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Government Deficit, Public Investment and Public Capital in the Transition to an Aging Japan

by

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Abstract

This paper tires to examine the effects of government deficits, public investment, public capital and public pension policies on the tax burden, capital accumulation and economic welfare in the transition to an aging Japan by applying a simulated method in the expanded life cycle general equilibrium growth model.

One of the main results of this paper is that the highest income, thus the highest economic growth, is achieved when the future government deficits are the highest. However, such a policy to achieve the highest economic growth with the highest government deficits is necessarily not most preferable for future generations, since disposable income under this policy is necessarily not the highest due to the reason that a drastic increase in a consumption tax rate has to be followed in the future to finance the huge amount of interest payments. Thus, only targeting high economic growth would mislead us as to the economic policy. The implication of this result is that a policy to reduce the future government deficits is most preferable for almost all generations, even though a cut in the future deficits must be followed by a decrease in public investment, thus a decrease in the future public capital.

By proposing three different scenarios regarding the future government deficit policy, this paper also presents numerical results of the effects on future consumption tax rates, tax burdens, social security burdens, and the generational accounting through the existing pay-as-you-go public pension scheme.

The effects of an introduction of technological progress as well as of inefficiency in public investment will also be examined numerically.

JEL Classification: H55, H54, H62, C68, J10

Keywords:

Government Deficits, Public Investment, Public Capital, Aging Population, Overlapping Generations Model, Public Pension Scheme, Simulation

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1 Introduction

This paper tries to examine the effects of future government deficits, public investment and public capital on the tax burden, capital accumulation and economic welfare in the transition to an aging Japan by applying a simulated method in the expanded life cycle general equilibrium growth model.[1]

Economic policies, specifically such as government debt policies, the future schedule of public investment, or the reform of a public pension scheme, should be evaluated intertemporally, since these policies involve redistributional effects on different generations. On one hand, benefits from public capital generated by public investment are partly transferred for a long time to future generations from current generations if public investment is financed by taxes imposed on current generations. On the other hand, issuing government bonds is the way to avoid to pay deficits of current generations back, and thus benefits are transferred from future generations to current generations, since an increase in government deficits must be followed by an increase in taxes imposed on future generations.

In the past, the huge amount of the existing public capital was used to be financed by issuing government bonds in Japan. If intergenerational effects of government debt policies of Japan are considered, public capital financed by issuing government bonds should also be taken into account to measure the net re-distributional effect of debt policies among different generations.

Furthermore, it is forecasted that Japan will become an aged society quite rapidly. An aging population implies an increase in the contribution to a public pension scheme provided that the existing pay-as-you-go scheme is maintained in Japan, thus, resulting in further burdens on future generations. An aging population induces transfers of benefits from current generations to future generations if the existing pay-as-you-go scheme is unchanged, and the future demographic change should also be taken into account.[2] Thus, if an intergenerational aspect of future government policies is exam-

[1] This paper expands Kato (2000, 2002b) by incorporating public capital into the model and re-examines the effects of the future Japanese government debt policy by presenting several scenarios.

[2] If bequest motives are strong enough to offset the effect to transfer benefits from current gen-

ined, these three channels (government deficits, public pension scheme, and public capital) must be comprehensively considered.

In the transition to an aging society, the effects of government policies are different among each future generation, as pointed out by Auerbach and Kotlikoff (1987). An insight can only be given by numerical examinations if future policies are examined specifically in the transition to an aging society. A simulated method based on the actual and forecasted data could give us as real evaluation of future government policies as possible. Numerical results could also be used to evaluate the ongoing structural reform facing the Japanese government.

It is generally evaluated that higher economic growth is more desirable, since higher economic growth results in higher income. An economic policy which induces higher economic growth in the long run is thus more preferable. However, since economic policies have different effects among future generations, the evaluation might not be straightforward, if the policies are examined intergenerationally. Furthermore, economic policies should ultimately be evaluated based on utility of different generations. In this paper, two measures will be given to evaluate future government debt policies: Economic growth at each time in the future and equivalent variation of lifetime utility of each generation. The latter corresponds to the overall evaluation of intertemporal government policies based on utility of each generation.

One of the main results of this paper is that a government deficit policy which achieves the highest income in a steady state is necessarily not most preferable, if the policy is evaluated on lifetime utility. The highest income is achieved when the future government deficits are the highest. Since future generations save more, expecting a drastic increase in a consumption tax rate in order to finance the huge amount of interest payments incurred from outstanding bonds in the future, higher government deficits induce more savings, thus, resulting in more supply of capital. The increase in the supply of capital induces higher income, and thus the highest economic growth can be achieved when the future government deficits are the highest. However, when

erations to future generations, the net transfer is zero between current and future genrations. It depends on the magnitude of bequest motives, and it is still true that a pay-as-you-go scheme transfers benefits from current to future generations in an aging society.

the future government deficits are the highest, the consumption tax rate is also the highest in the future, which implies that disposable income is necessarily not the highest. Thus, lifetime income is necessarily not the highest, and such a policy is not preferable if the policy is evaluated on utility, even though pre-taxed income is the highest. This result suggests that only targeting high economic growth would mislead us as to the economic policy.

This paper is organised as follows: Section 2 presents the feature of this paper by referring to the related literature and Section 3 presents the basic model employed in the simulation analysis. Section 4 shows the method of the simulation analysis and its assumptions. Section 5 evaluates the effects of future government deficit policies, and Section 6 examines the effect of an introduction of technological progress as well as of inefficiency in the future public investment. Section 7 summarizes and concludes the paper.

2 The Feature of this Paper

2.1 The Related Literature

There are three fields in the literature related to this paper: The Japanese government deficit, public capital in Japan, and the public pension scheme in an aging Japan.

2.1.1 The Japanese Government Deficit

The effects of the Japanese government debt policy have been discussed in different ways. However, an intergenerational aspect of government deficits has not been studied in detail, since their main concerns were with the evaluation of the past policies or the sustainability of the Japanese government debt policy by using the past actual data, where econometric methods were mainly used rather than simulated methods. Their concerns were in the test of the tax smoothing hypothesis presented by Barro (1979) and the test of the sustainability of the Japanese debt policy. In the former, Asako et al (1993) and Nakazato (2000) are categorized. Asako et al (1993) tested the hypothesis by the Phillips and Perron unit-root test, the Cochrane statistics, and Hall's (1978) test. Nakazato (2000) tested the hypothesis by Campbell's (1987) test. Both papers pointed out that there was a possibility for the past Japanese government debt policies to be made based on other aspects such as political power than tax smoothing. In the latter, Asako et al (1993), Fukuda and Teruyama (1994), Kato (1997), Doi and Nakazato (1998) and Doi (2000) are categorized.. They used different equations for tests, and have not come to the same conclusion regarding the sustainability of government deficits in Japan. There are also papers based on a simulated method to examine Japanese government deficits. Kawagoe (2000) recently presented several proposals by simulating the effect of government deficit policies of Japan based on OECD figures. Kato (2000, 2002a, 2002b) examined the effects of the future government deficits on future generations by presenting several scenarios. The main difference of this paper from Kato (2000, 2002b) is an incorporation of public capital to comprehensively explore the effects of the future government policy on future generations. This paper is also different from Kato (2002a) in the future population data used in the simulation. This paper uses the latest version of the actual forecasted population data estimated in 2002 by the National Institute of Population and Social Security Research, which was not available in Kato (2002a). Nothing is more natural in a simulation analysis than using the latest available data which is as realistic as possible.

2.1.2 Public Capital in Japan

Since Aschauer (1989a, 1989b), there have been several papers to estimate the effect of public capital in Japan. Their main concerns were related to the examination of the effect of public investment in Japan. Iwamoto (1990) discussed the socially optimal level of public investment in Japan, which is based on Arrow and Kurz (1970), and he estimated that the existing level of public capital would be lower than the optimal level. Doi (1995) also estimated the optimal level by using the data of local as well as urban areas and he concluded that the public capital in local (urban) areas would be higher (lower) than the optimal level due to the heterogeneity of political power in different areas. Asako and Sakamoto (1993), Asako et al (1994), Ogawara and Yamano (1995), and Yoshino and Nakano (1994, 1996) estimated the effect of public capital on production of the private sector. These econometric results of the effect of public capital on the private sector production are well summarised in two excellent books by Yoshino and Nakajima (1999) and Mitsui and Ohta (1995)[3]. Their concerns were with the estimation of parameters regarding the stock of public capital in the private sector production function[4], and the estimated parameters will be used in this paper to examine the effect of the public capital stock. Kato (2002a) explicitly incorporated public capital into the overlapping generations model in order to evaluate the effect of the future government deficit policy on different generations.

2.1.3 The Existing Public Pension Scheme in an Aging Japan

The effects of an aging population, and/or the effects of several tax policies and public pension policies in the transition to an aging Japan have been discussed by applying simulated overlapping generations models in the literature. A simulated Overlapping Generations Model originated by Auerbach and Kotlikoff (1983) was first applied to the analysis of the effect of tax policies and public pension policies of Japan by Homma et al (1987), and the existing studies have expanded Auerbach/Kotlikoff model to discuss several government policies in the transition to an aging Japan (Iwamoto (1990a), Iwamoto et al (1991 and 1993), Atoda and Kato (1993), and Kato (1998)). Hatta and Oguchi (1999) recently emphasized intergenerational redistribution of income through the public pension scheme by applying their own simulated method. Kato (2000, 2002a, 2002b) expanded Kato (1998) by incorporating government deficits into the model. In Japan the existing public pension scheme is a modified pay-as-you-go scheme, where a certain amount of fund is accumulated at the same time. This accumulated fund is supplied in the capital market, and the total

[3] See also Prof Doi's excellent web at http://www.econ.keio.ac.jp/staff/tdoi/ for the survey of the literature.

[4] An exception is Akagi (1996), where an aspect of public capital to improve utility such as public parks was considered under the assumption that the stock of utility related public capital is one of elements in utility.

sum of government bonds and the accumulated fund in the public pension scheme is the net real amount of government debts. Thus, the effect of government deficits should be discussed by taking into account the existing public pension fund. Kato (2000, 2002b) expanded Kato (1998) in the following two aspects: The one aspect was that in the simulation analysis of Kato (2000, 2002b) the later version of the actual forecasted population data estimated in 1997 by the National Institute of Population and Social Security Research was used. The other aspect was the explicit incorporation of government deficits into the model. Since the main concern of Kato (1998) was to discuss the effect of the transition of an aging population in Japan through the existing public pension scheme, little attention was paid to the effect of outstanding government debts in Japan.

2.2 The feature of this paper

The key feature of this paper is to explicitly incorporate public capital into Kato (2000, 2002b). In Japan the huge amount of the existing public capital was financed by issuing government bonds in the past. Since the benefits from the existing public capital is partly transferred for a long time to future generations, the Japanese government debt policy have to be evaluated by taking into account the effect of public capital on future generations, if the intergenerational effect on the past as well as on the future generations is considered. In the simulation of this paper, the past actual data of the public capital stock is used in order to make key parameters realistic.

This paper is also different from Kato (2000, 2002b) in the treatment of taxes. Apart from a consumption tax, a wage tax was also considered in Kato (2000, 2002b) as a tool to finance the future shortage of money. However, the effect of consumption taxation is only taken into account in this paper. This is not because consumption taxation is more preferable or plausible, but because it involves more complicated effects, which are often difficult to be analyzed in a completely theoretical setting. In a simulation analysis under realistic assumptions, the difficulty can numerically be overcome, and more realistic implication regarding the effect of the future government debt policy can be drawn. The change of a consumption tax rate induces tax distortion, which consists of a substitution effect as well as an income effect. If the goods are normal, these two effects function oppositely to each other, and thus, the overall effect can usually not be determined analytically. However, when labor is assumed to be exogenously given, the effect of the change of a wage tax rate is straightforward as long as the goods are normal, since there is no substitution effect. In this paper, labor is assumed to be exogenously given, and a consumption tax is only considered in order to deepen the analysis by changing several assumptions such as the degree of technological progress and the degree of efficiency in future public investment.

The difference of this paper from Kato (2002a) is in the future population data used in the simulation. In Kato (2002a) the low variant future population data estimated in 1997 was used. In this paper the latest version of the medium variant future population data estimated in 2002, which was not available in Kato (2002a), is used. The low variant estimation in the version of 1997 estimation was most predictable, and the medium variant estimation in the latest version estimated in 2002 is the closest to the most predictable estimation in 1997. Thus, in this paper the medium variant estimation in the latest version by the National Institute of Population and Social Security Research is used in the simulation analysis.

3 The Model

In an economy, where time is assumed to be discrete every year, there are three types of agents, households, firms, and a government. The behaviour of each agent is described as follows:

Households:

Each generation is assumed to have the same income, mortality rate, and utility function. It is also assumed that each generation appears in the economy as a decision making unit at the age of 21 and live to a maximum of 100 with a certain probability of death for every period. When $q_{j+1,j}$ is the conditional probability that a household of age $j+20$ survives to age $j+21$, the probability of a household of age 21 surviving until $s+21$ can be expressed as

$$S_s = \prod_{j=1}^{s-1} q_{j+1,j},$$

where $q_{j+1,j}$ is calculated from the actual data estimated by the National Institute of Population and Social Security Research in 2002. Assuming that each household makes lifetime decisions about the allocation of wealth between consumption and savings in order to maximise its expected utility, the expected utility at age $s+20$ would be

$$U = \sum_{s=1}^{80} S_s (1+\delta)^{-(s-1)} \frac{C_s^{1-\frac{1}{\gamma}}}{1-\frac{1}{\gamma}}, \tag{1}$$

where C_s represents consumption at age $s+20$, δ the discount rate, and γ the elasticity of intertemporal substitution. As expressed in (1), it is assumed that there are no bequest motives for simplicity.[5]

It is assumed that each household at age $s+20$ has the budget constraint such that

$$\begin{aligned} A_{s+1} &= [1+(1-\tau_r(t))\, r(t)]\, A_s + (1-\tau_y(t)-\tau_p(t))\, w(t)\, e_s \\ &\quad + b_s + a_s - (1+\tau_c(t))\, C_s, \end{aligned} \tag{2}$$

where A_s represents the amount of assets held by each household at the beginning of age $s+20$, $r(t)$ is the interest rate at period t, e_s is the efficiency unit of labor which depends on age, and w is the wage rate per efficiency unit of labor.. For the sake of brevity, the labor supply is assumed to be inelastic and the labor supply after retirement is assumed to be zero. For the estimation of the efficiency unit of labor e_s, the following equation has been estimated:

$$e = a_0 + a_1 A + a_2 A^2 + a_3 L + a_4 L^2,$$

where A represents age, L the length of employment, and e the wage rate per hour, respectively. The above equation has been estimated under the assumption that

[5] This assumption is only for simplicity. However, as has kindly been suggested by Makoto Saito, this drawback should be improved if bequest motives for savings in Japan are strong.

workers do not change their jobs during their working periods.[6]

All tax systems are based on proportional taxation, with τ_y representing the wage income tax rate, τ_r the interest income tax rate, τ_c the consumption tax rate, and τ_p the contribution to the public pension scheme. In order to reflect the actual aspect of the existing public pension scheme in Japan, 1/3 of the total amount of the public pension benefits is assumed to be financed by taxes. a_s is the expected amount of post-taxed bequests to be inherited. It is assumed that there is no private pension market. For simplicity bequests are assumed to be inherited at age 50.[7] b_s is the amount of public pension benefits, which is assumed such that

$$\begin{aligned} b_s &= \phi H \quad (s \geq RP) \\ b_s &= 0 \qquad (s < RP), \end{aligned}$$

$$H = \frac{1}{IR} \sum_{s=1}^{IR} w(t)\, e_s,$$

where ϕ and H denote the replacement ratio and the average annual remuneration, respectively. $RP+20$ and $IR+20$ denote the age at which households start to receive public pension benefits and the retirement age, respectively. Since the actual public pension system in Japan is a double indexation system, the above assumptions are only for simplicity.

Furthermore, the following two constraints are incorporated in addition to the conventional budget constraint. The first constraint is one the consumption level such that

$$C_s \geq C_{MIN}, \tag{3}$$

[6]This implies that it might have an upward bias. However, the author does not believe that this bias would be crucial for the aim of this paper.

By using the data from "The Investigation of the Wage Structure (Chingin Kozo Kiso Chosa) in 1994," the above variables have been estimated as

a_0	a_1	a_2	a_3	a_4
-0.1537	0.05539	-0.0007595	0.1045	-0.001901
(-0.5363)	(2.865)	(-4.019)	(4.823)	(-3.243)

[7]Several patterns of the timing when bequests are inherited have been examined in Atoda and Kato (1993).

where C_{MIN} denotes the minimum consumption level. The other constraint is the households' liquidity constraint. Considering the inaccuracy of lifetime in the model, the households are apt to see their public pension benefits, which they will receive from the age 65, as security and produce a high level of consumption when they are young, since the weight placed on consumption at old age is extremely reduce due to their uncertainty of their lifetimes, resulting in a very small amount of consumption when they are old. However, in reality the public pension benefits cannot actually offer security. Given that the assets at the end of each previous period are negative, a liquidity constraint is imposed on consumption at the present period in this way:

$$\begin{aligned} C_s &\leq [1+(1-\tau_r(t))\,r(t)]\,A_s+(1-\tau_y(t)-\tau_p(t))\,w(t)\,e_s+b_s+a_s \\ &\equiv DY_s. \end{aligned} \tag{4}$$

Now, suppose that each household maximises its utility under these constraints, and the maximization of (1) subject to (2), (3), and (4) yields (see Appendix for the detailed deduction)

$$C_s=\left(ANC_s\times C_1^{-\frac{1}{\gamma}}+AOB_s\right)^{-\gamma}, \tag{5}$$

where

$$\begin{aligned} ANC_s &= \frac{ANB(t)\,S_1\,(1+\delta)^{(s-1)}}{S_s}, \\ ANB(t) &= \frac{PC(t)}{PC(1)\prod_{t=1}^{80}ARA(t)}, \\ PC(t) &= 1+\tau_c(t), \\ ARA(t) &= 1+(1-\tau_r(t))\,r(t), \end{aligned}$$

and $PC(1)$ expresses $PC(t)$ of households at age 21. AOB_s is given by:

$$AOB_s=\frac{(1+\delta)^{(s-1)}}{S_s}\left\{\begin{array}{c} ANB(t)\left[\begin{array}{c}\phi_{11}-\phi_{21}- \\ PC(1)\sum_{s=2}^{80}\phi_{2s}DY_s\left(\prod_{t=1}^{s-1}ARA(t)\right)\end{array}\right] \\ +\phi_{2s}-\phi_{1s}\end{array}\right\}.$$

From (5), the optimal consumption behaviour of all ages can be derived if the initial consumption C_1 is specified, and the savings level can be calculated from (2) and (5).

Firms:

A main difference from Kato (2000, 2002b) is in the assumption of a production function. In this paper it is assumed that the public capital stock affects the private sector production as follows:

$$Y(t) = \Psi(t) K(t)^{\alpha} L(t)^{1-\alpha} G(t)^{\beta}, \tag{6}$$

where $K(t)$ represents the private capital, $L(t)$ the labor supply measured by the efficiency unit, and $G(t)$ the public capital stock, respectively. Note the difference between age, generation, and period. Denoting the generation by I, the age s, and the period t, they are related to each other such that $t = I + s - 1$.

$\Psi(t)$ denotes the scale parameter, which is also interpreted as the measure of technological progress. As assumed in (6), the total output is distributed to the private capital and the labor, and the complicated consideration of the return to the government is excluded. The value of β is given by the latest estimation by Yoshino and Nakajima (1999) in order to examine the scale of the effect of public capital on output in the transition to an aging Japan.

From the profit maximization of firms subject to (6), the first-order condition is derived to be:

$$\frac{w(t)}{r(t)} = \frac{1-\alpha}{\alpha}\left(\frac{K(t)}{L(t)}\right).$$

The property of a constant-return-to-scale production function with respect to the labor and the private capital yields

$$Y(t) = w(t) L(t) + r(t) K(t).$$

Government:

Suppose that the government consists of a narrower government sector and a public pension sector. A narrower government sector is assumed to spend revenue on general government expenditure. The narrower government sector consists of central as well as local governments expenditure, transfers and the expenditure on public investment. A 1/3 of the total amount of the public pension benefits is assumed to be transferred from the account of the narrower government sector to the account of the public pension sector. The budget of the narrower government sector is assumed to be financed by collecting taxes as well as issuing government bonds. The budget constraint on the narrower government sector at time t is given by:

$$D(t+1) - D(t) = GE(t) + r(t) D(t) + Pen(t) - R(t),$$

where $D(t)$, $R(t)$, and $GE(t)$ denote the amount of outstanding government debts, total tax revenue and general government expenditure at time t, respectively. $Pen(t)$ is the amount of the transfer from the narrower government sector to the public pension sector. The budget constraint on the public pension sector is given by:

$$F(t+1) - F(t) = r(t) F(t) + Pen(t) + P(t) - B(t),$$

where $F(t)$, $B(t)$ and $P(t)$ denote the amount of the public pension fund, total public pension benefits, and the total amount of the contribution to the public pension scheme, respectively. $R(t)$, $P(t)$ and $B(t)$ are given by

$$\begin{aligned} R(t) &= \tau_y(t) w(t) L(t) + \tau_r(t) r(t) AS(t) + \tau_c(t) AC(t) + \tau_h(t) BQ(t), \\ P(t) &= \tau_p(t) w(t) L(t), \\ B(t) &= \sum_{s=45}^{80} S_s N_s b_s, \end{aligned}$$

where τ_h and N_s denote the inheritance tax rate and the sum of s-year-old generations at time t, respectively. $AS(t)$, $AC(t)$ and $BQ(t)$ denote the total amount of savings, consumption and bequests inherited by the generation of age 50 in the economy at time t, respectively, and given by

$$\begin{aligned} AS(t) &= \sum_{s=1}^{80} S_s N_s A_s, \\ AC(t) &= \sum_{s=1}^{80} S_s N_s C_s, \\ BQ &= \sum_{s=1}^{80} (1 - S_s) N_s A_s. \end{aligned}$$

Market Equilibrium:

A equilibrium condition in the capital market is given by

$$AS(t) + F(t) = K(t) + D(t),$$

and in the goods market it is

$$Y(t) = AC(t) + K(t+1) - K(t) + GE(t).$$

4 Assumptions in the Simulation

4.1 Structure and Data

In order to examine the effects of changes in the demographic structure caused by the transition to an aging population, especially when applying the simulated method, it is most natural to use population data which are as realistic as possible. Using the latest actual population data estimated in 2002 by the National Institute of Population and Social Security Research, this paper has succeeded in reproducing these data exactly by applying the model constructed in Section 3. The demographic structure in this model has been generated by the following procedure.

4.1.1 Population Structure

All generations born before the generation of age 100 in 1990 (the generation born in 1890) are assumed to have the same birth and mortality rates as the generation of age 100 in 1990, so that the demographic structure of all generations born before 1890 is identical. It is also assumed that the population distribution will continue to be the same for each period from year 2100. Based on these assumptions, the actual future population data estimated in 2002 by National Institute of Population and Social Security Research have been used for the periods from year 2001 to 2100 and the actual population data in "Population Census of Japan (Kokusei-chosa)" for the periods before 2001.

For the period prior to 2001, whenever the actual data from the Population Census of Japan (Kokusei-chosa), which is held every five years, was not available, actual population data from the "Simple Static Life Table" (from the Japanese Ministry of Health and Welfare) were used. The estimated number of people at the age of 100 for the periods from 2001 to 2100 has been calculated by using the data on survival probabilities based on sex and age from the estimation made in 2002 by the National Institute of Population and Social Security Research. Such assumptions for the demographic structure were made due to the fact that the latest actual data available were those of 2000 and the estimation made in 2002 by National Institute of Population and Social Security Research only covers the periods from 2001 to 2100. The following point regarding the future population data should also be noted: In this paper the medium variant estimation has been used. This is because the low variant future population data in the previous version estimated in 1997 was most predictable and the medium variant estimation in the latest version estimated in 2002 is the closest to the most predictable low variant estimation in 1997. Thus, in this paper the medium variant estimation in the latest version by the National Institute of Population and Social Security Research has been used in the simulation analysis, since nothing is more natural in a simulation analysis than using the latest available data which is as realistic as possible.

In Table 2 the total population, the population between age 15 and 64, and the population of age 65 and over are shown[8]. The aging rate, which is defined as the ratio of the population of age 65 and over to the total population, is also shown in Table 2.

All parameters in this paper have been set so that the economic variables obtained from the actual Japanese data of 1997, such as the ratios of certain tax revenues to the total tax revenues, could be reproduced as exactly as possible. In other words, the induced estimation data of 1997 from the simulation analysis has been set as close as possible to the real Japanese data of 1997.

[8] The number of labor force is usually defined as the number of the employed and the unemployed of age 15 and over, and thus the population between age 15 and 64 is exactly not the same as the number of labor force. However, since the number of labor force in terms of the future population cannot be obtained, the population between age 15 and 64 of future generations can correspond to the number of labor force in the future. The population of age 65 and over shown in Appendix 2 is the number of recipients of the public pension scheme.

4.1.2 Outstanding Government debts and Public Pension Fund

The actual data of outstanding governments debts has been used until 1999, and the actual data of the public pension fund has been used until 1998. It is assumed that the public pension scheme started in 1956. The data consists of central government debts and local governments debts[9]. The actual GDP data has also been used until 1999. Since the main purpose of this paper is to explore the effect of future government deficits, the future value of the pubic pension fund-GDP ratio is assumed to be the same in all scenarios, as shown in Figure 1. It has been assumed that the future ratio of the public pension fund to GDP converges to the same value in all cases in a steady state under the assumption that the growth rate of the future ratio decreases through time until the growth rate becomes zero. The shortage of money spent in a public pension sector in each scenario is assumed to be financed all by an increase in the contribution rate τ_p. The replacement ratio in the public pension scheme is assumed to be 56% in all scenarios. The debt-GDP ratio and the public pension fund-GDP ratio prior to 1998 are actual ratios in this paper. Note that the actual values of the debt-GDP ratios in this paper are defined based on the actual outstanding levels of central and local governments debts, and thus they are not the same as the OECD values, where outstanding local government debts are not included.

Regarding the future debt-GDP ratio, the following three cases have been considered in this paper: The ratio of outstanding government debts to GDP (the D-G ratio) converges to a 120 % level in Case 1, a 150 % level in Case 2, a 90 % level in Case 3, respectively. The detailed values are given in Table 3. Note that the future values are also defined based on the level of outstanding central and local governments debts.

Narrowed or widened government deficits are always followed by an increase or a decrease in tax rates. Thus, when the effects of future government deficit policies are explored, a tax associated with future government deficit policies must be specified.

[9] The actual data of outstanding central government debts has been obtained from Budget Statistics (Zaisei Tokei) and that of outstanding local governments debts from Annual Report on Local Governments Bonds (Chihosai Tokei Nenpo).

In this paper a consumption tax has been used in each case[10]. It has also been assumed that a policy change occurs in 2003: Until 2002 the consumption tax rate is fixed and the wage tax rate is endogenously calculated in each scenario. The fixed consumption tax rates until 2002 have been given, taking into account the actual aspect of consumption taxation in Japan so that they have been set at 2 % before 1989, 5 % from 1990 to 1994, and 7 % from 1995 to 2002. After 2003 the consumption tax rate is endogenously obtained under the assumption that the wage tax rate remains at the level of 2002.

<**Case 1: 120 % D-G Ratio**>

The growth rate of the D-G ratio decreases until the D-G ratio converges to a 120 % level in a steady state. The shortage of money spent in a narrower government sector is assumed to be financed by a consumption tax after 2003. This case corresponds to a current debate that maintaining the D-G ratio at a 120 % level would be most reasonable.

<**Case 2: 150 % D-G Ratio**>

A steady state level of the D-G ratio is assumed to converge to a 150 % level. The shortage of money spent in a narrower government sector is assumed to be financed by a consumption tax after 2003. This case corresponds to the most possible situation the Japanese government is currently facing.

<**Case 3: 90 % D-G Ratio**>

A steady state level of the D-G ratio is assumed to converge to a 90 % level, which is lower than the current level (year 1999). The shortage of money spent in a narrower government sector is assumed to be financed by a consumption tax after 2003. This case takes into account a rapid increase in the growth rate of the D-G ratio in the past 3 years. This case corresponds to another debate that the Japanese government should decrease the amount of public investment to reduce future government deficits.

[10]Kato (2000, 2001) considered the cases with a wage tax as well.

4.1.3 General Government Expenditure

General government expenditure has been assumed to consist of central and local governments consumption, public investment and transfers. The transfer to a public pension sector is not included in this category. The actual data until 1999 has been used in this paper. It has been assumed that in all scenarios governments consumption and transfers partly grow at the same rate as the growth rate of an aging population. The growth rates have been given based on the following assumptions: The average ratio of transfers to the elderly to the total transfers through an account, which is specific to the elderly, in the public health insurance scheme in the past 10 years is 33.4 %. Thus, it has been assumed in this paper that a 33.4 % of governments consumption and transfers grows at the same rate as an aging population in the future. The detailed values are presented in Table 4.

4.1.4 Public Investment

Public investment in the future has been assumed to depend on the future government debt policy, since a certain amount of pubic investment has been financed by issuing construction bonds in the past. In the last fifteen years from 1984 to 1998, the ratio of public investment to outstanding government debts is quite stable around 12.75 %. In this paper it has been assumed that the ratio does not change in the future. Being based on this assumption, the future values of public investment are presented in Table 5, depending on different values of future government debts in each scenario. Case 1 corresponds to the case that pubic investment converges to the past average level, Case 2 to the highest level in the past 15 years, and Case 3 to the lowest level in the past 15 years in a steady state.

4.1.5 Public Capital

Economic Planning Agency of Japan (1998) estimated the stock levels of several types of public capital in Japan. Since public capital is assumed to affect the private sector only through the private production in this paper, the past data of a certain type of public capital has been used in this paper. According to the conventional definition of public capital which affects the private production, the public capital stocks of roads, ports, airports, and water for industrial use have been used to affect the private production. Using the estimated data of these four public capital stocks in Economic Planning Agency of Japan (1998), the depreciation rate of the future public capital stock was calculated at 4.48 %.

In Table 6, until 1993 the actual data of the ratio of productive public capital to GDP is presented. This actual data can be obtained in the estimation of Economic Planning Agency. Regarding the data from 1994 to 1999, the actual SNA and outstanding government debts data were used to calculate the values of the ratio of productive public capital to GDP, taking into account the stable past trend of the relationship between relevant variables such as public investment into productive public capital. In this calculation, the depreciation rate of public capital at 4.48 % was applied.

After 2000, the future ratio of productive public capital to GDP has been given depending on the level of future government deficits in each scenario, since the past actual public investment was mainly financed by issuing government bonds. The amount of public investment into productive public capital out of the total amount of public investment, which was calculated from SNA and Economic Planning Agency of Japan (1998), in the last fifteen years from 1979 to 1993 is quite stable around 46.93 %, and it has been assumed that this trend also continues in the future. Thus, the future stock levels of productive public capital can be calculated, if the amount of future public investment is given in each scenario. It has also been assumed that the ratio of productive public capital to GDP cannot be lower than a 10 % level in a steady state. Note that the future values in Table 6 are net values, which can be obtained by subtracting the depreciation from public investment. Thus, the future ratios of productive capital to GDP continue to decrease in a steady state even though the ratios of public investment to GDP are kept constant in a steady state.

4.2 Specification of Parameters

All parameters have been set so that the calculated values from the model could be reproduced as exactly as possible. The Calculated values given in Table 1 have been obtained in a benchmark, Case 1. The conventional definition of the ratio of indirect tax revenue to total tax revenue is based on the central government tax revenue, and thus the definition in this paper is not the same as the conventional one. [11]

5 Simulation Results

The effects of the future government deficits are examined by comparing each case. In Case 1, the debt-GDP ratio (the D-G ratio) converges to a 120 % level in a steady state. Case 1 corresponds to a current debate that maintaining the D-G ratio at a 120 % level would be most reasonable. In Case 2, the D-G ratio is assumed to converge to a 150 % level. Case 2 corresponds to the most possible situation that the Japanese government is currently facing. In Case 3, the D-G ratio is assumed to converge to a 90 % level. This case takes into account a rapid increase in the growth rate of the D-G ratio in the past 3 years. Case 3 corresponds to another debate that the Japanese government should decrease the amount of public investment to reduce future government deficits. Thus, in Case 3, a certain amount of a decrease in public capital is followed by the decrease in the future government deficits.

One of the main results of this paper is that the highest income, thus the highest economic growth, is achieved when the future government deficits are the highest (Case 2). However, in Case 2, since a drastic increase in a consumption tax rate has to be followed in the future to finance the huge amount of interest payments, disposable income is necessarily not the highest, and such a policy to achieve the highest economic growth with the highest government deficits is necessarily not most preferable for future generations. Furthermore, a policy to decrease public invest-

[11] According to the translation by Economic Planning Agency, Kokumin Hutanritsu, Sozei Hutanritsu, and Shakaihosyo Hutanritsu are translated into the ratio of public to national income, the tax burden ratio, and the social security contribution ratio in this paper, respectively.

ment associated with a future cut in government deficits (Case 3) achieves the lowest economic growth. However, such a policy is preferred by almost all generations, since the policy guarantees the highest disposable income of almost all generations. Thus, even though a cut in the future deficits must be followed by a decrease in public investment, thus a decrease in the future public capital, such a policy is most preferable for almost all generations. By comparing each case, the effects of future government deficits both on income and utility are presented in detail separately.

5.1 On Income and Interest Rates: Figure 2-1, and 2-2

As shown in Figure 2-1, per capita income declines after the late 2010's in all cases. This is because technological progress is assumed to be zero and the forecasted labor supply decreases. The assumption of zero technical progress will be examined in Section 6-1. A decrease in the labor supply comes not only from an aging population but also from a decrease in the total population estimated by the National Institute of Population and Social Security Research in 2002. A surprising result is that after the peak of an aging population, income in Case 2, where the government debt-GDP ratio (the D-G ratio) converges to the highest level, is the highest in all cases. Since in Case 2 the level of outstanding government debts in a steady state is the highest, the resource for private capital is expected to be the lowest, and this result is not intuitive. However, this result can be interpreted as follows: As it will be discussed in Section 5-3, the consumption tax rate in Case 2 is the highest due to interest payments incurred from outstanding government debts, and thus the tax burden ratio in Case 2 is also the highest. Since a consumption tax is imposed on consumption even when an individual becomes old, an increase in the consumption tax rate stimulates savings. This aspect of an increase in the consumption tax rate induces an increase in the supply in the capital market, and results in higher accumulation of private capital. In Case 2, this positive effect is large enough to offset a negative effect of the large scale of future outstanding government debts.

The future path of the interest rate determines the future level of marginal productivity of private capital, and the stock level of private capital. The path also determines the interest payment of the government, and a magnitude of intertemporal substitution of consumption. Figure 2-2 shows future interest rates in three different scenarios. As shown in Figure 2-2, the lowest (the highest) interest rate in a steady state can be achieved when the government deficits are the lowest (the highest). In Case 3 (the 90 % D-G ratio), the interest rate converges to 2.15 % in a steady state, and in Case 2 (the 150 % D-G ratio) it converges to 2.44 %. This implies that the higher are the outstanding government debts the less the private capital stock is. When the amount of the outstanding government debts are higher, public investment, thus the amount of the productive public capital stock, is also higher. An increase in government deficits reduces the ratio of the private capital stock to the total capital stock, and this implies that private capital is more crowd out when the outstanding government debts are higher.

Furthermore, it is not straightforward to conclude that keeping public investment at a higher level followed by higher outstanding government debts is always preferable, since higher consumption tax rates have to be followed in order to finance the interest payment incurred by the higher amount of outstanding government debts. If the consumption tax rate is too high to cancel out the positive effect of the high debt policy to increase income, then disposable income would not be higher when the outstanding government debts are higher. Thus, the deficit policy should be evaluated by the comparison in lifetime utility of different generations.

5.2 On Lifetime Utility: Figure 2-3

Although the policy to keep higher government deficits in the future achieves higher income, the policy should intertemporally be evaluated based on lifetime utility of different generations. In this paper, all of the cases have been evaluated by comparing their respective levels of utility. Setting different generations as I and the index measuring the utility level as EV, the definition of the utility level index of each generation is given by

$$EV\left(I\right)=\frac{\mu\left(p^0;p^1,y^1\right)}{\mu\left(p^0;p^0,y^0\right)},$$

where $\mu(\cdot)$ represents the money metric indirect utility function which is defined as

$$\mu\left(p^0; p^1, y^1\right) \equiv e\left(p^0, v\left(p^1, y^1\right)\right),$$

where $e(\cdot)$ and $v(\cdot)$ denote the expenditure function and the indirect utility function, respectively. p and y denote a price vector and income, respectively, and the superscripts 0 and 1 imply the circumstances under a benchmark policy and those under each proposed policy, respectively. A benchmark case is Case 1 in this paper. Thus, p^0 and y^0 are the price vector and income which each generation faces in Case 1. The price vector p^0 consists of the interest rate, the wage rate, and tax rates in Case 1. Thus, if $EV(I)$ is greater (smaller) than 1, it implies that a proposed policy is preferable (not preferable) by generation I to a benchmark policy. Note that a benchmark policy is to maintain a 120 % level of the D-G ratio in a steady sate. Note also that $EV(I)$ measures the evaluation of different policies by each generation, but not the evaluation of a policy by different generations[12].

Figure 2-3 shows utility of each generation in Case 2 and Case 3 in comparison with Case 1. Since $EV(I)$ is measured in comparison with Case 1, $EV(I)$ is always unity in all generations in Case 1. Note that the horizontal axis is measured in the year when each generation was born. Compared to a 120 % level of the D-G ratio in a steady state, a 90 % level of the D-G ratio is preferred by almost all generations

[12] Suppose that in Case 2

$$\begin{aligned} EV_2(I_1) &= 1.1, \\ EV_2(I_2) &= 1.3, \end{aligned}$$

and in Case 3

$$\begin{aligned} EV_3(I_1) &= 1.2, \\ EV_3(I_2) &= 1.5, \end{aligned}$$

are given to generation I_1 and I_2, respectively. This implies that both generation I_1 and I_2 prefer Case 2 and Case 3 to Case 1, and both generations relatively prefer Case 3 to Case 2. However, it does not imply that I_2 obtains more benefit than I_1 in Case 2 or Case 3.

except far future generations, but a 150 % level of the D-G ratio is not preferred by any generations born before year 2036. The magnitude of this disadvantage of a debt policy to maintain a 150 % level of the debt-GDP ratio becomes stronger specifically among the generations born after the late 1950's. As has been pointed out in the previous sections, a debt policy to maintain the highest level (150 %) of the debt-GDP ratio achieves the highest income, and the policy have to be followed by the highest successive consumption tax rate in the future. This implies that a debt policy with the highest debt-GDP ratio achieves the highest pre-taxed income, but the lowest post-taxed income. Thus, compared in lifetime utility, this policy is not preferred by the generations of which disposable income is smaller than that in Case 1.

Note also that a debt policy to maintain a 150 % level of the debt-GDP ratio is more preferable to a debt policy with a 120 % level of the debt-GDP ratio by the generations born after 2036. This can be interpreted as follows: As shown in Figure 2-1, per capita income with a 150 % level of the debt-GDP ratio is greater than that with a 120 % level, and the more time passes, the greater becomes the difference in per capita income. This is because a higher consumption tax rate stimulates savings, thus resulting in more private capital accumulation. This increase in private capital accumulation induces an increase in income of future generations. Among the generations born after 2036, this positive effect offsets the negative effect of increasing a consumption tax rate to finance interest payments incurred, and the amount of post taxed income in lifetime with a 150 % level of the debt-GDP ratio is greater than that with a 120 % level. As shown in Figure 2-1, the positive effect of increasing the consumption tax rate to stimulate savings is the smallest in Case 3 with a 90 % level of the debt-GDP ratio in the future, and the more time passes, the greater the difference in the positive effect between a debt policy with a 120 % level (Case 1) and that with a 90 % level (Case 3). Thus, the more time passes, the weaker the magnitude of the advantage of a debt policy to maintain a low level of the debt-GDP ratio in the future.

Case 3, which corresponds to a debt policy to cut the amount of public investment in relatively earlier periods in order to decrease burdens on future generations caused by higher government deficits, is preferred by almost all generations when all cases are compared in lifetime utility.

5.3 On the Consumption Tax Rates and Tax Burdens: Table 7 & 8

As has been pointed out in the previous section, maintaining a high level of government deficits in the future must be followed by a successive high consumption tax rate due to interest payments incurred from outstanding government debts. Furthermore, a consumption tax rate must increase when government deficits are reduced. Thus, the intertemporal path of a consumption tax rate depends on the intertemporal pattern of government deficits, and tax burdens on a particular generation also depends on the future government deficit policy.

Table 7 shows the future consumption tax rate in each case. In relatively earlier periods, the consumption tax rate in Case 3 with a 90% ratio of outstanding government debts to GDP is higher than those in other two cases. This is because in Case 3 a rapid decrease in the level of outstanding government debts in relatively earlier periods is followed by a high increase in the consumption tax rate. The consumption tax rate increases up to 18.57 % at a peak in year 2008. However, Case 3 achieves the lowest consumption tax rate in the future, since interest payments incurred from the relatively small amount of outstanding government debts are small in the future. On the other hand, in Case 2 a quite high consumption tax rate has to be maintained in the future to finance interest payments incurred from the huge amount of outstanding government debts. At a peak in year 2050, the consumption tax rate will have to increase up to 20.15 %. The values in detail are given in Table 7.

In Table 8, the tax burden ratio in each scenario is shown. The tax burden ratio is defined as the ratio of the total amount of taxes to GDP. As shown in Table 8, since year 2017, the tax burden ratio in Case 3 will be the lowest in all cases. In case 2, where the highest level of outstanding government debts is maintained at a 150% level, the tax burden ratio will increase up to a 37.85 % level. The detailed values are given in Table 8.

5.4 The Contribution Rates τ_p to the Public Pension Scheme, Social Security Burden Ratios, and Generational Accounting: Figure 2-4, Table 9 & Figure 2-5

Aso (1997 and 1998) pointed out that intergenerational redistribution in Japan would be caused mainly by an aging population through the existing pay-as-you-go public pension scheme and also that government deficits would not affect the distribution among different generations. Figure 2-4 shows future contribution rates τ_p under the assumption that the existing scheme is not changed. As shown in Figure 2-4, there is no much difference in the rate in each case, and this paper supports Aso (1997 and 1998). In this simulation, contribution rates rapidly increase until a peak of an aging population in the late 2030's up to between a 27 % and a 29 % levels in all cases. After the peak of an aging population, the contribution rate increases up to 30.2 % in Case 2 (150 % D-G ratio), and 32.3% in Case 3 (90 % D-G ratio). This difference in the contribution rate among scenarios comes from the difference in income as shown in Figure 2-1.

Reflecting increases in the contribution rate in all cases, the social security burden ratio also increases. The social security burden ratio is defined as the ratio of the total amount of contribution to the scheme to GDP. Table 9 shows the future ratios. The social security burden ratio converges to a 20.8 % level in a steady state in Case 1, a 19.7 % level in Case 2, and a 22.2 % level in Case 3, respectively. The detailed ratios are given in Table 9.

The concept of the generational accounting originated by Auerbach et al (1998) is also important to discuss intergenerational redistribution through a public pension scheme[13]. Hatta and Oguchi (1999) recently estimated the huge amount of transfer from future generations to old generations through the existing pay-as-you-go public pension scheme, and they asserted that the public pension scheme should be switched to a fully-funded scheme. Figure 2-5 shows the estimated generational accounting based on the model presented in Section 4. Note that the horizontal axis is measured

[13] See also Takayama et al (1998).

in the year when each generation was born. Note also that the generational accounting in this paper is defined as the net value (the total benefits minus the total contribution in lifetime) under the assumption that the contribution is only changed to maintain the existing public pension scheme. As shown in Figure 2-5, the huge amount of transfers is given to old generations from future generations through the existing public pension scheme, and the more time passes the worse the situation. It is forecasted in this simulation that all generations born after 1947 will be worse off in all scenarios.

6 Some Other Results

6.1 The Effect of Technological Progress

It has been assumed so far that there is no technological progress. This is because results in the simulation heavily depend on the degree of technological progress. However, it is also true that Japan has grown with technological progress. In this section, it is explored how much the results obtained in the previous sections are changed by an introduction of technological progress. In order to highlight the effect of technological progress, a debt policy in benchmark (Case 1) is only examined depending on the difference in the degree of technological progress.

It has been assumed in the following simulation that technological progress starts in year 2003 for 40 years with a diminishing increase in technological progress from a certain level: a 0.5% increase in technological progress per year, a 1.0% increase, and a 1.5 % increase. In these three cases, even though a starting point in the growth rate of technological progress is different in each case, technological progress ends in year 2043 in all cases, and thus the growth rate of technological progress is zero after year 2043. Under this assumption, technological progress is assumed to be incorporated into the model by changing the scale parameter $\Psi(t)$, shown in Figure 3-1.

6.1.1 On Income

Figure 3-2 shows the effect of technological progress on per capita income measured in a relative increase with non-technological progress. The vertical axis measures a relative increase in percentage. An introduction of 0.5 % diminishing growth of technological progress for 40 years eventuates in a 8.4 % increase in per capita income in a steady state, and 1.0 % diminishing growth achieves a 18.3 % increase in per capita income. In the case of 1.5 % diminishing growth of technological progress generates a 30 % increase in per capita income compared to non-technological progress.

6.1.2 On Lifetime Utility

Figure 3-3 shows the effect of technological progress on lifetime utility measured in equivalent variations in comparison with the no-technological progress case. Thus, if the value of a generation is greater (smaller) than unity, then technological progress more (less) preferable by the generation.

As time passes, generations get better off due to technological progress. As shown in Figure 3-2, this is because income with more technological progress is higher, and an increase in income is larger as time passes.

There is another result that technological progress is not preferable by old generations, which is not intuitive, since technological progress should have a positive effect on all generations. This result can be interpreted as follows: The future income level with more technological progress is relatively higher than that with no-technological progress.. This implies that households who want to have smooth consumption in their lifetime save less when they can expect to have more technological progress. A decrease in savings reduces supply in the capital market, and the resources for production in the private sector decrease. Thus, technological progress partly operates to reduce income through the optimal behavior of households when households expect higher income due to technological progress. If this effect of technological progress to reduce savings is stronger than a positive effect on production to induce higher income, then it is possible to decrease lifetime utility. Since the positive effect on production is accumulated through time, the negative effect of technological progress on income through the capital market relatively becomes smaller as time passes.

6.1.3 On the Consumption Tax Rate

Table 10 shows the effect of technological progress on the consumption tax rate in the future. A 0 % increase in growth of technological progress corresponds to Case 1 in Section 5-3. In Case 1, a peak in the consumption tax rate is obtained in year 2018. At the peak, the consumption tax rate has to increase up to 16.3 % in 0 % technological progress. However, it increases up to 14.8 % in 0.5 % technological progress, 13.2 % in 1.0 % technological progress, and 11.6 % in 1.5 % technological progress, respectively. As shown in Table 10, the degree of an introduction of technological progress does matter when the amount of burdens on future generations is explored.

6.2 The Effect of Efficiency in Public Investment.

It has been argued in Japan that an expansion of public investment does not stimulate the Japanese economy efficiently in the short-run due to a decrease in the multiplier effect. As pointed out by Ihori and Kondo (1998), there is another role of public investment to affect the supply side in the long-run, and they argued that efficient public investment is crucial for stable economic growth in the long-run. If not only the short-run effect but also the long-run effect weaken, keeping a certain level of public investment in the future only leaves the huge amount of burdens on future generations. In this section, the effect of inefficiency in public investment in the future is explored by assuming that a certain amount of public investment does not contribute to production in the private sector, even though the future level of public investment does not change. In this paper, the effect of inefficiency in public investment is examined by changing the value of β, the elasticity of the stock of productive public capital with respect to the private production function. By setting $\beta = 0.248$, 0.124, and 0 in Case 1, the effect has been examined. $\beta = 0.248$, which is the latest value of β estimated by Yoshino and Nakajima (1999), corresponds to a fully efficient case in public investment (a 0 % inefficient case). $\beta = 0.186$, $\beta = 0.124$ and $\beta = 0$ correspond to a 75 % efficient case (a 25 % inefficient case), a half efficient case (a 50

% inefficient case), and a zero efficient case (a 100 % inefficient case), respectively[14]. It has also been assumed that until year 2002 public investment is fully efficient, and inefficiency in public investment occurs in year 2003. The inefficiency is assumed to persist after 2003. The following results have been obtained in Case 1.

6.2.1 On Production (Income)

Figure 4-1 shows the effect of inefficiency in public investment on income in comparison with a full efficient case ($\beta = 0.248$), under the assumption that the amount of public investment is the same in all cases. In a steady state, when there is 25 % inefficiency (a 75 % efficient case) in public investment, a 6.5 % decrease in income is induced. 50 % inefficiency in public investment results in about 15 % decrease in income in a steady state, and income in a steady state decreases at 30 % if public investment does not contribute to production in the private sector at all.

6.2.2 On the Consumption Tax Rate

Inefficiency in public investment also affects the future consumption tax rate. Table 11 shows how much the consumption tax rate is affected by inefficiency in public investment. The more time passes, the greater becomes the negative effect of inefficiency in public investment on the consumption tax rate. In a steady state, the consumption tax rate increases at about 1.95 % when there is 25 % inefficiency in public investment, and at 4.98 % when there is 50 % inefficiency. If public investment does not contribute to the private sector production, then the consumption tax rate becomes over 26 %, and there is 11.66 % difference in the consumption tax rate in a steady state between a full efficient case and a zero efficient case.

6.2.3 On Lifetime Utility

Figure 4-2 shows the effect of inefficiency in public investment on utility measured in equivalent variations in comparison with a full efficient case. Thus, if the value of

[14] Although the production function is different in this paper, a zero efficient case corresponds to Kato (2000, 2002b), where a CES production function was assumed.

a generation is greater (smaller) than unity, then inefficiency in public investment is more (less) preferable by the generation.

As time passes, generations get worse off due to inefficiency in public investment, and the number of future generations which are worse off increases as the degree of inefficiency increases. When there is 25 % inefficiency, all generations born after year 1977 are worse off, and when there is 100 % inefficiency in public investment generations born after 1973 are worse off. The more inefficiency increases, the greater is the effect of inefficiency on utility of all generations. Since the cost paid by households through taxation to maintain a certain level of public investment does not change, greater inefficiency in public investment gives future generations more burdens through the negative effect on the accumulation of pubic capital.

Furthermore, inefficiency is more preferable by old generations. This result is not intuitive, since inefficiency should have a negative effect on all generations. However, this result can be interpreted as follows. Inefficiency in public investment reduces income in the future. This reduction in the future income is not desirable for households who want to have smooth consumption in their lifetime, and they save more when they are relatively young in order to have smooth consumption. Their response is greater as the expected reduction in their income is greater. An increase in savings induces a shift of supply in the capital market, and the resources for production in the private sector increase. Thus, inefficiency operates to induce higher income when households expect the reduction of their income. If this positive effect of inefficiency to stimulate savings offsets the negative effect to reduce public capital, then inefficiency increases lifetime income. Since the latter negative effect is accumulated through time, it is more likely for old generations to prefer inefficiency in public investment.

7 Concluding Remarks

This paper has tries to examine the effects of government deficits, public capital and the public pension policy on the tax burden, capital accumulation and economic welfare in the transition to an aging Japan by applying a simulated method in the expanded life cycle general equilibrium growth model. This paper expanded Kato (2000, 2002b) by incorporating public capital into the model and re-examined the effects of the future Japanese government debt policy by presenting several scenarios.

The results obtained in this paper are summarised as follows: First of all, a cut in future public investment associated with a decrease in government deficits reduces income and production in the future. A future decrease in government deficits avoids an increase in a consumption tax to finance interest payments incurred from the huge amount of outstanding government debts in the future, but at the same time a relatively small increase in a consumption tax weaken a positive effect of consumption taxation to stimulate savings, thus resulting in production being smaller in the scenario to reduce future government deficits. However, if such a policy is evaluated in lifetime utility of all generations, then it is most preferable by all generations, because such a policy achieves the highest disposable income. Thus, even though a policy to reduce future government deficits have to be followed by the reduction in pubic investment, the government should reduce the government deficits.

Secondly, as pointed out by Aso (1997 and 1998), and Hatta and Oguchi (1999), intergenerational redistribution through the existing pay-as-you-go public pension scheme can be explained by an aging population in Japan. The critical generation which is worse off through the existing public pension scheme is nearly the same as that pointed out by Hatta and Oguchi (1999).

Thirdly, the degree of technological progress does matter for the analysis. An introduction of 0.5 % diminishing growth of technological progress for 40 years eventuates in a 8.5 % increase in per capita income in a steady state, and 1.0 % diminishing growth achieves a 18.2 % increase in per capita income. In the case of 1.5 % diminishing growth of technological progress generates a 30 % increase in per capita income compared to non-technological progress. The difference in technological progress affects all important policy variables such as tax rates and the burden ratio.

Finally, as time passes, generations get worse off due to inefficiency in public investment, and the number of future generations which are worse off increases as the degree of inefficiency increases. Inefficiency also reduces future income. In a steady state, when there is 25 % inefficiency in public investment a 6.5 % decrease in income is induced. 50 % inefficiency in public investment results in about 15 % decrease in income in a steady state, and income in a steady state decreases at 30 % if public investment does not contribute to production in the private sector at all.

Several results have been obtained in this paper, and the following points are especially important as policy implications: Higher economic growth is necessarily not more desirable, and only targeting high economic growth would mislead us as to the economic policy. The economic policy should be evaluated based on lifetime utility of different generations, and one of the current policy options that the government should reduce the public investment level in the future in order to decrease government deficits is most evaluated by all generations even though it would be politically difficult. Furthermore, when the government policy in Japan is evaluated in terms of intergenerational redistribution, it should also be compared in welfare. As has been pointed out, it seems that the existing pay-as-you-go public pension scheme in Japan is not actuarially fair, and thus there is significant distortion in generational accounting in terms of intergenerational transfer. Although the distortion through the scheme, which causes the huge amount of transfer from future generations to old generations, should obviously be eliminated, the fact that public capital in Japan has been accumulated by public investment in the past partly financed by taxes imposed on old generations should also be taken into account. The huge amount of outstanding government debts mainly caused by public investment is the result of the past Japanese government policy, and it is just a policy to postpone the financial burden. Thus, if the Japanese government policy is evaluated in terms of intergenerational redistribution, these complicated aspects should all be taken into account. This can only be possible by the consideration within a general equilibrium framework, which this paper has been based on under the assumption that the existing public pension scheme is maintained in the future. The result in this paper that an economic policy to cut the future public investment in order to reduce government deficits is most preferable even by future generations would give another interpretation of the intergenerational redistribution policy of the Japanese government.

Appendix

For the utility maximization problem over time, the Lagrange function is given such that:

$$\begin{aligned} L &= U + \sum_{s=1}^{80} \lambda_s \left\{ A_{s+1} - \left(\begin{array}{c} \left[1 + \left(1 - \tau_r(t)\right) r(t)\right] A_s \\ + \left(1 - \tau_y(t) - \tau_p(t)\right) w(t) e_s + b_s \\ + a_s - \left(1 + \tau_c(t)\right) C_s \end{array} \right) \right\} \\ &\quad + \sum_{s=1}^{80} \left\{ \phi_{2s} \left(DY_s - C_s \right) + \phi_{1s} \left(C_s - C_{MIN} \right) \right\}, \end{aligned}$$

and the first order conditions are

$$\begin{aligned} S_s (1+\delta)^{-(s-1)} C_s^{-\frac{1}{\gamma}} - \lambda_s PC(t) - \phi_{2s} + \phi_{1s} &= 0, \\ -\lambda_s + \lambda_{s+1} ARA(t) &= 0, \\ \phi_{2s} \left(DY_s - C_s \right) &= 0, \\ \phi_{1s} \left(C_s - C_{MIN} \right) &= 0, \end{aligned}$$

where

$$\begin{aligned} PC(t) &= 1 + \tau_c(t), \\ ARA(t) &= 1 + \left(1 - \tau_r(t)\right) r(t), \end{aligned}$$

and λ_s, ϕ_{1s} and ϕ_{2s} denote the Lagrange multipliers for (2), (3) and (4), respectively. The above first order conditions yield

$$C_s = \left(ANC_s \times C_1^{-\frac{1}{\gamma}} + AOB_s \right)^{-\gamma},$$

where

$$\begin{aligned} ANC_s &= \frac{ANB(t)\, S_1 (1+\delta)^{(s-1)}}{S_s}, \\ ANB(t) &= \frac{PC(t)}{PC(1) \prod_{t=1}^{80} ARA(t)}, \\ PC(t) &= 1 + \tau_c(t), \\ ARA(t) &= 1 + \left(1 - \tau_r(t)\right) r(t), \end{aligned}$$

and

$$AOB_s = \frac{(1+\delta)^{(s-1)}}{S_s} \left\{ \begin{array}{c} ANB(t) \left[\begin{array}{c} \phi_{11} - \phi_{21} - \\ PC(1) \sum_{s=2}^{80} \phi_{2s} DY_s \left(\prod_{t=1}^{s-1} ARA(t) \right) \end{array} \right] \\ + \phi_{2s} - \phi_{1s} \end{array} \right\}.$$

From (5), the optimal consumption behaviour of all ages can be derived if the initial consumption C_1 is specified, and the savings level can be calculated from (2) and (5). To derive C_1, (5) is substituted into the life cycle budget constraint such that

$$\begin{aligned} \sum \frac{PC(t) C_s}{\prod ARA(t)} &= \sum \frac{(1 - \tau_y(t) - \tau_p(t)) w(t) e_s}{\prod ARA(t)} \\ &+ \sum \frac{b_s}{\prod ARA(t)} + \sum \frac{a_s}{\prod ARA(t)}. \end{aligned}$$

Table 1

Values of 1997 (%)

	actual values	calculated values
tax burden ratio 1)	18.16	18.47
social security burden ratio 2)	10.66	11.46
ratio of public to national income 3)	28.82	29.93
contribution rate τ_p	17.95	18.05
inheritance tax ratio 4)	2.62	2.74
ratio of indirect tax revenue to total tax revenue 5)	22.64	23.96

1): total tax revenue/GDP

2): total social security contribution/GDP

3): 1)+2)

4): inheritance tax revenue/total tax revenue

5): total consumption tax revenue (central + local government)/total tax revenue

$\alpha = 0.2, \gamma = 0.45, \delta = -0.035, \Psi = 0.2, \beta = 0.248$[15]

[15] $\beta = 0.248$ is the value estimated in Yoshino and Nakajima (1999).

Table 2

Future Population
(On Medium Variant Estimation)

	Total Population	Between age 15 and 64	Age 65 and over	Aging Rate*
2000	126,917,773	86,379,791	22,032,569	17.36%
2005	127,694,274	84,589,587	25,377,823	19.87%
2010	127,445,846	81,664,841	28,707,090	22.52%
2015	126,217,403	77,296,408	32,723,625	25.93%
2020	124,040,343	74,452,584	34,492,736	27.81%
2025	121,034,281	72,324,999	34,624,095	28.61%
2030	117,433,337	69,576,040	34,623,952	29.48%
2035	113,412,787	65,890,711	34,955,253	30.82%
2040	109,113,615	60,989,925	36,106,985	33.09%
2045	104,671,101	57,108,438	36,107,326	34.50%
2050	100,233,531	53,889,136	35,502,869	35.42%
2055	95,811,711	51,317,543	34,227,686	35.72%
2060	91,264,627	48,992,827	32,449,380	35.56%

Aging Rate:age (65 and over)/(Total Population)

Table 3 (The D-G Ratios)

Future Values of the debt-GDP ratio

	Case 1 (120%)	Case 2 (150%)	Case 3 (90%)
1967	8%	8%	8%
1968	8%	8%	8%
1969	8%	8%	8%
1970	8%	8%	8%
1975	17%	17%	17%
1980	41%	41%	41%
1985	55%	55%	55%
1990	50%	50%	50%
1995	65%	65%	65%
2000	97%	97%	101%
2005	110%	114%	120%
2010	116%	127%	111%
2015	119%	135%	103%
2020	119%	141%	98%
2025	120%	144%	95%
2030	120%	146%	93%
2035	120%	148%	92%
2040	120%	149%	91%
2045	120%	149%	90%
2050	120%	150%	90%
2055	120%	150%	90%
2060	120%	150%	90%

The values until 1998 are actual values.

Table 4 The Ratio of Public Capital to GDP

	Case 1 (120%)	Case 2 (150%)	Case 3 (90%)
1956	51.65%	51.65%	51.65%
1957	47.05%	47.05%	47.05%
1958	46.66%	46.66%	46.66%
1959	42.87%	42.87%	42.87%
1960	38.74%	38.74%	38.74%
1965	39.10%	39.10%	39.10%
1970	34.07%	34.07%	34.07%
1975	29.42%	29.42%	29.42%
1980	27.64%	27.64%	27.64%
1985	30.05%	30.05%	30.05%
1990	30.84%	30.84%	30.84%
1995	38.16%	38.16%	38.16%
2000	43.24%	43.24%	43.33%
2005	43.75%	43.93%	44.68%
2010	44.02%	44.82%	44.79%
2015	43.76%	45.47%	43.48%
2020	42.99%	45.71%	41.46%
2025	41.84%	45.50%	39.14%
2030	40.45%	44.90%	36.75%
2035	38.92%	44.00%	34.43%
2040	37.33%	42.88%	32.24%
2045	35.74%	41.62%	30.21%
2050	34.19%	40.27%	28.36%
2055	32.70%	38.90%	26.70%
2060	31.29%	37.53%	25.21%

The values until 1993 are real values.

The values from 1994 to 1999 have been calculated from SNA.

The values from 2000 have been given based on each scenario..

Table 5

The Ratio of General Government Expenditure to GDP

	Case 1 (120%)	Case 2 (150%)	Case 3 (90%)
1970	18.06%	18.06%	18.06%
1975	22.54%	22.54%	22.54%
1980	23.26%	23.26%	23.26%
1985	20.34%	20.34%	20.34%
1990	19.46%	19.46%	19.46%
1995	23.40%	23.40%	23.40%
2000	25.56%	25.56%	25.85%
2005	27.19%	27.47%	27.87%
2010	28.32%	29.07%	27.93%
2015	29.42%	30.60%	28.35%
2020	30.00%	31.49%	28.52%
2025	30.22%	31.93%	28.51%
2030	30.46%	32.32%	28.59%
2035	30.84%	32.79%	28.87%
2040	31.52%	33.53%	29.49%
2045	31.94%	33.98%	29.86%
2050	32.17%	34.23%	30.08%
2055	32.20%	34.28%	30.12%
2060	32.10%	34.19%	30.01%

The values until 1999 are real values.

Table 6

The Ratio of Public Investment to GDP

	Case 1 (120%)	Case 2 (150%)	Case 3 (90%)
1970	8.18%	8.18%	8.18%
1975	9.16%	9.16%	9.16%
1980	9.52%	9.52%	9.52%
1985	6.60%	6.60%	6.60%
1990	6.51%	6.51%	6.51%
1995	8.81%	8.81%	8.81%
2000	6.79%	6.79%	7.08%
2005	7.74%	8.02%	8.42%
2010	8.15%	8.90%	7.76%
2015	8.31%	9.49%	7.24%
2020	8.38%	9.87%	6.91%
2025	8.41%	10.12%	6.69%
2030	8.42%	10.27%	6.55%
2035	8.42%	10.37%	6.45%
2040	8.42%	10.43%	6.39%
2045	8.42%	10.47%	6.35%
2050	8.42%	10.49%	6.34%
2055	8.42%	10.50%	6.34%
2060	8.42%	10.51%	6.34%

The values until 1999 are real values.

Table 7

Consumption Tax Rates

	Case 1 (120%)	Case 2 (150%)	Case 3 (90%)
2003	8.01%	7.76%	9.76%
2005	9.82%	9.48%	14.35%
2010	13.43%	13.88%	18.08%
2015	15.69%	17.51%	17.29%
2020	15.94%	18.89%	15.74%
2025	15.04%	18.59%	13.94%
2030	14.42%	18.35%	12.81%
2035	14.06%	18.21%	12.16%
2040	14.70%	19.16%	12.46%
2045	15.12%	19.79%	12.64%
2050	15.35%	20.15%	12.68%
2055	15.24%	20.06%	12.57%
2060	15.01%	19.80%	12.36%

Table 8

The Tax Burden Ratio

	Case 1 (120%)	Case 2 (150%)	Case 3 (90%)
2003	23.85%	23.23%	24.49%
2005	25.42%	24.71%	28.27%
2010	28.66%	28.51%	31.51%
2015	30.99%	31.84%	31.48%
2020	32.14%	33.94%	31.23%
2025	32.16%	34.56%	30.48%
2030	32.31%	35.14%	30.16%
2035	32.45%	35.53%	30.05%
2040	33.34%	36.66%	30.68%
2045	33.88%	37.36%	31.05%
2050	34.24%	37.83%	31.26%
2055	34.20%	37.82%	31.24%
2060	34.01%	37.63%	31.06%

Table 9

The Social Security Burden Ratio

	Case 1 (120%)	Case 2 (150%)	Case 3 (90%)
2003	11.30%	11.05%	11.53%
2005	11.11%	10.86%	11.32%
2010	11.15%	10.85%	11.32%
2015	11.98%	11.61%	12.22%
2020	13.94%	13.43%	14.32%
2025	15.71%	15.05%	16.26%
2030	17.17%	16.36%	17.90%
2035	18.16%	17.23%	19.05%
2040	18.65%	17.63%	19.68%
2045	19.09%	18.00%	20.24%
2050	19.62%	18.48%	20.87%
2055	20.09%	18.92%	21.40%
2060	20.52%	19.34%	21.87%

Table 10

Consumption Tax Rates

(The Effect of Technical Progress: Case 1 (120%))

	0% technological progress	0.5% technological progress
2003	8.01%	7.04%
2005	9.82%	8.71%
2010	13.43%	12.07%
2015	15.69%	14.18%
2020	15.94%	14.36%
2025	15.04%	13.35%
2030	14.42%	12.63%
2035	14.06%	12.13%
2040	14.70%	12.60%
2045	15.12%	12.87%
2050	15.35%	12.94%
2055	15.24%	12.69%
2060	15.01%	12.32%

Consumption Tax Rates

(The Effect of Technical Progress: Case 1 (120%))

	1% technological progress	1.5% technological progress
2003	6.16%	5.30%
2005	7.63%	6.58%
2010	10.71%	9.37%
2015	12.64%	11.13%
2020	12.76%	11.17%
2025	11.68%	10.02%
2030	10.87%	9.14%
2035	10.26%	8.46%
2040	10.62%	8.69%
2045	10.79%	8.74%
2050	10.74%	8.54%
2055	10.34%	8.01%
2060	9.86%	7.43%

Table 11

Consumption Tax Rates

(The Effect of Inefficiency: Case 1 (120%))

	0% inefficient	25% inefficient	50% inefficient	100% inefficient
2003	8.01%	8.02%	8.16%	8.42%
2005	9.82%	9.91%	10.17%	10.81%
2010	13.43%	13.66%	14.17%	15.74%
2015	15.69%	16.08%	16.84%	19.38%
2020	15.94%	16.52%	17.49%	20.97%
2025	15.04%	15.79%	16.97%	21.42%
2030	14.42%	15.32%	16.71%	21.91%
2035	14.06%	15.13%	16.74%	21.27%
2040	14.70%	15.94%	17.82%	22.77%
2045	15.12%	16.54%	18.71%	24.15%
2050	15.35%	16.96%	19.43%	25.35%
2055	15.24%	17.04%	19.80%	26.15%
2060	15.01%	16.96%	19.99%	26.67%

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Figure 1
The Ratio of Public Pension Fund to GDP

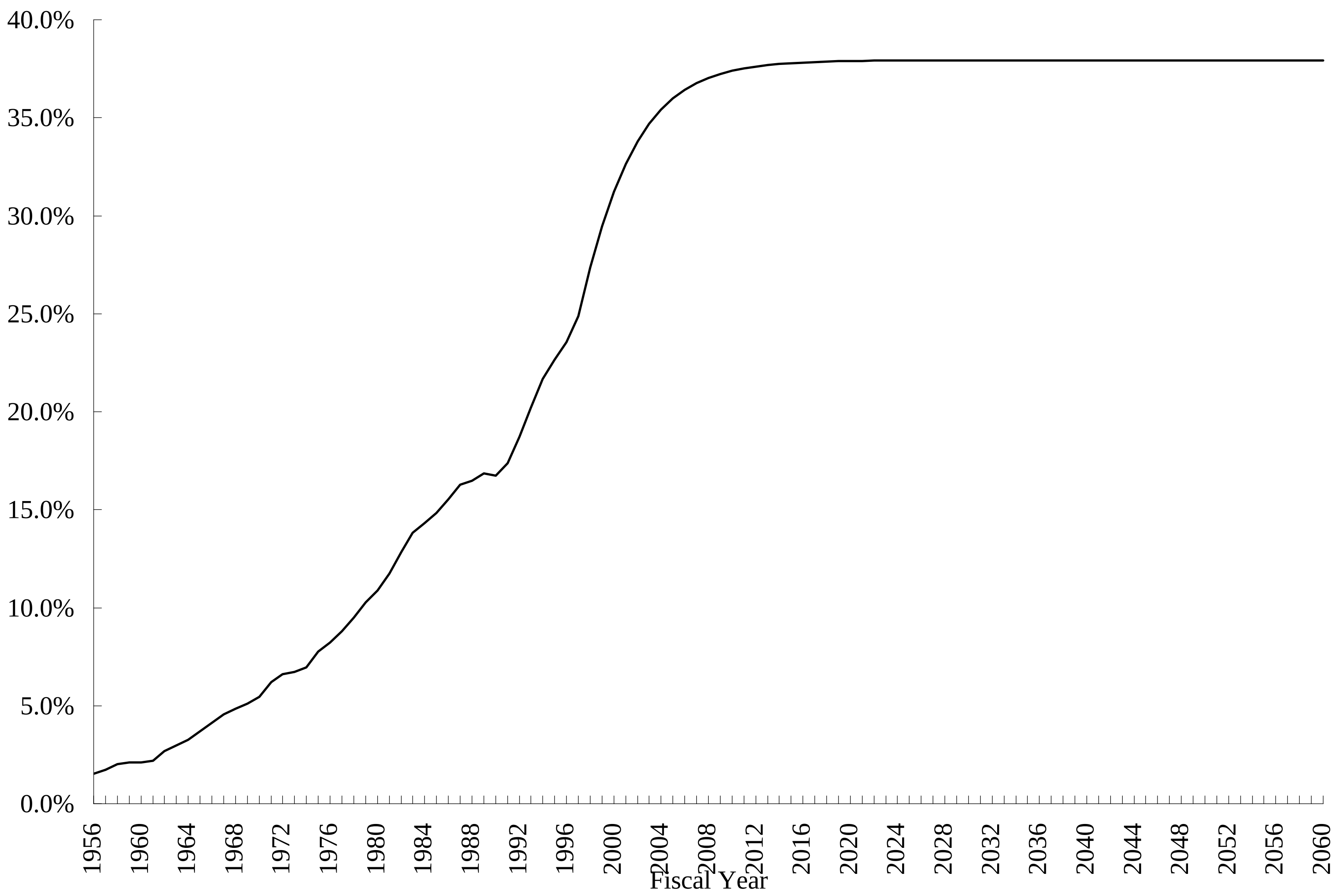


Figure 2-1
Per Capita Income

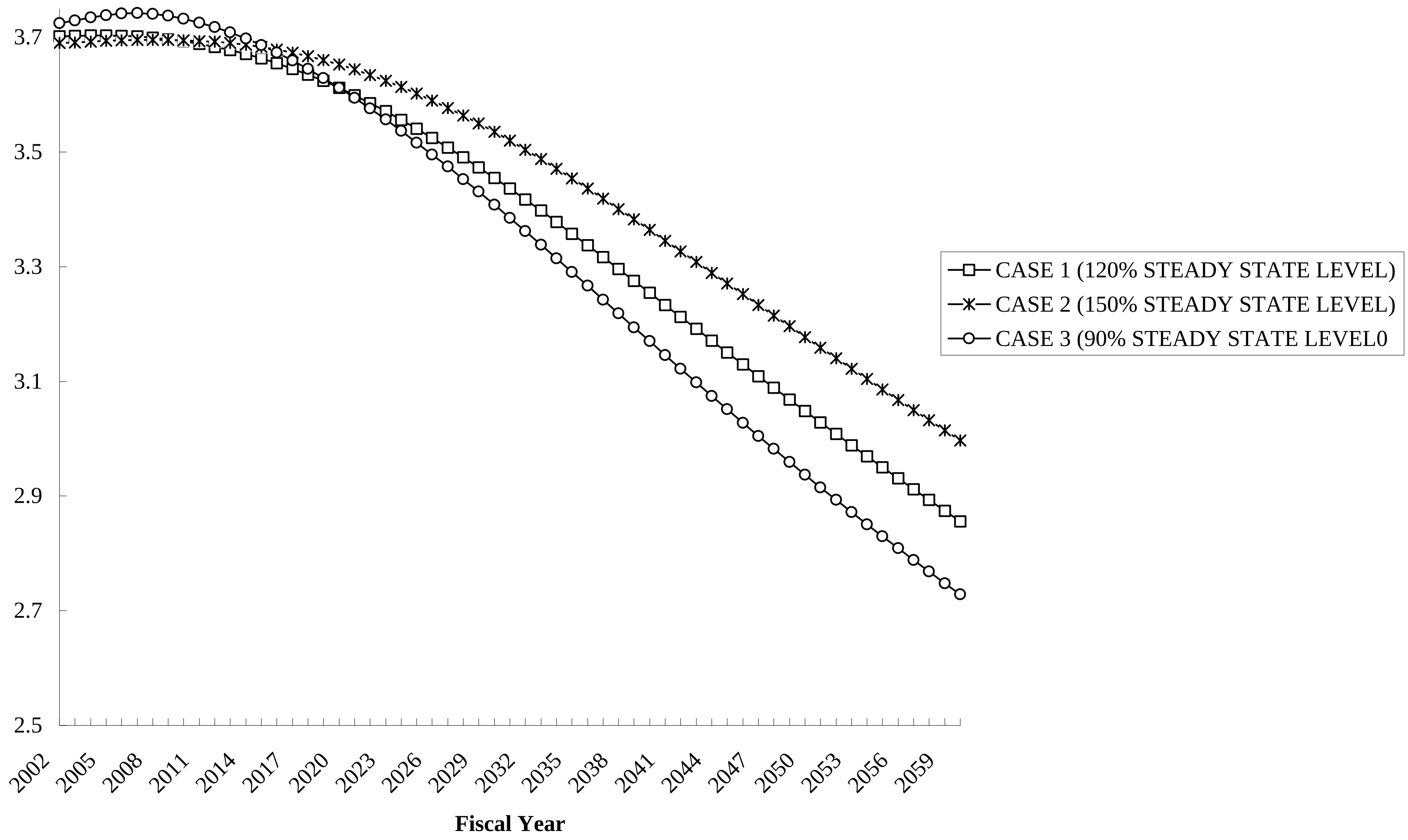


Figure 2-2
Interest Rates

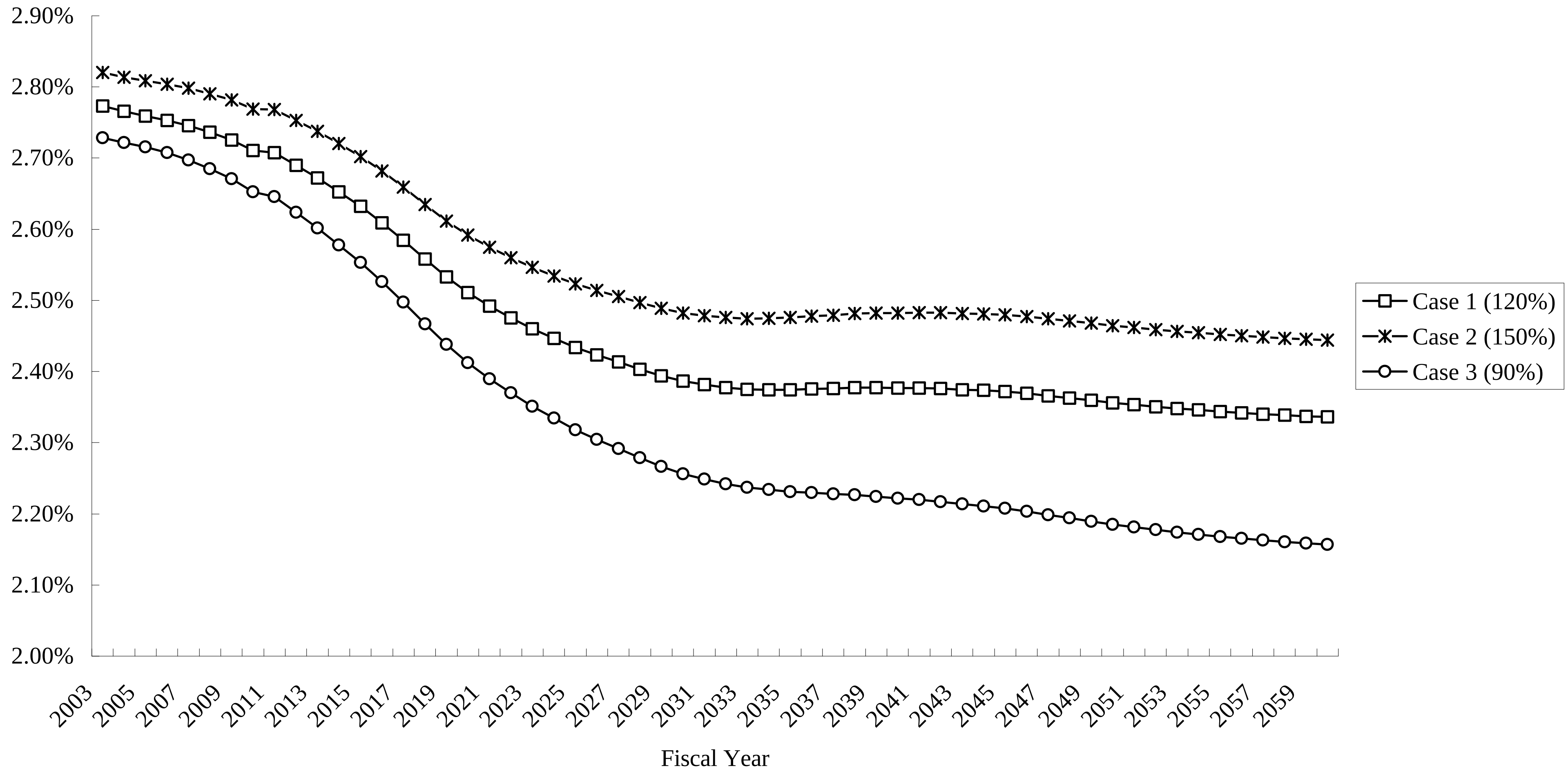


Figure 2-3
Utility Comparion in Equivalent Variations

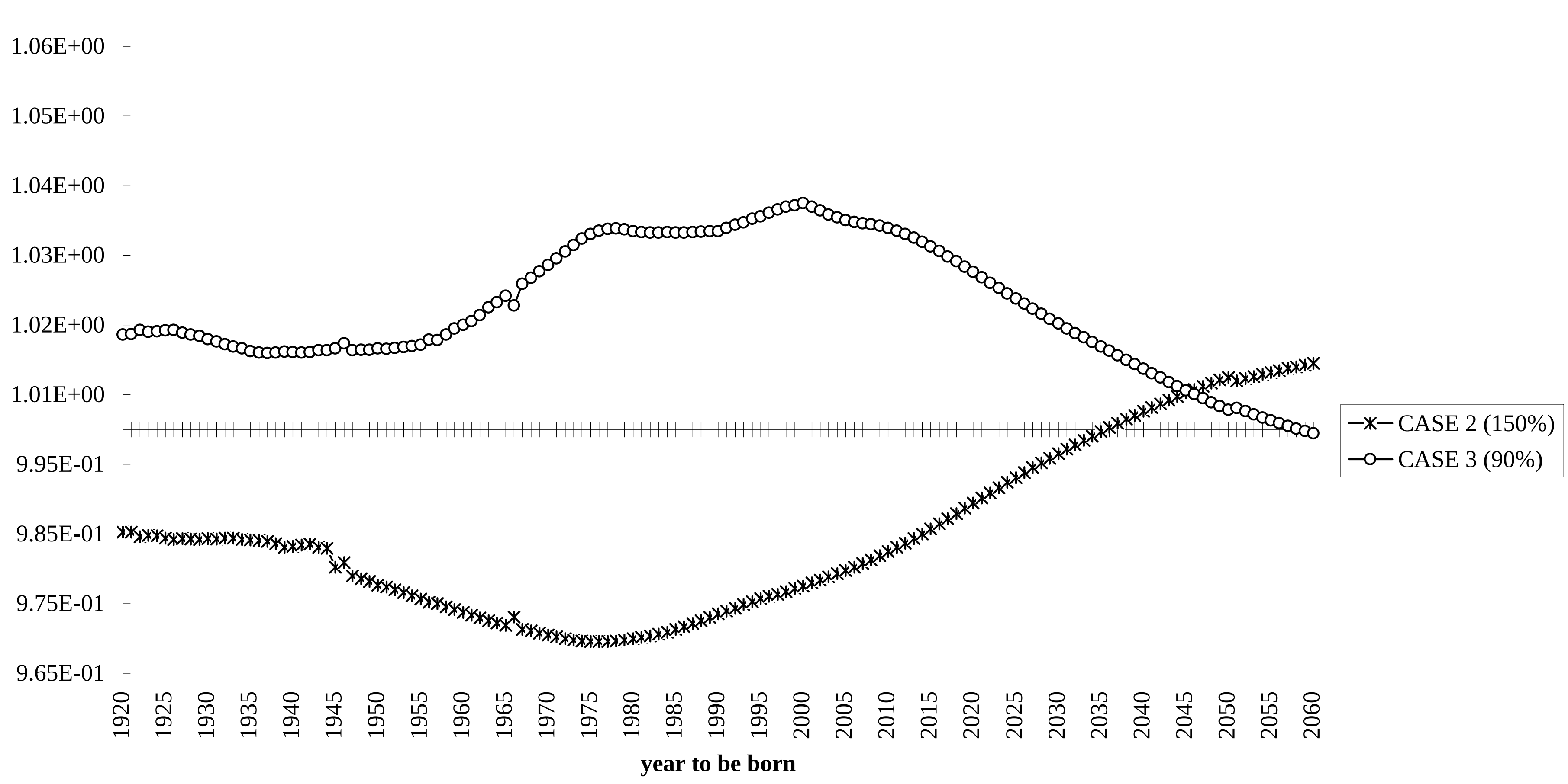


Figure 2-4
Contribution Rates to the Public Pension Scheme

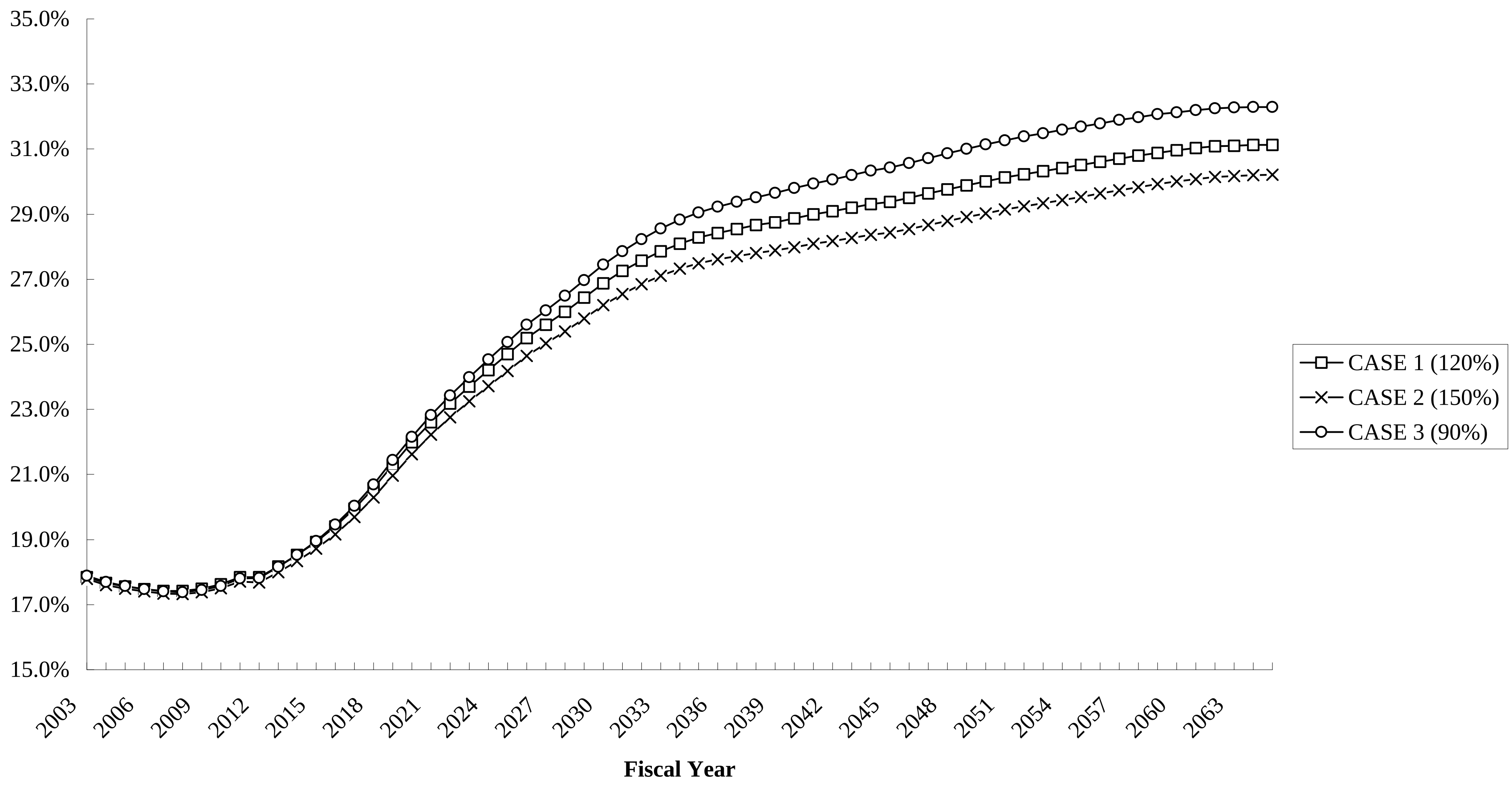
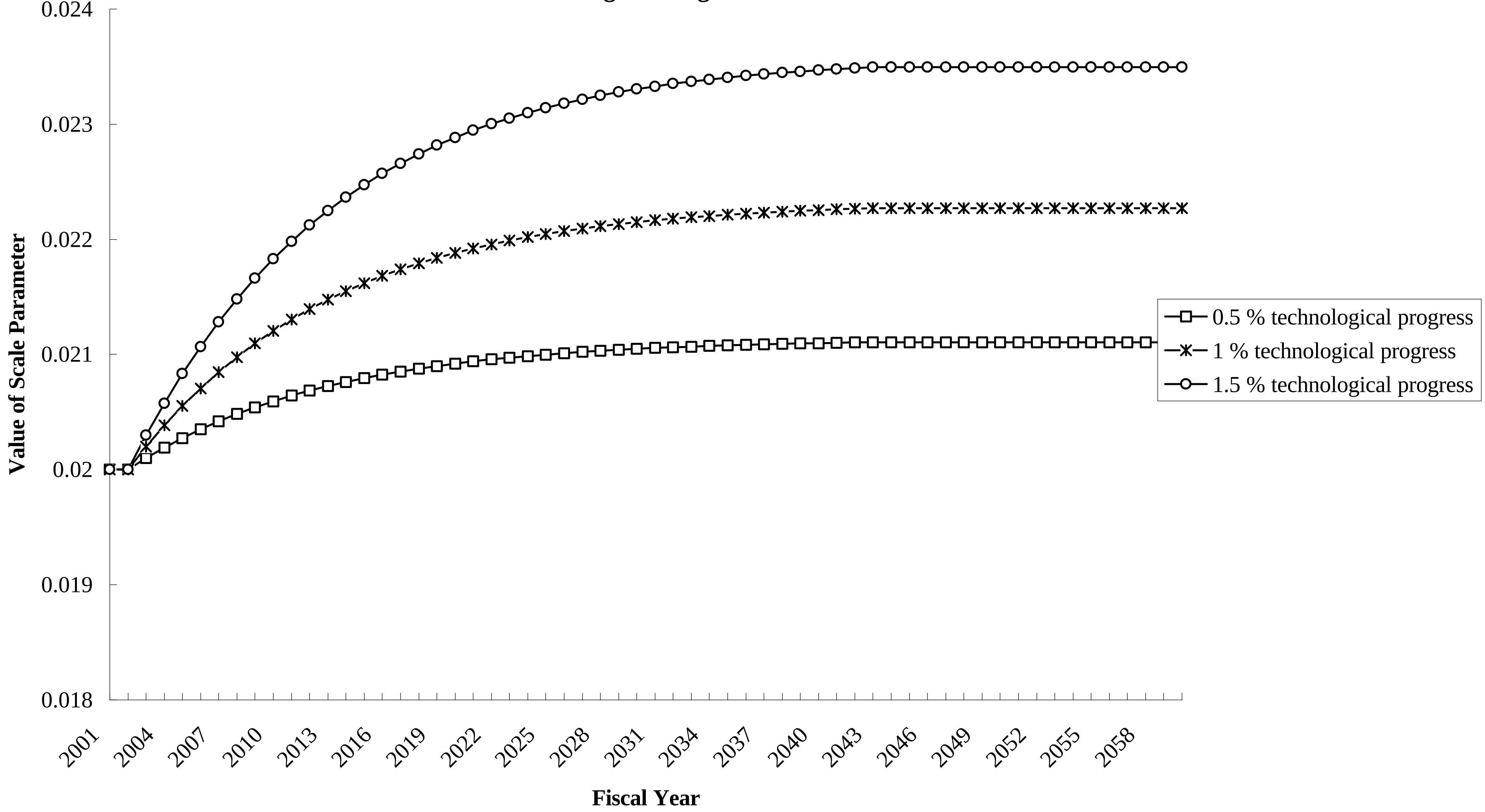


Figure 2-5
Generational Accounting through the existing Public Penssion Scheme

Figure 3-1
The Effect of Technological Progress on the Values of Scale Parameter



Fiugure 3-2
The Effect of Technological Progress on Per Capita Income
(In Comparison with a 0 % Technological Progress (Benchmark: Case 1))

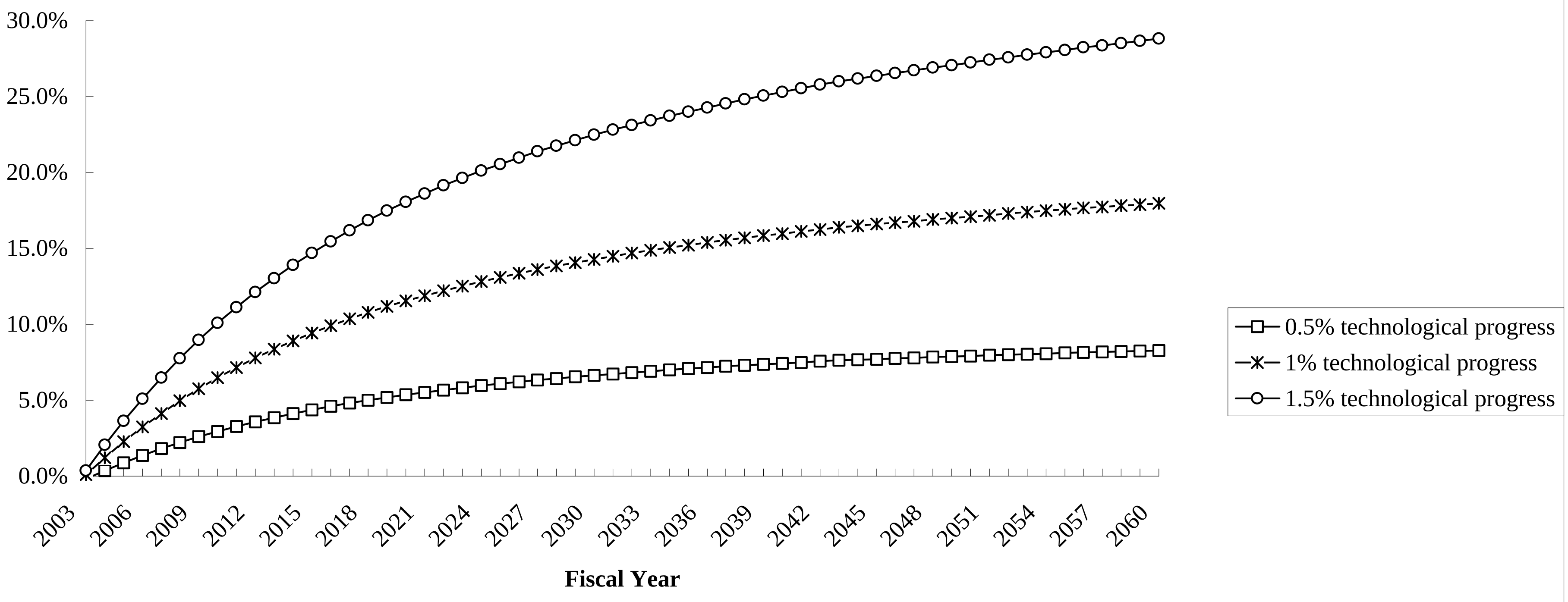


Figure 3-3
The Effect of Technological Progress on Utility

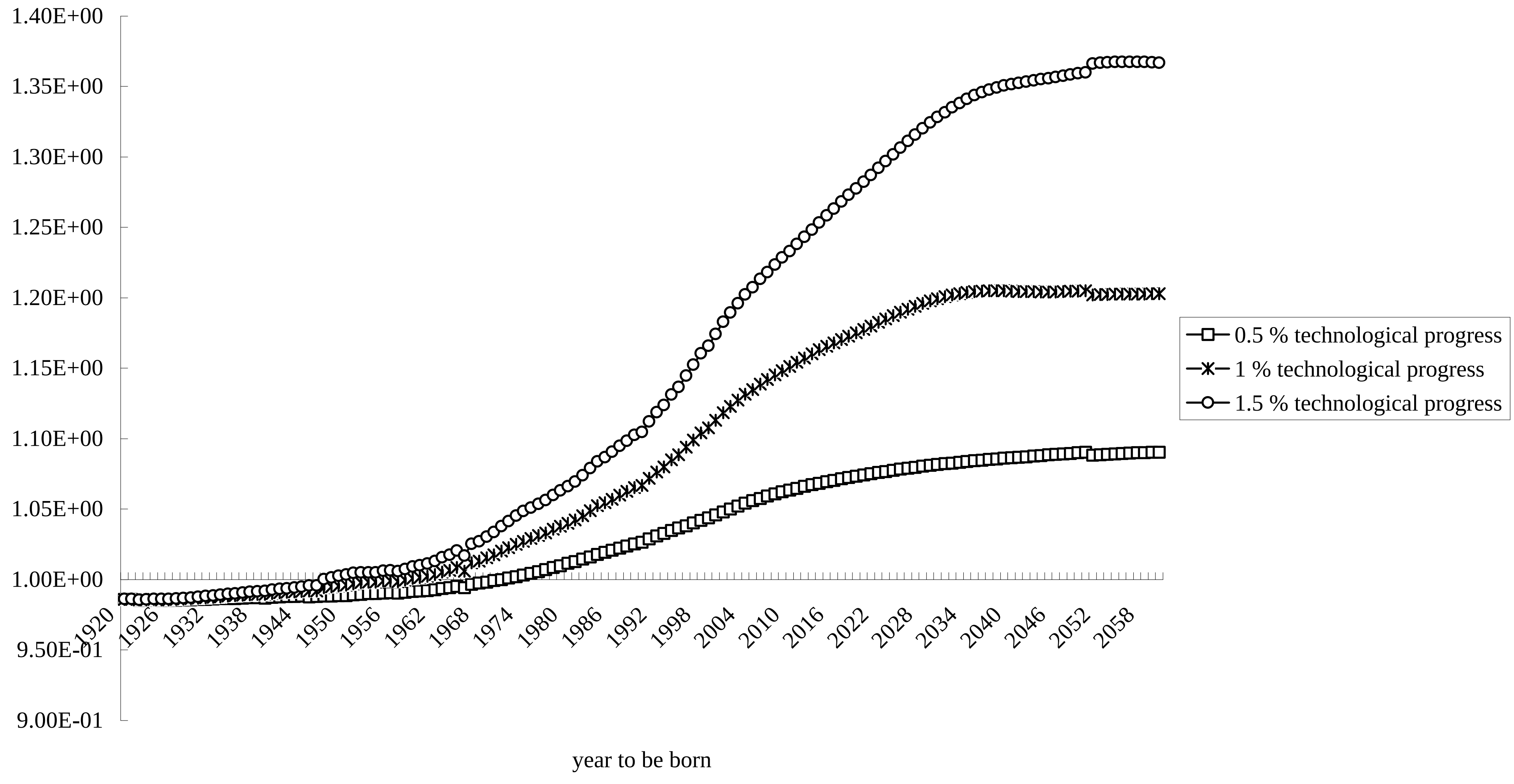


Figure 4-1
The Effect of Inefficiency in Public Investment on Per Capita Income
(In Comparison with a Full Effcient Case)

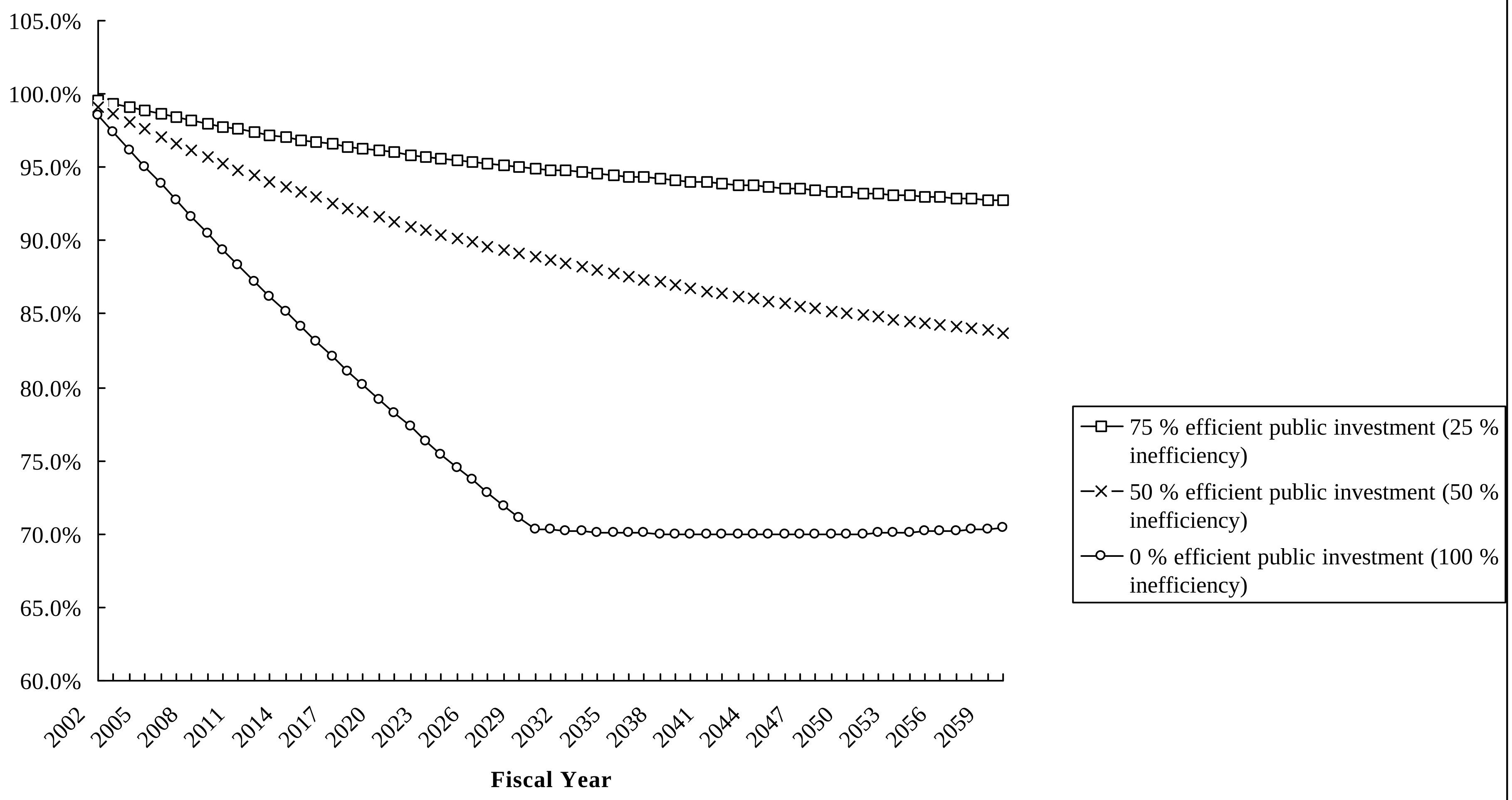


Figure 4-2

The Effect of Inefficiency in Public Investment on Utility (Equivalent Variations)

(In Comparison with a Full Efficient Case (0 % Inefficieny in Public Investment)