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Public Policy and Economic Growth: Japan and the United States

by

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Abstract

We incorporate a public sector into a simple, constant returns model of economic growth developed by Barro (1990) and Jones and Manuelli (1990). There are interesting choices about the relations among the size of government, the productivity of public sector, the saving behavior, the social security system, and the rate of economic growth. We investigate policy implications of the analytical results for the performance of the Japanese and the U.S. economic growth.

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1. Introduction

Recent models of economic growth can generate long-run growth without relying on exogenous changes in technology or population. A general feature of these models is the presence of constant or increasing returns in the factors that can be accumulated.[1]

In this paper we build on one aspect of this literature by incorporating a public sector into a simple, constant returns model of economic growth developed by Barro (1990) and Jones and Manuelli (1990). There are interesting choices about the relations among the size of government, the productivity of public sector, the saving behavior, the social security system, and the rate of economic growth. We investigate policy implications of the analytical results for the performance of the Japanese and the U.S. economic growth.

Useful models must be quite abstract. There are many interesting details that cannot be incorporated because they render the model intractable. It is therefore essential to explore how robust the growth results are to the specification studied. For the class of infinitely-lived representative agent models it is well known that to affect the growth rate it suffices to influence the rate of return: substitution effects dominate long run behavior. Is it then reasonable for a government, interested in understanding the effects of alternative policies on the growth rate, to restrict attention to the impact of any given policy on the rate of return on saving or accumulation of human capital, and to ignore for example the possible redistributive or income effects?

The organization of the paper is as follows. Section 2 investigates public policy and economic growth in the infinite horizon model with private and public capital. It seems possible to argue that the class of infinitely-lived models is too narrow to accomodate some forms of heterogeneity. In particular, it is impossible, in the standard setting, to understand the effect of intergenerational income redistribution on growth.[2] Section 3 analyzes an overlapping generations version of the model and demonstrates that intergenerational transfers can generate long run growth. This section also examines the relations among the size of government, the productivity of public sector, the saving behavior, the social security system, and the rate of economic growth. Finally, Section 4 considers some policy implications of the results for the Japanese and the U.S. economic growth.

2. The Infinite Horizon Model

2.1 Household Sector

In this section we present a standard infinitely-lived agent model of economic growth. The representative, infinite-lived household in a closed economy seeks to maximize overall utility, as given by

$$U = \sum_{t=0}^{\infty} \beta^t u(c_t), \qquad (1)$$

where c is consumption per person and $\beta = 1/(1+\rho)$ is the discount factor; $\rho > 0$ is the constant rate of time preference. Population, which corresponds to the number of workers-consumers, is constant. The utility function is specified as

$$u(c) = (c^{1-\sigma}-1)/(1-\sigma), \qquad (2)$$

where $\sigma > 0$ and the elasticity of marginal utility is given by $-\sigma$.

Each household has access to the production function

$$y = f(K) = AK, \qquad (3)$$

where y is output per worker and K is capital per worker. Following Rebelo (1991), we assume constant returns to a broad concept of capital which includes human capital as well as physical capital. Each person works a given amount of time using human capital; there is no labor-leisure choice.

2.2 Public Sector

We now incorporate a public sector. Let g be the quantity of public capital owned by the government. In this section we assume that the services of public capital are provided to the private sector without user charges and are not subject to congestion effects. Later we also consider the case where the services of public capital are not distributed to the private sector.

We only consider the role of public stock as an input to production. Production exhibits constant returns to scale in private capital k and public capital g together but diminishing returns in k and g separately. Namely, even with a broad concept of private capital k, which includes nonhuman capital and human capital, production involves decreasing returns to provide outputs if the government capital g does not expand in a parallel manner.

Given constant returns to scale, we have

$$K = k^{1-\alpha}g^{\alpha},$$

or, the production function can be written as

$$y/k = A(g/k)^{\alpha}, \qquad (4)$$

where $0 < \alpha < 1$ and it is assumed that the production function is Cobb-Douglas.

A number of questions arise concerning the specification of public services as input to production. First, Barro (1990) considered the case of the government as doing no production and owning no capital. The government there just buys a flow of output from the private sector. Barro conjectured that as long as the government and the private sector have the same production functions, the results would be the same if the government buys private inputs and does its own production, instead of purchasing only final output from the private sector. However, as will be shown, the results would not necessarily be the same, depending upon the formulation of the government budget constraint.

Barro and Sala-i-Martin (1990) considered three versions of public services: publicly-provided private goods, which are rival and excludable; publicly-provided public goods, which are non-rival and non-excludable; and publicly-provided goods that are subject to congestion. The present model can be modified to include these aspects of public services without altering the general nature of the results.

2.3 The Command Economy

First of all, let us investigate the first-best solution in the centrally planned economy. A set of constraints that govern capital accumulation are as follows:

$$k_{t+1} = (1-\delta)k_t + x_{kt}, \tag{5-1}$$

$$g_{t+1} = (1-\delta)g_t + x_{gt}, \tag{5-2}$$

where x_{kt} and x_{gt} are investment in private and public capital at time t and δ is the depreciation rate. The feasibility condition of the economy is

$$c_t + x_{kt} + x_{gt} = y_t. \tag{6}$$

The first best problem is to maximize (1) subject to (5-1), (5-2), and (6). From the first order conditions of the utility maximization problem, the optimal (gross) growth rate of consumption at each point in time, $\gamma \equiv c_{t+1}/c_t > 1$, is given by (see Appendix)

$$\gamma = \{\beta(q_k-\delta+1)\}^{1/\sigma}, \tag{7}$$

$$q_k = q_g, \tag{8}$$

where q_k is the marginal product of private capital and q_g is the marginal product of public capital.

The economy is in a position of steady-state growth in which all quantities grow at the same rate γ shown in equation (7). In this economy, a higher level of marginal productivity of private capital (high q_k), a higher level of total productivity (high A), a lower depreciation rate (low δ) and a high discount factor β (low ρ) result in higher growth, while a small intertemporal elasticity of substitution $-\sigma$ (high σ) reduces the growth rate.

A standard arbitrage condition (8) means

$$q_g = A\alpha(g/k)^{\alpha-1} = A(1-\alpha)(g/k)^{\alpha} = q_k,$$

or,

$$a \equiv g/k = \alpha/(1-\alpha). \tag{9}$$

Then, as might be expected, the long run optimal public to private capital ratio (a) is determined by their relative marginal product, i.e., the coefficient of the Cobb-Douglas production function. The higher the marginal and average product of public capital (α) the higher the optimal ratio of public to private capital.

Substituting (8) and (9) into (7), we have

$$\gamma = \{\beta[A\alpha^{\alpha}(1-\alpha)^{1-\alpha}+1-\delta]\}^{1/\sigma}. \tag{10}$$

As for α, $\alpha = 0.5$ produces the highest rate of growth.

2.4 The Competitive Economy

2.4.1: The First Best Solution

In the competitive economy the private budget constraint is given as

$$c_t+x_{kt}+b_{t+1} = q_{kt}k_t+q_{gt}g_t+[1+r_t]b_t+T_t, \tag{11}$$

where r is the real rate of interest, b is the debt, and T is a lump sum transfer. It is assumed here that the return of public capital $q_g g$ is distributed to the private sector.

The government budget constraint is given as

$$x_{gt}+T_t = 0. \tag{12}$$

It is well known that in the infinitely-lived consumer model Ricardian debt neutrality holds. The government can attain the first best optimum using lump sum taxes. For simplicity we thus assume that the government can neither finance deficits by issuing debt nor run surpluses by accumulating assets.

As is well known, the maximization of the representative household's overall utility (1) subject to the budget constraint (11) implies

$$\gamma = \{\beta(1+r)\}^{1/\sigma}, \tag{13}$$

and the private arbitrage condition between debt and private capital implies

$$r = q_k-\delta. \tag{14}$$

Substituting (14) into (13), we have (7). Thus, private optimization still leads to a path of consumption that satisfies equation (7).

Furthermore, if the government adopts a public investment and lump sum tax policy so that satisfies (9), then the first best solution (10) will be realized. The rate of return on private capital is crucial for determining the rate of growth, but lump sum transfers do not appear in (13). The engine of growth consists of two effects, the <u>intertemporal incentive effect</u> (r) and the <u>intertemporal preference effect</u> (β). The former effect means that when the marginal product of private capital is high, economic growth is promoted. As in the standard endogenous growth model, a high level of the real rate of interest is a key to promote high growth. The latter effect means that the higher the discount factor, the higher the growth rate.

2.4.2: Suboptimality Of Public Investment

The arbitrage condition in equation (9) can be regarded as the optimal condition for public investment. In the real economy, this condition need not hold. If the government does not use the lump sum transfer to attain (9), substituting $A(1-\alpha)a^{\alpha} = q_k$ into (13) and (14), the long run (gross) growth rate is given by

$$\gamma = \{\beta[Aa^{\alpha}(1-\alpha)+1-\delta]\}^{1/\sigma}. \tag{15}$$

In this economy, a lower ratio of public capital to private capital (a) means lower growth. Put another way, the higher is a, the higher the rate of growth. In the context of this model, as well as in many others, a higher growth rate is not necessarily better. The optimal growth rate is given by (10).

2.4.3: Capital Income Tax

We now introduce distortionary taxes. Let τ be the tax rate on private capital income. Then the sequential budget constraint (11) is rewritten as

$$c_t+x_{kt}+\tau q_{kt}k_t+b_{t+1} = q_{kt}k_t+q_{gt}g_t+[1+(1-\tau)r_t]b_t+T_t. \qquad (11)'$$

And the government budget constraint is rewritten as

$$\tau_t q_{kt}k_t = T_t + x_{gt}. \qquad (12)'$$

In this case the household utility maximization implies

$$\gamma = \{\beta[(1-\tau)r+1]\}^{1/\sigma}, \qquad (13)'$$

and

$$(1-\tau)r = (1-\tau)q_k-\delta. \qquad (14)'$$

(13)' and (14)' are almost the same as (13) and (14), except that q_k is replaced by the (after-tax) private marginal return to capital. And if the government employs the optimal public investment policy for an arbitrarily given level of τ and lump sum transfers are endogenously determined to satisfy the government budget constraint (12)', the arbitrage condition is rewritten as

$$(1-\tau)q_k = q_g,$$

or,

$$a \equiv g/k = \alpha/[(1-\tau)(1-\alpha)]. \tag{9'}$$

Therefore, from (9)' (13)' and (14)', the long run growth rate is given by

$$\gamma = \{\beta[(1-\tau)A\alpha^{\alpha}((1-\tau)(1-\alpha))^{1-\alpha}+1-\delta]\}^{1/\sigma}. \tag{16}$$

In this economy a higher tax rate on capital income (high τ) will reduce the growth rate. When taxes are also levied on public capital income, we have (9) in place of (9)' and the long run growth rate is given by

$$\gamma = \{\beta[(1-\tau)A\alpha^{\alpha}(1-\alpha)^{1-\alpha}+1-\delta]\}^{1/\sigma}. \tag{16'}$$

Thus, high τ will reduce the growth rate as in (16). Since lump sum taxes are available, it is not desirable to raise τ to finance public investment.

2.4.4: Public Investment Financed By Capital Income Tax

We then consider the case where there is the strong link between taxes and public investment; $T_t = 0$. In such a case (12)' may be rewritten as

$$g_{t+1} = (1-\delta)g_t + \tau q_{kt}k_t. \tag{17}$$

Substituting $A(1-\alpha)a^{\alpha} = q_k$ into (17) yields in the long run

$$\gamma a = (1-\delta)a+\tau A a^{\alpha}(1-\alpha). \tag{18}$$

Note that $g_{t+1}/g_t = k_{t+1}/k_t = c_{t+1}/c_t = \gamma$ in the long run. Similarly, since we do not have the optimal public investment policy as in 2.4.2, we obtain in place of (15)

$$\gamma = \{\beta[(1-\tau)A a^{\alpha}(1-\alpha)+1-\delta]\}^{1/\sigma}. \tag{19}$$

Equations (18) and (19) determine the long run rate of growth γ and the relative public-private capital ratio a.

Figure 1 describes the relation between γ and a which satisfies (18) and (19). Curve A corresponds to (18), which is downward sloping. Curve B corresponds to (19), which is upward sloping. An increase in τ will shift curve A up and to the right. An increase in τ will shift curve B downwards. Hence, as shown in Figure 1, equilibrium a is increased but the effect on γ is ambiguous. From the comparative static analysis, it is easy to see that the sign of $d\gamma/d\tau$ corresponds to the sign of $-1+(1-\tau)A\alpha(1-\alpha)a^{\alpha-1}$. When τ is high, a is high and hence $(1-\tau)A\alpha(1-\alpha)a^{\alpha-1}$ is low. Thus, when τ is very low (high), it is likely that $d\gamma/d\tau$ will be positive (negative).

The intuition for this result is as follows. When τ is very low, the marginal product of public capital is very high, and hence increases in τ produce more public capital which may in turn increase the growth rate. At very high tax levels, the negative effect on private rates of return more than outweighs the positive impact of additional public capital and the growth rate declines with the tax rate. This result is qualitatively the same as Barro (1990) although the tax base of capital income taxation in Barro (1990) is national income in place of private capital income here.

3. The Effect Of Finite Lifetimes

3.1 Bequest Behavior

In this section we study the long run properties of a model that has the same technology but in which individuals live for a finite number of periods. To make the point clear consider a two-period overlapping generations model similar to Samuelson (1958) and Diamond (1965) with private and public capital. We extend the standard overlapping generations model to allow for bequests as well as public capital.[3]

There are several theoretical models of bequeathing behavior that have appeared in the literature, (i) the altruistic bequest model, where the offspring's indirect utility function enters the parent's utility function as a separate argument, (ii) the bequest-as-consumption model, where the bequest itself enters the parent's utility function as a separate argument, (iii) the bequest-as-exchange model, where the parent gives a bequest to his offspring in exchange for a desirable action undertaken by the offspring, and (iv) the accidental bequest model, where a parent may leave an unintended bequest to his offspring because lifetimes are uncertain and annuities are not priced in an actuarially fair way. In this section we will adopt the Bequest-As-Consumption model for simplicity. On the bequest model we use see Yaari (1965), Becker (1981), and Menchik and David (1982).

A representative individual born at time t solves

$$\text{Max} \quad u^t = u(c_1^t,\ c_2^t,\ b_t), \tag{20}$$

subject to

$$c_1^t+s_t+b_t = (1+r_t)b_{t-1}, \tag{21}$$

$$c_2^t = (1+r_{t+1})s_t, \tag{22}$$

where c_i^t is consumption in the i-th period of each individual's life of a member of generation t, b_{t-1} is the inheritance received at time t-1, b_t is his bequest at time t, and s_t is his savings at time t. The inheritance is determined when young and saved for his child. The inheritance could be assumed entirely financial or physical. However, we follow the interpretation suggested by Becker and Tomes (1979), under which b includes transfers in support of human capital accumulation as well. Note that physical capital and human capital are perfect substitutes in our model. When young, the individual works a given amount of time using human capital which is left by his parent. Thus, (1+r)b includes wage income. (21) means that the inheritance from the parent determines the lifetime income. It is assumed for simplicity here that the return on public capital, $q_g g$, is not distributed to the private sector.

3.2 Capital Accumulation

Capital accumulation is given as

$$s_t+b_t = k_{t+1}. \tag{23}$$

Suppose for simplicity the utility function is given by the Cobb-Douglas one.

$$U_t = u_t + \varepsilon_3 v(b_t),$$

$$= \varepsilon_1 \log(c_1^t) + \varepsilon_2 \log(c_2^t) + \varepsilon_3 \log(b_t). \tag{24}$$

ε_3 is the parent's marginal benefit of his bequeathing. $1 = \varepsilon_1 + \varepsilon_2 + \varepsilon_3$. $v(\ )$ is a proxy of his offspring's utility. Hence, ε_3 may be regarded as the private discount factor of the future generation. Then the consumption and bequest functions are respectively given as

$$c_1^t = \varepsilon_1(1+r_t)b_{t-1}, \tag{25-1}$$

$$c_2^t = \varepsilon_2(1+r_t)(1+r_{t-1})b_{t-1}, \tag{25-2}$$

$$b_t = \varepsilon_3(1+r_t)b_{t-1}. \tag{25-3}$$

In this case from (25-2) and (25-3), (23) may be rewritten as

$$b_t = \varepsilon k_{t+1}, \tag{23)'$$

where $0 < \varepsilon \equiv \varepsilon_3/(\varepsilon_2+\varepsilon_3) < 1$. If we use (2) in place of the Cobb-Douglas one, ε_i would be dependent on r. However, the qualitative results would be almost the same as in the present formulation.[4]

3.3 Public Policy And Economic Growth

3.3.1: Public Investment Without Taxes

It is assumed here that the government collects the return on public capital and reinvests without imposing any other taxes. In other words, the government budget constraint is given as

$$(1+q_{gt}-\delta)g_t = g_{t+1}. \tag{26}$$

In the long run equilibrium since we have $b_t = \gamma b_{t-1}$, from (25-3) γ is given as

$$\gamma = \varepsilon_3(1+r), \tag{27}$$

which can be greater than 1 if ε_3 is high. In this economy considering $A(1-\alpha)a^{\alpha} = q_k$ and (14), (27) is rewritten as

$$\gamma = \varepsilon_3[Aa^{\alpha}(1-\alpha)+1-\delta]. \tag{28}$$

(28) means that it is possible to have positive economic growth even in the finite horizon lifetime model when we allow for intergenerational transfers. Jones and Manuelli (1990) explored a growth effect of redistribution using the standard two-period overlapping generations model. Without incorporating public capital, they showed that the laissez faire competitive equilibrium fails to grow because the new generation does not have sufficient income, while an income tax-financed redistributive policy can be used to induce equilibrium growth. In their formulation the assumption that the marginal product of capital is positive and bounded above zero is crucial. Our analysis shows that the competitive economy can grow. Suppose as in Jones and Manuelli public capital is assumed away and the lower limit of r is bounded above zero. Then (27) implies that the

competitive economy can grow if $\varepsilon_3 > 1/(1+r)$. When we include public capital as in the present model, (28) implies that positive growth is consistent with the assumption that the limit of r is zero.

(26) implies

$$\gamma = 1+q_g-\delta. \tag{26)'$$

Considering (28), we know that $q_k > q_g$. In this economy public capital is overaccumulated. Growth of public capital is given by (26)', while growth of private capital is given by (27). Since $\varepsilon_3 < 1$, public capital grows faster than private capital if $q_k = q_g$.

3.3.2: Public Investment Financed By Lump Sum Taxes

We then introduce a lump sum tax policy to attain the arbitrage condition (9). Let T_t be a lump sum transfer to the younger generation at time t. The government budget constraint is now

$$(1+q_{gt}-\delta)g_t - T_t = g_{t+1}. \tag{29}$$

The bequest function is now rewritten as

$$b_t = \varepsilon_3[(1+r_t)b_{t-1}+T_t]. \tag{25-3)'$$

Substituting (29) into (25-3)' we have

$$b_t = \varepsilon_3[(1+r_t)b_{t-1}-g_{t+1}+(1+q_{gt}-\delta)g_t].$$

Substituting (24)' into the above equation we have

$$\varepsilon\gamma = \varepsilon_3[(1+r)\varepsilon-\gamma a+(1+q_g-\delta)a].$$

Considering the arbitrage condition (9) we finally get

$$\gamma = \varepsilon_3[A\alpha^{\alpha}(1-\alpha)^{1-\alpha}+1-\delta](\varepsilon+a)/(\varepsilon+\varepsilon_3 a), \tag{30}$$

where $a \equiv \alpha/(1-\alpha)$. In this economy higher ε_3 and ε_2 mean a higher growth rate. ε_2 reflects the saving motive for the life cycle behavior. ε_3 reflects the saving motive for the intergenerational transfer. The stronger motive for the life cycle behavior and/or the intergenerational transfer, the higher the rate of growth. Note that the result is the same if we introduce the return on public capital to the private budget constraint instead of the government budget constraint.

3.3.3: Public Investment Financed By Capital Income Tax

As in 2.4.4, suppose that the government finances public investment by imposing capital income taxes. The government budget constraint is now

$$(1+q_{gt}-\delta)g_t + \tau q_{kt}k_t = g_{t+1}. \tag{31}$$

The bequest function is now

$$b_t = \varepsilon_3[1+r_t(1-\tau)]b_{t-1}. \tag{32}$$

Thus, we have from (31)

$$\gamma a = a[1+A\alpha a^{\alpha-1}-\delta]+\tau A a^{\alpha}(1-\alpha), \tag{33}$$

and from (32)

$$\gamma = \varepsilon_3[1+(1-\tau)A(1-\alpha)a^{\alpha}-\delta]. \tag{34}$$

As in 2.4.4, we can draw a diagram of the long run equilibrium like Figure 1. Curve A corresponds to (33), which is downward sloping. Curve B corresponds to (34), which is upward sloping. An increase in τ will shift curve A up and to the right. An increase in τ will shift curve B downwards. Hence, as shown in Figure 1, equilibrium a is increased but the effect on γ is ambiguous. From the comparative static analysis, we know that the sign of $d\gamma/d\tau$ corresponds to the sign of $-1+(1-\tau)A\alpha(1-\alpha)a^{\alpha-1}$ as in 2.4.4. Thus, if τ is very low (high), it is likely to have that $d\gamma/d\tau$ is positive (negative).

3.3.4: Public Transfer Policy

b may be regarded as the public transfer policy. Suppose the government transfers income from the older generation to the younger generation in the following way. At time t the government collects b_t from the t-th generation and invests it to the private capital market. At time t+1 the government transfers the return $(1+r_{t+1})b_t$ to the t+1-th generation. Such a transfer is the same as the voluntary transfer considered above. A higher ε_3 implies a higher degree of intergenerational transfers. Thus, the more transfer is conducted by the government from the older generation to the younger generation, the higher the rate of growth.

The model of this section can be used to study the effect of social security on the growth rate. The above public transfer policy may be regarded as the combination of the fully funded social security system plus intergenerational transfer from the old to the young. If the social security system has a feature of the pay-as-you-go system, income is transferred from the young to the old. Thus, the larger the pay-as-you-go system is, the lower the growth rate.

4. Policy Implications

4.1 Summary Of The Analytical Results

Our analysis has shown how the long run growth rate is related to the preference, technology and public policy. In the infinitely-lived representative consumer model, a higher level of marginal productivity (high q_k and q_g), a higher level of total productivity (high A), a lower depreciation rate (low δ) and a higher discount factor β (low ρ) result in higher growth, while a smaller intertemporal elasticity of substitution (high σ) reduces the growth rate. When the government does not employ the optimal investment policy, an increase in the ratio of public to private capital (a) raises the growth rate. When the government imposes the capital income tax rate τ, an increase in τ will normally reduce the equilibrium growth rate. When public investment is financed by capital income taxes and τ is very low, an increase in τ may raise the growth rate.

In the finitely-lived consumer model, intergenerational transfers can ensure a positive growth rate. We have the similar comparative statics results as in the infinitely-lived consumer model. Furthermore, the stronger motive for the life cycle behavior and/or the intergenerational transfer, the higher the rate of growth. The more transfer from the older generation to the younger generation is conducted by the government, the higher the rate of growth.

4.2 Empirical Results On Government Spending And Growth

The literature includes a number of empirical studies on the relationship between government spending and economic growth. Although the present paper has not investigated the relation between government consumption and economic growth, it would seem fair to say that government consumption normally reduces the growth rate. Kormendi and Meguire (1985) studied 47 countries in the post-World War II period, using data on total government consumption expenditures and other variables. They found no significant relation between average growth rates of real GDP and average growth rates or levels of the share of government consumption spending in GDP.

Grier and Tullock (1987) extended the Kormendi-Meguire form of analysis to 115 countries. They found a significantly negative relation between the growth rate of real GDP and the growth rate of the government share of GDP, although most of the relation derived from the 24 OECD countries.

Landau (1983) studied 104 countries on a cross-sectional basis and found significantly negative relations between the growth rate of real GDP per capita and the level of government consumption expenditures as a ratio to GDP. Barth and Bradley (1987) found a negative relation between the growth rate of real GDP and the share of government consumption spending for 16 OECD countries. Barro (1989) studied 98 countries and found that an increase in resources devoted to non-productive but possibly utility-enhancing government services is associated with lower per capita growth.

We then consider the relation between public investment and economic growth. For the 76 countries for which data on public investment were available, Barro (1989) showed that the point estimate was positive but insignificantly different from zero. He argued that this result is consistent with the hypothesis that the typical country comes close to the quantity of public investment that maximizes the growth rate. However, as shown in sections 2 and 3 of the present paper, such an argument is correct only if public investment is financed by capital income taxes. See 2.4.4 and 3.3.3. In the real economy public investment need not be financed by capital income taxes. In such a case as shown in 2.4.2 or 3.3.1, an increase in public capital relative to private capital (or GNP) will raise the growth rate.

During the period 1973 to 1985, public net investment in the U.S. and Japan averaged 0.3% and 5.1% of gross domestic product, while their respective growth rates of real gross domestic output per employed person were 0.6% and 3.1% per annum. Aschauer (1989) showed that a simple regression of average annual growth rates of labor productivity in the 'G-7' countries against ratios of public investment to gross domestic output for the period 1973-85 yields a slope coefficient of 0.47 with an associated T-statistic of 3.98. This is consistent with our 2.4.2 or 2.4.4.

Nemoto et. al. (1990) assessed optimality of Japanese public capital using the social discount rates for public investment. They found that actual levels of public capital stocks during the 1960-1982 period had been persistently less than optimal levels based on a variant of Burgess (1988)'s social discount rate. Their result implies the deficiency of public capital, which happens to be consistent with intuitive claims prevailing in Japan. They also found that public capital had been accumulated at a higher rate than the optimal level had grown and hence that the gap between actual and optimal levels of public capital had continuously diminished. If so, equation (15) in 2.4.2 suggests that higher growth of public capital has stimulated the Japanese growth rate.

4.3 Taxation On Capital Income

Our results has shown that capital income taxes will normally reduce the growth rate. Tachibanaki and Kikutani (1991) summarized the effective marginal capital income tax rates in 1961, 1970, and 1980 for Japan and the U.S. The effective marginal tax rate is calculated by

$$t = (p-s)/p,$$

under the various asset type, industrial sector, source of finance, and owner of the returns. Here p is the before tax real rate of return on one unit of investment net of depreciation, and s is the after-tax real rate of return to the saver who supplied the finance for one unit of investment.

Table 1 presents their results for the U.S. and Japan. In the case of zero inflation rate Japan shows minor changes in the effective tax rates. The effective tax rates in the U.S. decreased considerably in 1980. This was due mainly to the major tax reform held in the two countries.

The effective tax rate in the absence of inflation was lowest in 1970 in which it is corresponding to the period of the rapid economic growth. The effective tax rate was lowest in 1980 if we pay attention to the case of the actual inflation rate. During the period of high inflation the cost of capital may have been saved significantly, and raised the degree of investment activity due mainly to the lower effective tax rate on capital income. Contrary to the Japanese case an increase in the effective tax rate with an increase in the inflation rate was observed in the U.S. Tachibanaki and Kikutani suggested that this may be one of the causes for the relatively poor performance of the American economy.

Although the quantitative results are dependent on the rate of inflation, the tax rate was consistently lower in Japan than in the U.S. This may explain the difference in the economic growth rates between Japan and the U.S.

4.4 Saving Behavior And Intergenerational Transfer

Japan's saving rate is one of the highest in the world, and this high saving rate has played a valuable role throughout the postwar period, providing the funds needed to finance corporate investment in plant and equipment during the high-growth era of the 1950s, 1960s, and early 1970s, and helping to finance the central government's deficits and to meet capital shortages abroad during the post-1973 era of stable growth. See Table 2.

Our analysis has shown that in the finite horizon model the saving motives $(\varepsilon_2, \varepsilon_3)$ are crucial for growth. It has also been shown that the saving motive for bequests ε_3 stimulates the growth rate for all the cases, while the saving motive for the old age ε_2 is relevant only for the case where public investment is financed by lump sum taxes, compare Section 3.3.2. In this sense, the bequest motive is more important than the preparation motive for the old age to attain high growth.

There are a number of empirical studies that shed light on the nature of the bequest motive in Japan. See Dekle (1990) and Ohtake (1991). These findings suggest that bequests are important in the case of Japan and that they are intended bequests. A number of studies have also applied the methodology of Kotlikoff and Summers (1981) to the case of Japan in order to estimate the shares of life cycle and transfer wealth (wealth deriving from intergenerational transfers). As summarized in Table 3, the share of transfer wealth in Japan appears to be roughly comparable to the corresponding figures for the U.S.

Bequests are relatively prevalent in Japan. Thus, Hayashi (1986) concluded that bequests are the main cause of Japan's high saving rate. On the other hand, Horioka (1991) pointed out that the bulk of these bequests appear to be unintended or accidental bequests arising from risk aversion in the face of uncertainty about future medical expenses, the timing of death, etc., or intended bequests motivated by implicit annuity contracts between aged and their children or by a strategic bequest motive, all of which are consistent with the life cycle model. Whether the dynasty model or the life cycle model has greater applicability in the case of Japan is an unsettled question. However, it seems fair to say that intergenerational transfers are important in Japan, which suggests ε_3 is high. Thus, our analysis means that the high level of intergenerational transfers can be valuable in promoting high economic growth of the Japanese economy.

Appendix

Define the following Lagrange function, W.

$$W = \Sigma_{t=0}^{\infty}\beta^t[u(c_t) + \lambda_t\{c_t+k_{t+1}-(1-\delta)k_t+g_{t+1}-(1-\delta)g_t-y_t\}]$$

where λ is a Lagrange multiplier for (6). Then we have three first-order conditions with respect to c_t, k_{t+1}, and g_{t+1}.

$$\partial U/\partial c_t = u'(c_t) + \lambda_t = 0 \quad \text{(A-1)}$$

$$\partial U/\partial k_{t+1} = -\beta\lambda_{t+1}[(1-\delta)+q_{kt+1}]+\lambda_t = 0 \quad \text{(A-2)}$$

$$\partial U/\partial g_{t+1} = -\beta\lambda_{t+1}[(1-\delta)+q_{gt+1}]+\lambda_t = 0 \quad \text{(A-3)}$$

where $q_{kt} = \partial y_t/\partial k_t$ and $q_{gt} = \partial y_t/\partial g_t$.

Thus, we have

$$u'(c_t) = \beta u'(c_{t+1})[(1-\delta)+q_{kt+1}] \quad \text{(A-4)}$$

$$q_{kt} = q_{gt} \quad \text{(A-5)}$$

When the utility function is given by (2), (A-3) will be reduced to (7).

Notes.

1. See Rebelo (1991) and Barro and Sala i Martin (1992) among others.

2. Recently several papers have considered endogenous economic growth by extending the framework of the standard overlapping generations model. Jones and Manuelli (1990) showed that an income tax financed redistributive policy can be used to induce positive growth. Azariadis and Drazen (1990) and Caballe (1991) presented models of endogenous growth in which the accumulation of human capital is subject to externalities.

3. Ihori (1993) incorporates non-altruistic and altruistic bequest motives and examines the effect of social security programs on the growth rates when voluntary intergenerational transfers in terms of bequests are operative.

4. When we consider the altruistic bequest model where the offspring's indirect utility function enters the parent's utility function as a separate argument, we would have the same bequest function. In such a case ε_3 is the parent's marginal benefit of his offspring's utility and may be regarded as the private rate of generation preference or the private discount factor of the future generation.

Table 1

Effective Marginal Tax Rates for Japan and the U.S.

inflation rate	Japan	the U.S.
ten	3.3	48.2
actual	8.1	48.4
1970		
zero	22.0	43.8
ten	-3.2	47.4
actual	1.8	47.2
1980		
zero	28.7	32.0
ten	4.7	38.4
actual	9.6	37.2

Source: Tachibanaki and Kikutani (1991)

Table 2

Household Saving Rates

	Japan	the U.S.
1975-79	21.4	9.3
1980-84	17.1	8.6
1885-87	15.8	6.1
1975-87	20.1	8.3

Source: Horioka (1991)

Table 3

Estimates of the Share of Transfer Wealth

Author of study	Year	Share of transfer wealth
Japan		
Campbell	1974-84	At most 28.1
Dekle	1968-83	3-27
Hayashi	1969-74	At least 9.6
Barthold and Ito		At least 27.7-41.4
Dekle	1983	At most 48.7
the U.S.		
Ando and Kennickell	1960-80	15.0-41.2
Kotlikoff and Summers	1974	20-67
Barthold and Ito		At least 25
Menchik and David	1946-64	18.5
Projector and Weiss		15.5
Barlow et al.	1964	14.3-20
Morgan et al.		less than 10

Source: Horioka (1991)

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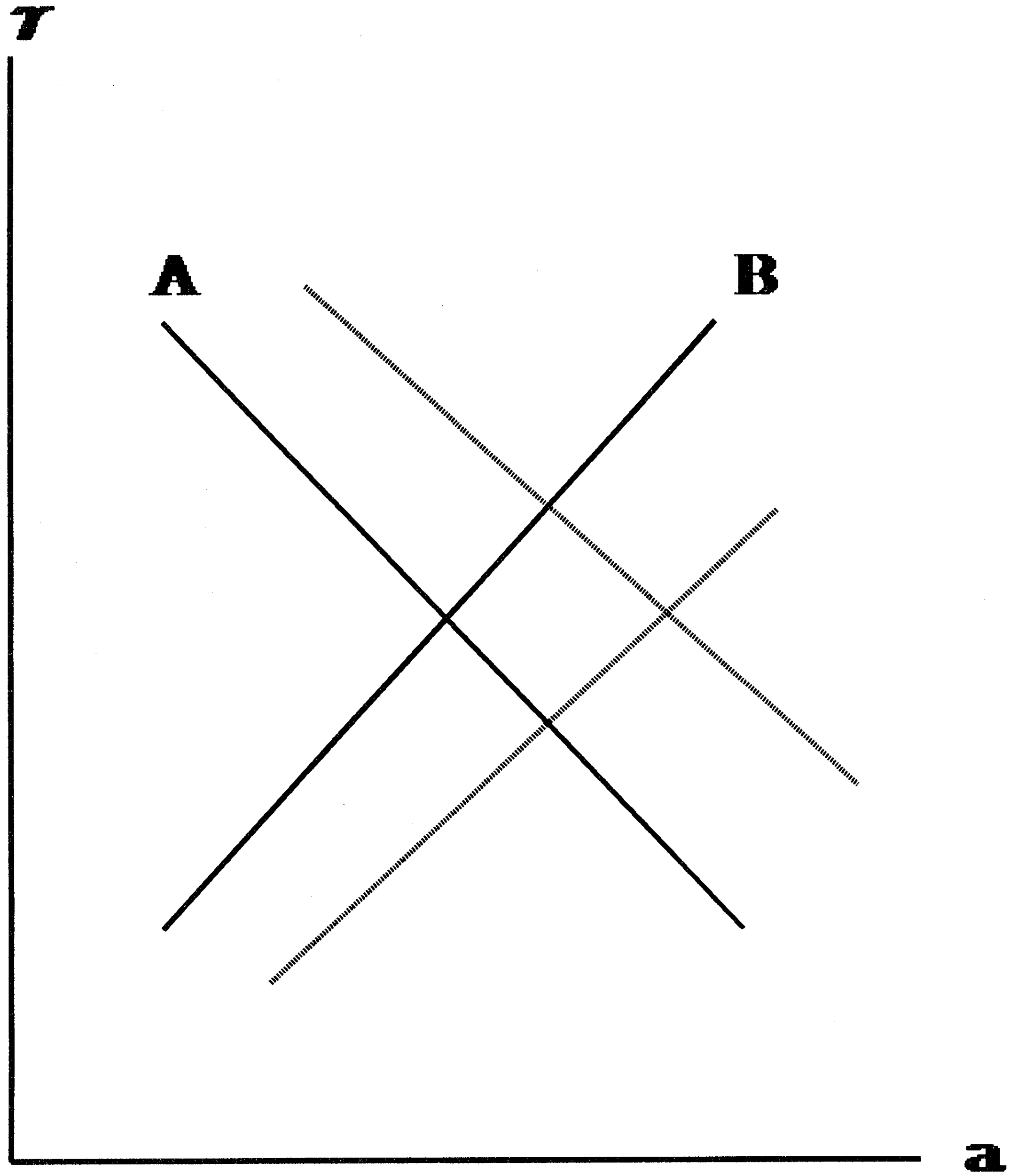

FIGURE 1