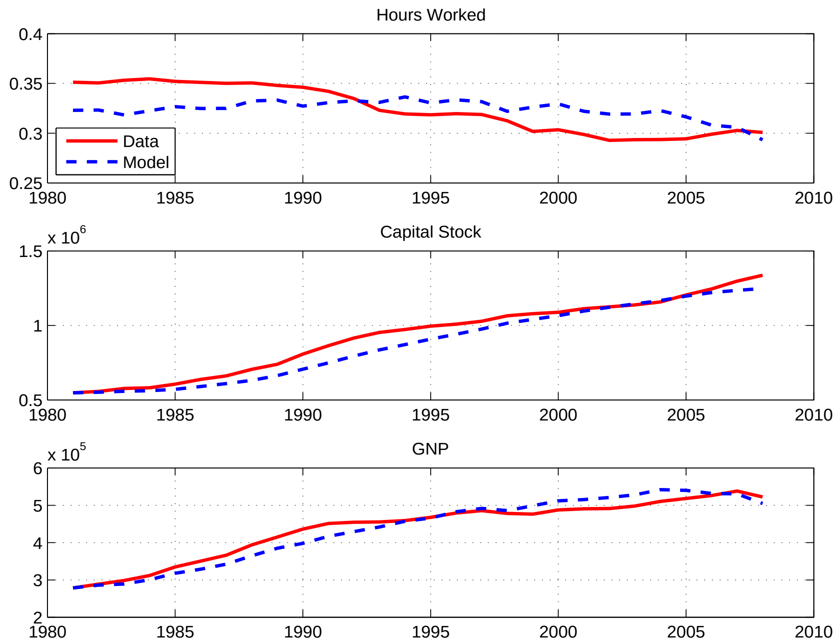


Figure 10: Capital, Labor and Output

The most striking aspect of Figure 10 is that our model does not match the observed time path for hours worked. During the 1990's, labor supply fell significantly in Japan. Hayashi and Prescott (2002) attribute some of this decline to the legislated reduction in the length of the work week in Japan, a feature that is absent in our model. As a result, the model predicts a flatter hours path than observed in the data.

Figure 11 illustrates observed and model consumption, investment and capital-output ratio. Here, one can see that the model predicts higher investment during the 1990's and early 2000's than actually observed. This may be due to the substitution toward capital goods with lower depreciation rates during this period, something that is not featured in our model. Toward the end of the 1981-2008 period, there is more agreement between the model and the data.

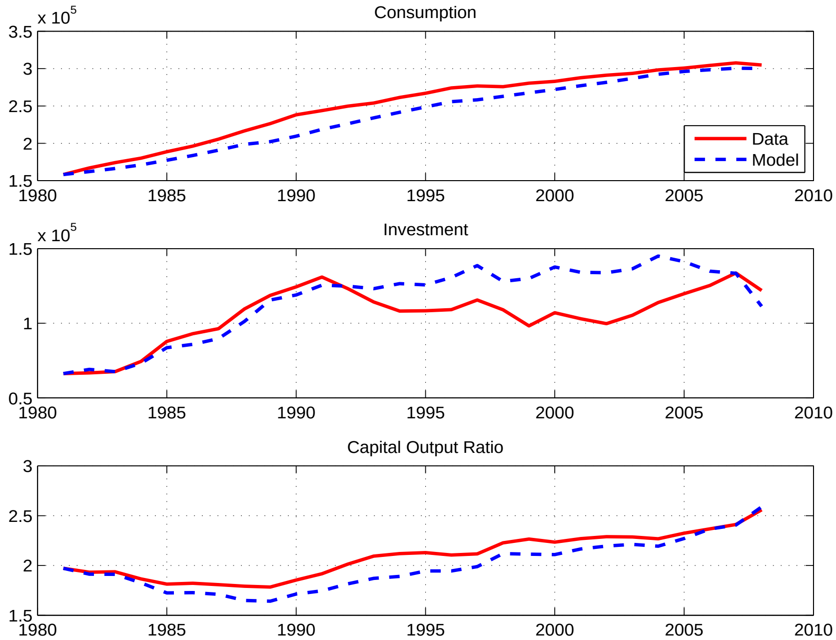


Figure 11: Consumption, Investment, and Capital-Output Ratio

Figure 12 shows the bond price and debt to output ratio we estimate from the Japanese data and that implied by our model. Recall that the model was calibrated so that individuals hold, on average, the amount of debt issued by Japan during the sample period. The bottom panel reflects this fact. Although the model over predicts debt to output prior to 1995 and under predicts debt after 1995, the model gets it right on average by construction. In addition, the debt to output ratios at the end of the sample are close to the same for the model and data. The top panel indicates that people held this debt at a higher bond price on average than predicted by our model. The model also predicts smoother bond prices than observed in the data.

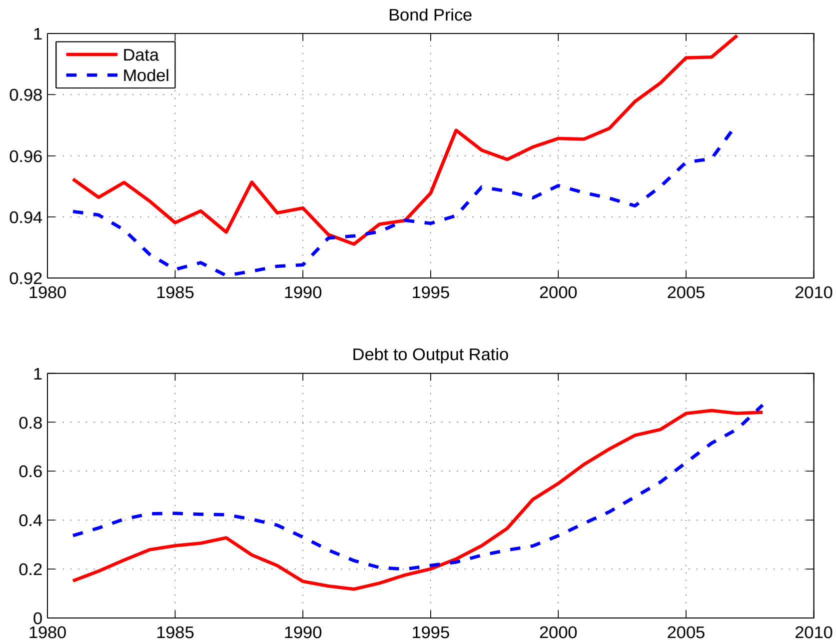


Figure 12: Bond Price and Debt to GNP Ratio

## 4.2 Fiscal Policy Experiments

Our benchmark model assumes that the Japanese government can effectively impose lump sum taxes and/or alter transfer payments to achieve fiscal balance in the steady state. Under these assumptions, ones that maintain the projected levels of government expenditures, very large increases in lump sum taxes, or alternatively, very large decreases in transfer payments, in the order of about 20-30% of aggregate consumption, are required. In this subsection, we compare our benchmark economy with ones that use use the consumption tax or the labor income tax to achieve fiscal balance.

Below, we repeat Figure 7 to reiterate our assumptions regarding key exogenous variables for these experiments. The projected fiscal burden due to the aging of the Japanese population is reflected in the projected increases in government purchases and transfer payments. Taking these demographic and expenditure variables as given, and assuming a target of an eventual 60% debt to GNP ratio in the steady state, we compute the magnitude of the consumption or the labor income tax rate necessary to achieve fiscal balance in Japan.

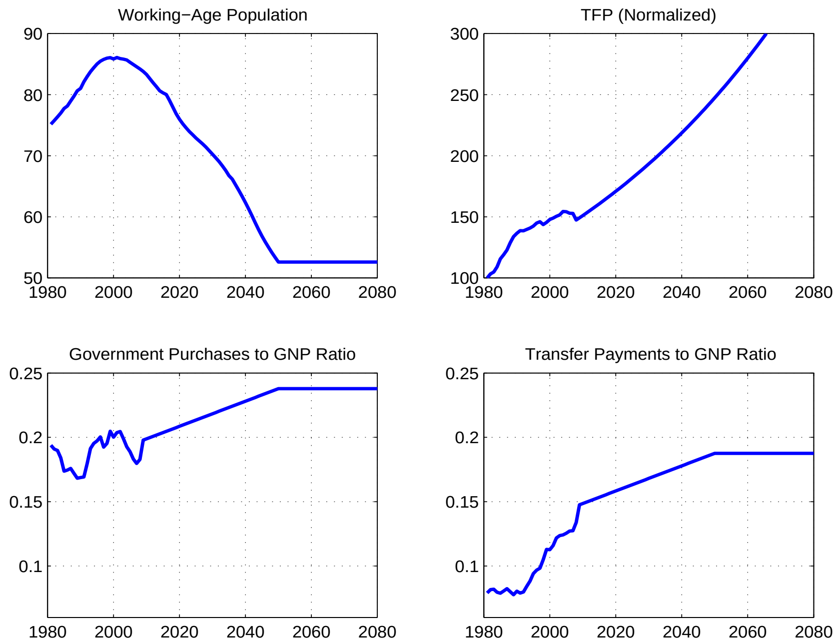


Figure 13: Model Inputs

Before we can proceed, however, we need to fully specify the fiscal policies we consider. The specific fiscal policies considered are motivated by two considerations. First, we accept the likely political reality that there will be a tendency to put off any reform until it can't be put off any further. This is why we use the debt to output trigger described below. Second, we focus on consumption and labor income tax rates because of their simplicity. Further research should explore things like increasing the retirement age, other reforms of entitlement programs, encouraging immigration, encourage female labor supply, and other possible reforms that might mitigate the fiscal situation in Japan.

We take as given the actual tax rates levied by Japan from 1981 to 2009. As described in section 2.1, the fiscal policies we consider hold tax rates at their 2009 values until the debt to GNP ratio reaches a threshold level, $b_{\max}$. At this point, depending on the experiment, one of the tax rates (either $\tau_c$ or $\tau_h$) is increased to $\overline{\tau}_x + \pi$, where $\overline{\tau}_x$ is the steady state tax rate for $x = c$ or $x = h$ consistent with maintaining a debt to GNP ratio of $\overline{b}$ in the steady state. The parameter $\pi$ is an additional increment to the tax rate so that sufficient funds can be raised to i) finance the projected increases in government expenditures, and, ii) buy back the debt towards its steady state value. As soon as the trigger is activated, the government collects large tax revenues and starts to reduce its debt to GNP ratio.

With this tax rate, the debt to GNP ratio will eventually fall below its steady state level. At this point, we set the tax rate equal to its steady state level. This fiscal policy can be summarized as follows (where $x = c$ or $h$ and $t \geq 2010$):

$$\tau_{x,t} = \begin{cases} \tau_{x,2009} & \text{if } B_s/Y_s \leq b_{\max} \text{ for all } s \leq t \\ \overline{\tau}_x + \pi & \text{if } B_s/Y_s > b_{\max} \text{ for some } s \leq t \text{ and } B_t/Y_t > \overline{b} \\ \overline{\tau}_x & \text{if } B_t/Y_t \leq \overline{b}. \end{cases}$$

In our fiscal policy implementation, $\pi$ is chosen as the smallest increment that still leads to the activation of the second trigger.

### 4.2.1 Consumption Tax Experiment

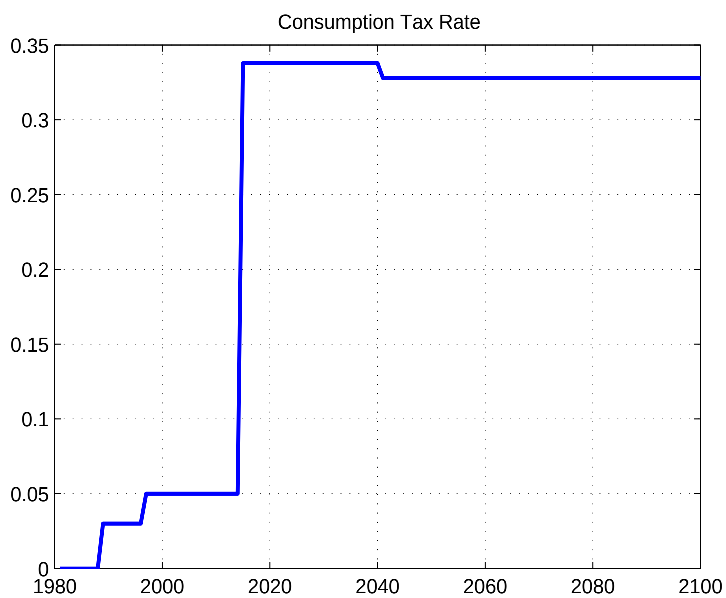


Figure 14: Consumption Tax Rate

Figure 14 shows the projected time path of $\tau_c$ when this tax rate is used to finance the projected increases in social insurance expenditures and to reduce the debt to GDP (eventually) to 60%. This particular fiscal policy calls for a very rapid and sharp increase in the tax rate from its current value of 5% to almost 35%. In particular, the value of $\pi$ is 0.003 and the steady state value of the tax is nearly 34%.[4]

### 4.2.2 Labor Income Tax Experiment

Using the labor income tax instead of the consumption tax yields the path of labor income tax rate shown in Figure 15. Here, fiscal balance requires an almost doubling of the labor

[4]When we assume that the steady state debt to GDP ratio is 150%, instead of 60%, then the steady state consumption tax rate is 36.4%. It is higher so that the government can service the higher debt to GDP ratio in the steady state.

income tax rate from about 30% to about 60% for several decades until it goes down to its steady state level of about 55%. [5]

Note that the first trigger for our fiscal policy is activated a few years later in the case of the labor income tax. This is due to an anticipation effect whereby the household intertemporally substitutes labor for leisure in anticipation of much higher labor income tax rates in the future. As a result, the increase in the tax base buys a few years of time until the debt to GDP ratio rises above the threshold.


Figure 15: Labor Income Tax Rate

#### 4.2.3 Comparing the Benchmark with the Two Alternative Policies

Below, we compare the equilibrium transition paths of key macroeconomic indicators under the benchmark fiscal policy and the two alternative fiscal policies, increasing the consumption tax or increasing the labor income tax.

[5]When we assume that the steady state debt to GDP ratio is 150%, instead of 60%, then the steady state labor income tax rate is 57.7%.

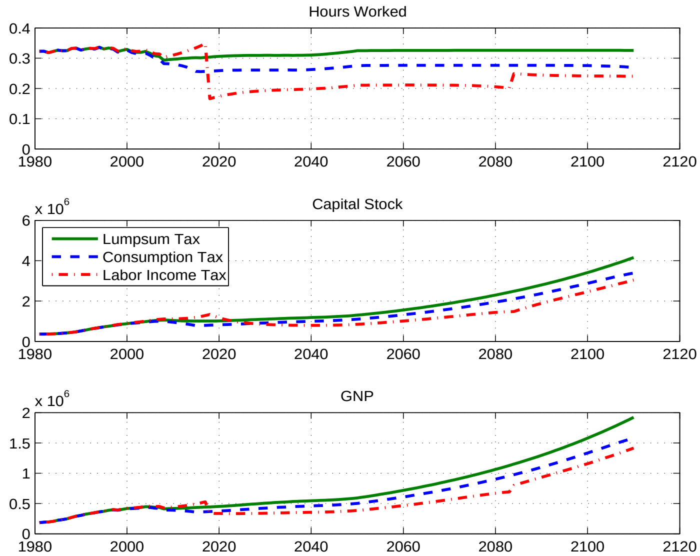


Figure 16: Labor, Capital, and Output

In Figure 16 above, we see the reduction in hours worked, capital stock and output when a consumption tax is used to restore fiscal discipline relative to the case of a lump sum tax. However, the economic outcome is much worse in terms of lower output when a labor income tax rate is used to achieve fiscal balance. Consumption and investment shown in Figure 17 below depict a similar picture, indicating the relative underperformance of the economy with distorting taxes.

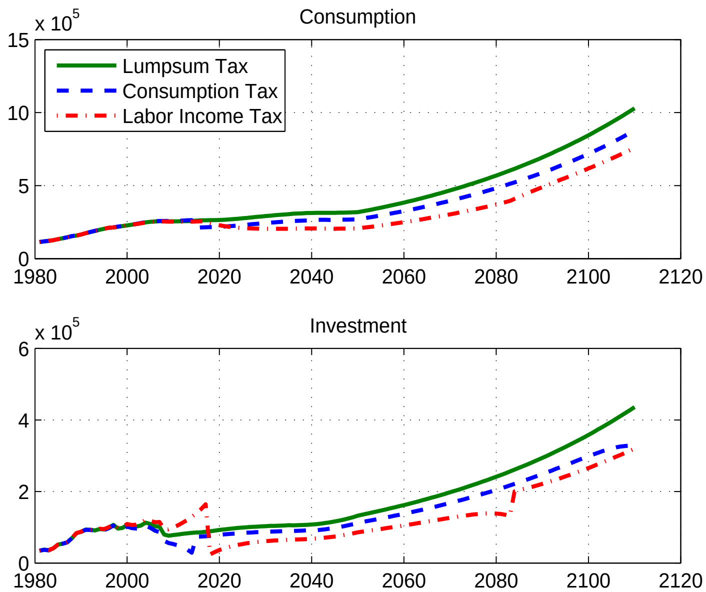


Figure 17: Consumption and Investment

Looking at the detrended equilibrium conditions (2) - (6), one can see that changes over time in the consumption tax rate creates an intertemporal distortion in equations (2) and (3) and the level of the consumption and labor income tax rates affect the static first order condition governing the labor-leisure decision in (4). We can define an effective tax rate as a function of $\tau_c$ and $\tau_h$ using equation (4).

$(1-\tau) = (1-\tau_h)/(1+\tau_c)$, which implies that $\tau = (\tau_c + \tau_h)/(1+\tau_h)$.

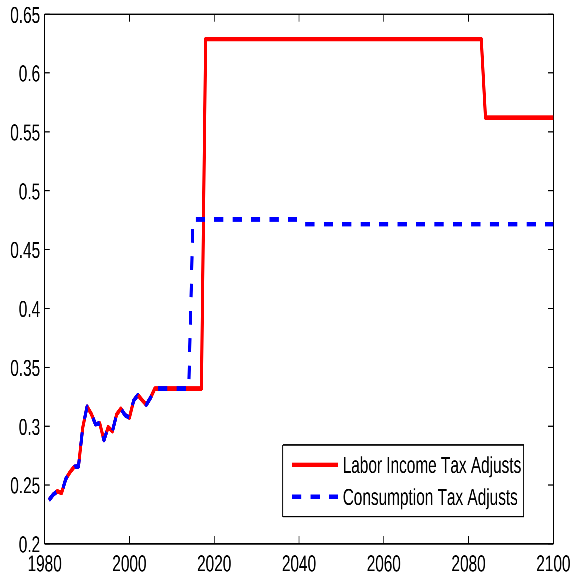


Figure 18: Effective Tax Rate

As Figure 18 above shows, the necessary increase in $\tau$ is much higher if the labor tax is used to retire Japan's debt than if the consumption tax is used. This reflects that fact that government revenue in equation (8) depends on $\tau_c$ and $\tau_h$ separately and not on the effective tax rate $\tau$. Because the labor income tax is more distorting in this environment, hours worked and output are more depressed when the labor income tax is used compared to the case when the consumption tax rate is used, as Figure 16 indicates.

Figure 19 below shows the transition paths for debt to GNP ratios under the two policies.

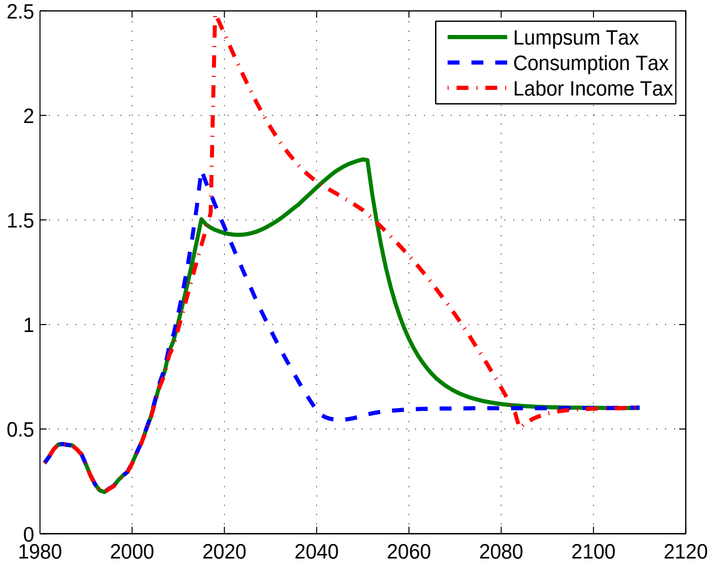


Figure 19: Debt to GNP Ratios

Note in Figure 19 that it takes much longer for the Japanese government to reduce its debt to output ratio to its steady-state target of 60% when a labor income tax rate is used, in addition to financing the increased government expenditures. The reason for this protracted reduction is the decline in labor supply and hence the tax base when the labor income tax rate is about doubled. There is no such large reduction in the tax base when the consumption tax is used. Hence, the government achieves fiscal balance much faster with the (less distorting) consumption tax.

In Figure 20, we show the effects of using distorting taxes on output, relative to the benchmark transition path. The household anticipates a huge increase in the labor income tax and intertemporally substitutes labor for leisure, but when the labor tax rate does increase, there is a large decline in the labor input and output shows a large and permanent decrease relative to the benchmark. If a consumption tax is used instead, there is no temporary gain in output but the long run decline is much smaller than the case of labor income tax.

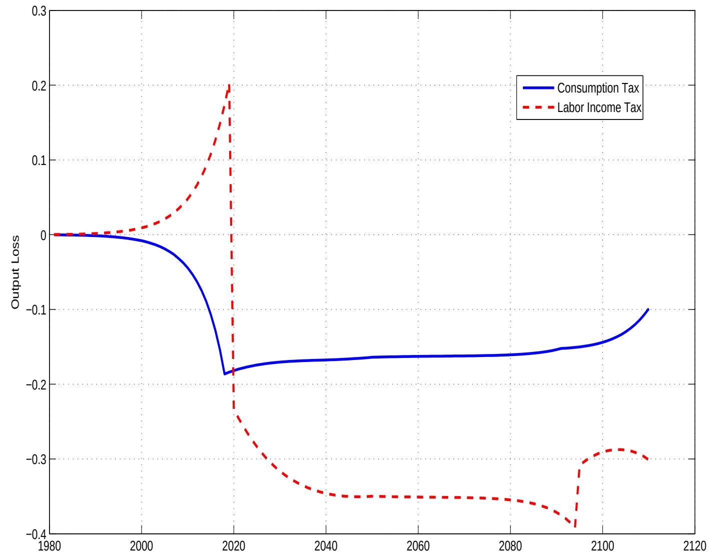


Figure 20: Output Effects

#### 4.2.4 Welfare Costs

In order to make a welfare comparison of using various taxes to achieve fiscal balance, we calculate the compensating variation in consumption as a measure of welfare. In particular, we compute

$$\lambda_c = \exp\left(\frac{W_{bench} - W_{tax}}{D} - 1\right),$$

where $W_{bench}$ is the lifetime utility of the household when a lump sum tax is available, as in the benchmark equilibrium transition, $W_{tax}$ is the lifetime utility when a distorting tax is used, and $D = \sum_{t=2010}^{\infty} \beta^t N_t$. For the equilibrium transitions that use a consumption tax and a labor income tax, we calculate a $\lambda$ of 1.41% and 3.22%, respectively. For example, the representative household would require an annual consumption supplement of 3.22% in order to go from the lump sum tax environment to the labor income tax transition.

# 5 Conclusions

Japan is aging rapidly. The ratio of the number of Japanese that are 65 or older to those between 21 and 64 is projected to increase from 1 to 3 in 2009, to close to 1 to 1 in 2070. This dramatic shift in the number of elderly in the society is expected to raise public retirement and health expenditures significantly. Indeed, the ratio of these aging-related expenditures to GDP is projected to rise an additional 8 percentage points. In addition, past spending decisions has already caused the net debt to GNP ratio to soar well above 100 percent.

We study the implications of two simple fiscal policy responses to the projected fiscal burden using a neoclassical growth model. We find that if the Japanese government uses the consumption or labor income tax rate to finance future expenditures, then an additional 30 percentage points are needed.

In our model, both consumption and labor income taxes are effectively taxes on labor income. The increase in the effective tax rate when the consumption tax rate is increased is half as much as that when the labor income tax rate is increased. Therefore the consumption tax is a less distorting tax and the welfare loss under labor income taxation is more than twice that incurred when consumption taxation is used to achieve fiscal balance.

Even the 30 percentage point increase in the consumption tax is an unprecedented tax hike. Therefore, policy makers are likely to explore measures that will allow some of the fiscal adjustment to come from other sources. These may include reducing expenditures via reforms public pensions and health expenditures, a new approach to immigration, family policies to raise fertility, and increase female labor force participation.

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