DISCUSSION PAPER SERIES

Discussion paper No.49

Fiscal Competition, Decentralization, Leviathan, and Growth

Ken Tabata
Kwansei Gakuin University

November 2009

SCHOOL OF ECONOMICS

KWANSEI GAKUIN UNIVERSITY

1-155 Uegahara Ichiban-cho

Nishinomiya 662-8501, Japan

Fiscal Competition, Decentralization, Leviathan, and Growth *

Ken Tabata †

November 17, 2009

Abstract

This paper studies the implications of different fiscal regimes (i.e. centralized vs decentralized) for economic growth and welfare by incorporating Wilson (2005)-type fiscal competition model into a Barro (1990)-type endogenous growth model. We show that fiscal decentralization is more desirable than fiscal centralization for economic growth, when the degree of selfishness of central government bureaucrats is high, and the relative political power of the young to the old is low. We also show that the growth-maximizing fiscal regime is also welfare-maximizing.

Fiscal competition; Decentralization; Leviathan; Overlapping generations;
JEL classification: H71; H72; E62

*I am grateful to Akira Momota, Etsuro Shioji, Yasusada Murata, and seminar participants at Osaka Prefecture University, Hitotsubashi University, Nihon University and Kwansei Gakuin University. I acknowledge financial support by the Grand-in-Aid for Young Scinentist (B) No 20730217, the Ministry of Education, Culture, Sports, Scinence and Technology, Japan.

†Corresponding author.Address: Kwansei Gakuin University School of Economics 1-155 Ichiban-cho Uegahara, Nishinomiya-shi, Hyogo-ken 662-8501 Japan E-mail tabataken@kwansei.ac.jp

1 Introduction

A common phenomenon in both industrialized and developing countries has been the devolution of the internal fiscal system. Therefore, the effect of fiscal decentralization on government policies and its consequent impacts on economic growth has been a major concern of both academic researchers and policy makers. However, existing empirical evidence on the relationship between fiscal decentralization and growth are mixed. While some authors find a negative relationship (e.g., Danvoodi and Zou 1998, Zhang and Zou 1998), others find a positive relationship or none at all (e.g., Lin and Liu 2000, Akai and Sakata 2002). [1]

One of the significant channels by which fiscal decentralization affects growth is intense fiscal competition among sub-central governments. Brenman and Buchanan (1980) argued that competition for mobile factors of production may help solve economic distortion induced by a self-interested Leviathan government that abuses tax revenues for private gains. Owners of production factors are sensitive to public sector inefficiencies and allocate their factors in jurisdictions where taxes are low and public services are good. Because immobile voters suffer from factor dislocation, they will become disappointed with their government. Therefore, politicians, who want to be re-elected, are forced to provide better conditions for mobile factors of production by offering better services at lower taxes. Their discretion is reduced and the Leviathan is tamed. Consequently, fiscal competition corrects public sector inefficiencies and may positively affect growth.

Studies such as those by Edwards and Keen (1996), Sato (2003), and Arikan (2004) formalize this idea in the static fiscal competition model and show two-competing influences of fiscal competition on economic efficiency. Fiscal competition indeed increases the pressure on the state to use its tax revenues more efficiently. However, the increased mobility of the tax base induces fiscal externalities and under-provision of public sector services. Consequently, the overall impact of fiscal competition on economic efficiency is ambiguous. On the other hand, Wilson (2005) considers the situation where the electorate or their representatives have substantial control over the tax rate, but cannot adequately make the required innumerable specific expenditure decisions. Thus, they must delegate these decisions to self-interested government bureaucrats, leaving the electorate with only rudimentary methods of control. In this case, Wilson (2005) shows that the efficiency-enhancing effect of fiscal competition dominates the efficiency-deteriorating effect, and

[1] Feld et al. (2008) provides an excellent survey of the theoretical and empirical literature on fiscal decentralization and growth.

thus fiscal competition improves economic efficiency.

These existing studies are quite appealing and plausible. However, these studies employ static models and thus cannot explicitly examine how intense fiscal competition induced by fiscal decentralization influences economic growth. To my knowledge, the literature on fiscal competition and growth is still limited. [2] In particular, few growth models focus on the role of fiscal competition as a remedy for public sector inefficiencies induced by a self-interested Leviathan government. Rauscher (2005, 2007) authored two exceptional studies. Rauscher (2005) follows the tradition of the optimum-taxation-and-growth literature spurred by Judd (1985) and constructs an endogenous growth model with fiscally competing Leviathans. Rauscher (2005) also showed that the effect of intense fiscal competition on growth is generally ambiguous, and depends on the parameter value of the government's elasticity of inter-temporal substitution. If the value of this parameter is sufficiently greater than 1, the effect of intense fiscal competition on growth is unambiguously negative. On the other hand, Rauscher (2007) constructs an endogenous growth model with public sector innovation and fiscally competing Leviathans. Raucher (2007) showed that fiscal competition reduces the frequency of public sector innovation and thus lowers economic growth for reasonable parameter values. These existing growth studies are quite interesting and valuable. However, due to the complicated structures of their models, it is sometimes difficult to understand the economic intuitions behind their results. Moreover, it is sometimes hard to compare their implications with those of existing static models. In this sense, these existing growth models are not very tractable. Therefore, to complement existing growth studies, this paper constructs a tractable growth model that enables us to analytically examine how intense fiscal competition induced by fiscal decentralization influences economic growth. [3]

This paper develops the Diamond (1965)-type two-period overlapping generations model with Barro (1990)-type productive government expenditures and Wilson (2005)-type fiscal competition models. Following Wilson (2005), we consider the system of regions where tax rate and allocation of government expenditure are chosen by separate decision-makers. We assume that the tax rate is determined by the politicians who are elected at the beginning of each period. The politicians in the legislature have substantial control

[2]This point is also stressed by Becker and Rauscher (2007). Their introduction provides a recent survey of the theoretical literature on fiscal competition and growth.

[3]This paper is also related to a large body of literature on the effects of public infrastructure funding on capital accumulation and growth. Examples of work in this literature include Barro (1990), Futagami, Morita and Shibata (1993), Glomm and Ravikumar (1994).

over tax rate. However, they cannot adequately handle the innumerable specific expenditure and regulatory decisions and must therefore delegate these decisions to government bureaucrats. Thus, the allocation of government expenditure is determined by government bureaucrats. However, as stressed in the literature on the "leviathan government, " government bureaucrats may not be perfect agents of politicians or voters. [4] Thus, given the choice of tax rate by the politicians, self-interested government bureaucrats, who are neither wholly selfish nor totally benevolent, determine their favored allocation of government expenditures. Therefore, the politicians who wants to maximize a weighted average utility of all voters in that period, decide their tax rate explicitly accounting for the incentive effects that their taxes create for expenditure decisions of government bureaucrats.

Under these public policy-making processes, this paper studies the implications of different fiscal regimes (i.e. centralized vs decentralized) for economic growth and welfare in a simple dynamic model of a national economy with many indentical and independent small regions. Then, we show that fiscal decentralization is more desirable than fiscal centralization for economic growth, when the degree of selfishness of central government bureaucrats is high, and the relative political power of the young to the old is low. We also show that the growth-maximizing fiscal regime is also welfare-maximizing. These results are explained as follows. In the decentralized regime, under the small region assumption, local government bureaucrats in each region behave competitively to attract capital into their region by allocating more tax revenues for productive government expenditures. This expenditure competition highers the growth rate in the decentralized regime relative to that in the centralized regime where there are no fiscal competitions for capital among local jurisdictions. However, politicians in each region also behaves competitively to attract capital into their regions by lowering their tax rate. This tax competition decreases total tax revenue and productive government expenditures, and lowers the growth rate in the decentralized regime relative to that in the centralized regime. [5] Therefore, the overall growth effect of fiscal decentralization depends on these two competing effects of fiscal competitions. This paper shows that the share of tax revenue devoted to productive government expenditure in the centralized regime is negatively related to the degree of selfishness of central government bureaucrats, and the relative political power of the young to the old. These results suggest

[4] As stressed by Wilson (2005), this appears to be a good description of the situation in most government bureaucracies because the electorate can easily monitor what happens to tax rates but has a harder time monitoring the quality of different expenditures.

[5] Although this lower tax rate leads to higher capital accumulation through increased wages, the former negative effect always dominates the latter positive effect.

the lack of expenditure competition provides substantial negative impacts upon per-capita output growth rate in the centralized regime, when the degree of selfishness of central government bureaucrats is high, and the relative political power of the young to the old is low. Therefore, we can confirm that fiscal decentralization is more desirable than fiscal centralization for economic growth, when the degree of selfishness of central government bureaucrats is high, and the relative political power of the young to the old is low. Moreover, we show that the welfare level of individuals is positively related with growth rate of the economy. Therefore, we can confirm that the growth-maximizing fiscal regime is also welfare-maximizing.

This paper is organized as follows. Section 2 examines the case where the eonomy employs decentralized fiscal regime. Section 3 examines the case where the eonomy employs centralized fiscal regime. Section 4 presents growth and welfare comparisons of these fiscal regimes. Finally, Section 5 provides concluding remarks.

2 Decentralized Regime

This paper considers a national economy with $I \geq 1$ identical regions. We first consider the case where the economy employs the fiscal regime denoted "decentralized regime". In this regime, each region decides independently on the size and the composition of its respective public budget. In the present model, we focus on the case where the economy consists of many identical and independent jurisdictions (i.e. I is sufficiently large number). Therefore, we employ the small region assumption under which each region faces given rental price of capital. Each region i is populated by two-period lived overlapping generations. The population size of each generation in this economy is L and remains constant over time (i.e. $L_t = L$ holds for all t). All households are assumed to be immobile, and each region i has $L_{i,t} = L/I$ indentical young (old) agents.

2.1 Households

Agents derive utility from their own consumption in both youth and old age. Thus, the lifetime utility of the agent in generation t in region i is expressed as:

$$u_{i,t} = (c_{i,t})^{\gamma}(d_{i,t+1})^{1-\gamma}, \tag{1}$$

where $c_{i,t}$ and $d_{i,t+1}$ denote the consumption when young and old, respectively, and $\gamma \in (0, 1)$ expresses the weight given to the consumption when young.

In youth, each agent is endowed with one unit of labor, supplies this labor to local firms, and obtains wage income. An agent in generation t divides his or her wage income $w_{i,t}$ between his or her own current consumption $c_{i,t}$ and saving $s_{i,t}$. In old age, agents retire and consume their returns on savings $(1+r_{t+1})s_t$. Since agents invest their savings where they attain the highest return, the same interest rate r_{t+1} must prevail in all region in equilibrium. Thus, the lifetime budget constraints of the agent in generation t in region i are:

$$c_{i,t} + s_{i,t} = w_{i,t}, \tag{2}$$

$$d_{i,t+1} = (1 + r_{t+1})s_{i,t}. \tag{3}$$

By maximizing (1), subject to (2) and (3), we obtain the following saving equation:

$$s_{i,t} = (1 - \gamma)w_{i,t}. \tag{4}$$

The indirect utility function of the agent in generation t in region i is then given by

$$v_{i,t} = \Gamma(1 + r_{t+1})^{1-\gamma} w_{i,t}, \tag{5}$$

where $\Gamma \equiv \gamma^{\gamma}(1-\gamma)^{1-\gamma}$.

2.2 Firms and capital market

In each region i, competitive firms produces a single output. The production function of a representative firm in region i is represented by $Y_{i,t} = F(K_{i,t}, L_{i,t}) = A(K_{i,t})^{\alpha}(p_{i,t}L_{i,t})^{1-\alpha}$, $\alpha \in (0,1)$, where $Y_{i,t}$, $K_{i,t}$, $L_{i,t}$ stand for output, capital stock and labor, respectively, employed by the firm in region i. As in Barro (1990), the productivity of worker is enhanced by per-capita productive government expenditure, $p_{i,t}$, where $p_{i,t} \equiv \frac{P_{i,t}}{L_{i,t}}$. Here, $P_{i,t}$ stands for the productive government expenditure provided by the local government in region i. This production function can be written in an intensive form as $y_{i,t} = F(k_{i,t}, p_{i,t}) = Ak_{i,t}^{\alpha}p_{i,t}^{1-\alpha}$, where $y_{i,t} \equiv \frac{Y_{i,t}}{L_{i,t}}$, $k_{i,t} \equiv \frac{K_{i,t}}{L_{i,t}}$.

Capital is freely moblile across regions, which requires the net of tax return of capital to be equal for all regions. We assume that each local government levies a proportional tax $\tau_{i,t}$ on the total revenue of the firm in each region. Thus, denoting the rental price of capital as ρ_t, the per-capita capital demanded in region i is determined by

$$\rho_t = (1 - \tau_{i,t})F_k(k_{i,t}, p_{i,t}), \quad \forall i. \tag{6}$$

Solving (6) for $k_{i,t}$ yields the per-capita capital demand function $k(\rho_t, p_{i,t}, \tau_{i,t})$, with $\frac{\partial k_{i,t}}{\partial \rho_t} = \frac{1}{(1-\tau_{i,t})F_{kk}} < 0$, $\frac{\partial k_{i,t}}{\partial p_{i,t}} = -\frac{F_{kp}}{F_{kk}} > 0$, and $\frac{\partial k_{i,t}}{\partial \tau_{i,t}} = -\frac{F_k}{(1-\tau_{i,t})F_{kk}} < 0$.

Assuming that capital depreciates fully, an arbitrage condition $\rho_t = 1 + r_t$ holds because the capital market is competitive. Additionally, the wage rate in region i, $w_{i,t}$, is given by

$$w_{i,t} = (1 - \tau_{i,t})F(k_{i,t}, p_{i,t}) - \rho_t k_{i,t}. \tag{7}$$

The total capital endowment in this economy in period t is given by K_t. Thus capital allocations in period t must satisfy $\sum_{i=1}^{I} k_{i,t}L_{i,t} = K_t$. Noting $L_{i,t} = \frac{L}{I}$, this capital endowment condition is rewritten as

$$\sum_{i=1}^{I} k_{i,t} = Ik_t, \tag{8}$$

where $k_t \equiv \frac{K_t}{L}$.

2.3 Policy-making processes

Following Wilson (2005), we consider the system of regions where tax rate and allocation of government expenditure are chosen by separate decision-makers. We assume that the tax rate is determined by the politicians who are elected at the beginning of each period t. The politicians in the legislature have substantial control over tax rate. However, they cannot adequately handle the innumerable specific expenditure and regulatory decisions that affect the tax base and must therefore delegate these decisions to government bureaucrats. Thus, we assume that the allocation of government expenditure is determined by government bureaucrats who gain their power through delegation from elected politicians. However, as stressed in the literature on the "leviathan government, " government bureaucrats may not be perfect agents of politicians or voters. Simply put, we assume that government bureaucrats are neither wholly selfish nor totally benevolent, but that government bureaucrats are concerned about both their own welfare (obtained from corrupt earnings) and their voters' welfare.

At the beginning of each period t, the tax rate $\tau_{i,t}$ is determined within a probabilistic voting framework (See, e.g., Lindbeck and Weibull, 1987). In this framework, political platforms in period t in region i simply maximize a weighted average utility of voters in period t in region i. Thus, the equilibrium tax policy maximizes a political objective function, given by:

$$V_{i,t} = \lambda ln(v_{i,t}) + (1 - \lambda)ln(v_{i,t-1}), \tag{9}$$

where

$$v_{i,t} = \Gamma(\rho_{t+1})^{1-\gamma} w_{i,t},$$

and

$$v_{i,t-1} = (c_{i,t-1})^{\gamma}(\rho_t s_{i,t-1})^{1-\gamma}.$$

From (5), $v_{i,t}$ and $v_{i,t-1}$ express the welfare level of the young (i.e., generation t), and the old (i.e., generation $t-1$) in period t in region i, respectively, and $\lambda \in [0,1]$ expresses the relative political power of the young. In this model, the population size of the young $\frac{L}{I}$ in period t is equal to that of the old $\frac{L}{I}$. Thus, the parameter λ simply expresses the relative political bargaining power of the young caused by factors other than its population size.

Given the tax choices made by politicians, government bureaucrats in region i choose their level of productive government expenditures. The government bureaucrats' objective in the present model is to maximize a weighted sum of the utility obtained from corrupt earnings and politician's objective function $V_{i,t}$ defined in (9). The objective function is thus given by:

$$W_{i,t} = \psi ln(z_{i,t}) + (1-\psi)[\lambda ln(v_{i,t}) + (1-\lambda) ln(v_{i,t-1})], \tag{10}$$

where $z_{i,t}$ is the part of the government's budget not spent on productive public expenditures or corrupt earnings, expressed on a per-capita basis. We interpret that $z_{i,t}$ includes any unproductive government expenditure which benefits government bureaucrats only, and does not benefits others residents. $\psi \in [0,1]$ expresses the weight given to corrupt earnings. A larger ψ implies are less benevolent or more selfish.

Additionally, the budget constraint that local government bureaucrats in region i face is given by:

$$p_{i,t} + z_{i,t} = \tau_{i,t} F(k_{i,t}, p_{i,t}). \tag{11}$$

In the following, our analysis focus on the case where complete elimination of $z_{i,t}$ is impossible. The part of governemnet budget is spent unproductively due to some technical reasons. We specify the maximum attainable share of tax revenue devoted to productive government expenditure as $\xi \in (0,1)$. Thus the technical constraint for $p_{i,t}$ is given by

$$0 \le p_{i,t} \le \xi \tau_{i,t} F(k_{i,t}, p_{i,t}). \tag{12}$$

We assume that the value of ξ is sufficiently large enough and almost equals to 1. This assumption is restrictive but simplifies the following analysis greatly.

2.4 Government bureaucrats

Under these public policy-making processes, we first analyze the behavior of local government bureaucrats, given tax choices made by politicians. Local government bureaucrats are assumed to have no control over their taxes $\tau_{i,t}$. However, as expected from (10) with $\frac{\partial k_{i,t}}{\partial p_{i,t}} > 0$, they can increase their tax revenue through their choice of productive government expenditures $p_{i,t}$ by attracting capital $k_{i,t}$ into their regions. Since we employ the small region assumption, local government bureaucrats in each region i consider the rental price of capital ρ_t as given. [6] Thus, given the tax choices $\tau_{i,t}$ made by politicians and the rental price of capital ρ_t, local government bureaucrats choose their level of $p_{i,t}$ to maximize (10), subject to (6), (7), (11), (12), and $k_{i,t} = k(\rho_t, p_{i,t}, \tau_{i,t})$. Then, we obtain:

$$\begin{aligned} p_{i,t} &= \xi \tau_{i,t} F(k_{i,t}, p_{i,t}), \\ &= \xi^{\frac{1}{\alpha}} (\tau_{i,t})^{\frac{1}{\alpha}} A^{\frac{1}{\alpha}} k_{i,t}. \end{aligned} \tag{13}$$

Appendix A explains the derivations of (13). Equation (13) implies that the maximum attainable share of tax revenue are devoted to the productive government expenditure, although local government bureaucrats are concerned about their corrupt earnings. This somewhat counter-intuitive result is derived from intense expenditure competition for capital among local jurisdictions. In the small region case, local government bureaucrats in each region behave competitively to attract capital into their region by increasing their level of productive government expenditure. This intense expenditure competition among local jurisdictions generate externalities under regional capital mobility, increasing the local government bureaucrats' marginal value of productive government expenditure relative to corrupt earnings. Consequently, the maximum attainable share of tax revenue are devoted to the productive government expenditure.

2.5 Politicians

Next, we analyze the behavior of politicians. Politicians in region i decide their taxes $\tau_{i,t}$ by explicitly accounting for the incentive effects that their taxes create for the expenditure decisions of local government bureaucrats. The respose function of local government bureaucrats is given by (13). Since we employ the small region assumption, the politicians in region i also consider the rental price of capital ρ_t as given. Thus, given the rental price of

[6] We also assume that local government bureaucrats and politicians take the rental price of capital in the next period ρ_{t+1} as given. Thus local government bureaucrats (politicians) decide their level of $p_{i,t}$ ($\tau_{i,t}$) without accounting for the effects that their choice of $p_{i,t}$ ($\tau_{i,t}$) influence the evolutions of capital. This assumption is also restrictive, but simplifies our analysis greatly.

capital ρ_t, politicians in region i choose their level of $\tau_{i,t}$ as to maximize (9), subject to (6),(7), (11), (13) and $k_{i,t} = k(\rho_t, p_{i,t}, \tau_{i,t})$. Then, we obtain:

$$\tau_{i,t} = \frac{1-\alpha}{1+\alpha} \equiv \tau^D, \tag{14}$$

Appendix B explains the derivations of (14). In the small region case, the politicians in region i also behave competitively to attract capital $k_{i,t}$ into their region by lowering their level of tax rate. The equilibrium tax rate τ^D in (14) is obtained as a result of this intense tax competitions among local jurisdictions. We will explain it rigorously later by comparing the result of decentralized regime with that of centralized regime.

2.6 Growth and welfare

The market clearing condition for capital in this economy is given by $K_{t+1} = \sum_{i=1}^{I} s_{i,t}L_{i,t}$. Since we assume indentical regions, every local governments choose the same tax rates (i.e. $\tau_{i,t} = \tau_t$), and the same level of productive government expenditure (i.e. $p_{i,t} = p_t$). Consequently, the per-capita capital, wage rate, and savings must be the same in all regions (i.e. $k_{i,t} = k_t$, $w_{i,t} = w_t$, and $s_{i,t} = s_t$). Therefore, capital market equilibrium condition is rewiritten as

$$k_{t+1} = s_t. \tag{15}$$

By substituing (4),(6),(7), (13), (14) into (15), the gross per-capita output growth rate G^D in the decentralized regime is described by:

$$\frac{k_{t+1}}{k_t} = (1-\gamma)(1-\alpha)A^{\frac{1}{\alpha}}T(\tau^D)\xi^{\frac{1-\alpha}{\alpha}} \equiv G^D. \tag{16}$$

where

$$T(\tau^D) \equiv (1-\tau^D)(\tau^D)^{\frac{1-\alpha}{\alpha}}.$$

Moreover, by substituting (6), (7),(13), (14) and $1 + r_t = \rho_t$ into (5), and rearranging it with (16), the indirect utility function of the agent in generation t, v_t^D, in the decentralized regime is given by:

$$v_t = \Lambda(G^D)^{t+2-\gamma}k_0 \equiv v_t^D, \tag{17}$$

where $\Lambda \equiv \frac{\gamma^\gamma}{1-\gamma}(\frac{\alpha}{1-\alpha})^{1-\gamma}$, and k_0 expresses the initial capital labor ratio. [7] From (17), we can see that the welfare level of the agent in generation t, v_t, is positively related with economic growth G^D.

[7] The utility function of the initial old agent (i.e. generation -1) is given by $u_{i,-1} = d_{i,0}^{1-\gamma}$. The budget constraint is $d_0 = (1 + r_0)k_0$. Thus, by substituting (6), (13), (14) into u_{-1}, and rearranging it with (16), we obtain the indirect utility function of the initial old agent, v_{-1}^D, in the decentralized regime: $v_{-1}^D = [\frac{1}{1-\gamma}\frac{\alpha}{1-\alpha}G^D k_0]^{1-\gamma}$.

3 Centralized Regime

In this section, we consider the case where the economy employs the fiscal system denoted "centralized regime". In this regime, a central government determines whole physcal policies of all regions. However, since we consider a economy with identical regions, the centralized regime simply corresponds to the one region economy with L identical young (old) agents (i.e. $I = 1$). Therefore, there are no fiscal competitions for capital among local jurisdictions. In addition, even in the system of central government, the tax rate is assumed to be determined by the politicians, and allocation of government expenditure is assumed to be determined by central government bureaucrats. Since descriptions of households' as well as firms' behaivors are the same as those in the previous section, the following subsections mainly describe the behaviors of central government.

3.1 Government bureaucrats

We first analyze the behavior of central government bureaucrats. In the centralized regime, central government bureaucrats consider the per-capita capital k_t as given (i.e. no fiscal competitions for capital among local jurisdictions). In addition, given $\rho_t = (1-\tau_t)F_k(k_t, p_t)$, they can affect the rental price of capital ρ_t through their choice of p_t. [8] [9]

Therefore, given the tax choices τ_t made by politicians and the per-capita capital k_t, central government bureaucrats choose their level of p_t to maximize (10), subject to (6), (7), (11) and (12). Then, we obtain:

$$\begin{aligned} p_t &= \Psi(\psi,\lambda)\tau_t F(k_t, p_t), \\ &= [\Psi(\psi,\lambda)]^{\frac{1}{\alpha}}(\tau_t)^{\frac{1}{\alpha}} A^{\frac{1}{\alpha}} k_t. \end{aligned} \tag{18}$$

where

$$\Psi(\psi,\lambda)\begin{cases} =\xi & \text{if } \hat{\Psi}(\psi,\lambda) \geq \xi, \\ =\hat{\Psi}(\psi,\lambda) & \text{if } \hat{\Psi}(\psi,\lambda) \leq \xi, \end{cases}$$

[8] For simplicity of the following analyses, we assume that central government bureaucrats and politicians take the rental price of capital in the next period ρ_{t+1} as a given. They do not account for whether their choice of p_t and τ_t affects the rental price of capital in the next period through its impact on k_{t+1}. Analogous simplifications are employed in many previous studies such as, for example, Gradstein and Kaganovich (2003) and Ono (2005).

[9] In appendix G, we also examine the case where central governement bureaucrats (politicians in cnetral government) consider the rental price of capital ρ_t as given. Then, we can easily confirm that the main implication of this paper does not alter significantly, even if we employ these alternative assumptions.

and

$$\hat{\Psi}(\psi, \lambda) \equiv \frac{\psi(1-\alpha) + (1-\psi)(1-\alpha)[\lambda + (1-\lambda)(1-\gamma)]}{\psi + (1-\psi)(1-\alpha)[\lambda + (1-\lambda)(1-\gamma)]}.$$

Appendix C explains the derivations of (18). In the following analyses, we focus on the parameter ψ, which expresses the degree of selfishness of central government bureaucrats and the parameter λ, which expresses the political bargaining power of the young relative to the old. To stress these parameters, we define Ψ as $\Psi(\psi, \lambda)$. $\Psi(\psi, \lambda)$ expresses the share of tax revenue devoted to productive government expenditure in the centralized regime, and satisfies $\Psi(\psi, \lambda) \leq \xi$. Since $\Psi(\psi, \lambda) \leq \xi$, the share of productive government expenditure in the centralized regime is lower than that in the decentralized regime. Therefore, lack of expenditure competition for capital in the centralized regime induces larger unproductive government expenditure by central government bureaucrats.

Moreover, $\Psi(\psi, \lambda)$ satisfies the following properties: $\frac{\partial \Psi}{\partial \psi} \leq 0$ and $\frac{\partial \Psi}{\partial \lambda} \geq 0$. $\frac{\partial \Psi}{\partial \psi} \leq 0$ simply indicates that an increase in the degree of selfishness of central government bureaucrats ψ decreases the share of tax revenue devoted to productive government expenditure. $\frac{\partial \Psi}{\partial \lambda} \geq 0$ indicates that an increase in the relative political power of the young relative to the old λ increases the share of tax revenue devoted to productive government expenditure. From (10), we can see that an increase in w_t increases the welfare of the young in period t (i.e. generation t), whereas the increase in ρ_t increases the welfare of the old in period t (i.e. generation $t-1$). Noting these features, from (6), (7) and (9), we can confirm that the marginal welfare effect of p_t on the young agent is larger than the marginal welfare effect of p_t on the old agent (i.e. $\frac{\partial ln(v_t)}{\partial p_t} > \frac{\partial ln(v_{t-1})}{\partial p_t}$ for $\forall p_t$). [10] Therefore, when $\psi > 0$, the higher the relative political power of the young becomes, the higher the share of tax revenue devoted to the productive government expenditure becomes.

3.2 Politicians

Next, we analyze the behavior of politicians. Politicians decide their taxes by explicitly accounting for the incentive effects that their taxes create for the expenditure decisions of central government bureaucrats. In the centralized regime, politicians also consider the per-capita capital k_t as given, and can affect the rental price of capital ρ_t through their choice of τ_t using $\rho_t = (1-\tau_t)F_k(k_t, p_t)$. Therefore, given the per-capita capital k_t , politicians

[10] Given the rental price of capital in the next period ρ_{t+1} and savings in the previous period s_{t-1}, using (7),(8),(10) and (13), we obtain $\frac{\partial lnv_t}{\partial p_t} = (1-\tau_t)(1-\alpha)\frac{1}{p_t}$ and $\frac{\partial lnv_{t-1}}{\partial p_t} = (1-\gamma)(1-\tau_t)(1-\alpha)\frac{1}{p_t}$. Therefore, we can confirm $\frac{\partial lnv_t}{\partial p_t} > \frac{\partial lnv_{t-1}}{\partial p_t}$ for $\forall p_t$.

choose their level of τ_t as to maximize (9), subject to (6),(7), (11) and (13). Then, we obtain:

$$\tau_{i,t} = 1 - \alpha \equiv \tau^C, \tag{19}$$

Appendix D explains the derivations of (19). From (14) and (19), the equilibrium tax rate in the decentralized regime τ^D becomes lower than that in the centralized regime τ^C (i.e. $\tau^D < \tau^C$). Tax competition for capital among local jurisdictions lowers the equilibrium tax rate in the decentralized regime, because politicians in each region tries to attract capital into their region by lowering their tax rate $\tau_{i,t}$.

3.3 Growth and welfare

The market clearing condition for capital in this economy is given by $K_{t+1} = s_t L$. Thus, capital market equilibrium condition is rewiritten as (15). By substituing (4),(6),(7), (18), (19) into (15), the gross per-capita output growth rate G^C in the centralized regime is described by:

$$\frac{k_{t+1}}{k_t} = (1-\gamma)(1-\alpha)A^{\frac{1}{\alpha}} T(\tau^C)[\Psi(\psi,\lambda)]^{\frac{1-\alpha}{\alpha}} \equiv G^C. \tag{20}$$

where

$$T(\tau^C) \equiv (1-\tau^C)(\tau^C)^{\frac{1-\alpha}{\alpha}}.$$

Moreover, by substituting (6), (7),(18), (19) and $1 + r_t = \rho_t$ into (5), and rearranging it with (20), the indirect utility function of the agent in generation t, v_t^C, in the centralized regime is given by:

$$v_t = \Lambda (G^C)^{t+2-\gamma} k_0 \equiv v_t^C, \tag{21}$$

where $\Lambda \equiv \frac{\gamma^\gamma}{1-\gamma}(\frac{\alpha}{1-\alpha})^{1-\gamma}$, and k_0 expresses the initial capital labor ratio. [11] From (21), we can see that the welfare level of the agent in generation t, v_t, is again positively related with economic growth G^C.

4 Comparison of fiscal regimes

In this section, we compare the different fiscal regimes by analyzing growth rate and welfare in the decentralized regime and those in the centralized regime.

[11] The indirect utility function of the initial old agent, v_{-1}^C, in the centralized regime is given by $v_{-1}^C = [\frac{1}{1-\gamma}\frac{\alpha}{1-\alpha} G^C k_0]^{1-\gamma}$.

4.1 Growth

By utilizing (16) and (20), we first compare the growth rate in the decentralized regime with that in the centralized regime .

In the decentralized regime, as discussed in section 2-4, the maximum attainable sahre of tax revenue are devoted to the productive government expenditure due to the expenditure competition for capital among local jurisdictions. However, in the centralized regime, the share of productive government expenditure decreases due to the lack of expenditure competition for capital. Therefore, expenditure competition highers the growth rate in the decentralized regime G^D relative to that in the centralized regime G^C. The comparison of $\xi^{\frac{1-\alpha}{\alpha}}$ in (16) and $[\Psi(\psi, \lambda)]^{\frac{1-\alpha}{\alpha}}$ in (20) expresses these growth effects of expenditure competition. Since $\Psi(\psi, \lambda) < \xi$, we can confirm that expenditure competition highers the growth rate in the decentralized regime relative to that in the centralized regime G^C.

Moreover, as discussed in section 3-1, the tax rate in the decentralized regime τ^D becomes lower than that in the centralized regime τ^C due to the tax competition for capital among local jurisdictions. This decrease in the tax rate τ provides two competing impacts on per-capita output growth rate in the decentralized regime. First, the decrease in τ increases the wage rate from (7), enhancing capital accumulation and thus positively affecting per-capita output growth rate in the decentralized regime. We denote this as the positive growth effect of tax competition. However, the decrease in τ decreases the tax revenue from (11), decreasing productive government expenditure, and thus negatively affecting per-capita output growth rate in the decentralized regime. We denote this as the negative growth effect of tax competition. The comparison of $T(\tau^D)$ in (16) and $T(\tau^C)$ in (20) expresses these growth effects of tax competition. From the properties of $T(\tau)$, we can easily confirm that the relation $T(\tau^D) < T(\tau^C)$ holds. [12] This result implies that the negative growth effect of tax competition always dominates the positive growth effect, and thus tax competition lowers the growth rate in the decentralized regime relative to that in the centralized regime.

These results suggest that expenditure competition highers the growth rate in the decentralized regime relative to that in the centralized regime, whereas the tax competition lowers the growth rate in the decentralized regime relative to that in the centralized regime. Therefore, whether $G^D > G^C$ or $G^D < G^C$ holds depends upon these two competing effects of fiscal

[12] By differentiating $T(\tau) = (1-\tau)(\tau)^{\frac{1-\alpha}{\alpha}}$ with respect to τ, we can see that the relations $\frac{\partial T}{\partial \tau} > 0\ \forall \tau \in (0, 1-\alpha)$ and $\frac{\partial T}{\partial \tau} < 0\ \forall \tau \in (1-\alpha, 1)$ hold. In addition, from (14) and (19), the relation $\tau^D < \tau^C = 1-\alpha$ holds. Therefore, we can easily confirm the relation $T(\tau^D) < T(\tau^C)$ holds.

competitions.

From (16) and (20), we have the following relationship

$$G^D \geq G^C \Leftrightarrow [\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}} \geq \frac{\Psi(\psi,\lambda)}{\xi}, \tag{22}$$

where

$$[\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}} = \frac{2^{\frac{\alpha}{1-\alpha}}}{(1+\alpha)^{\frac{1}{1-\alpha}}}.$$

The larger value of $[\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}}$ implies that the negative effect on G^D due to the tax competition becomes smaller, whereas the smaller value of $\frac{\Psi(\psi,\lambda)}{\xi}$ implies that the positive effect on G^D due to the expenditure competition becomes larger. Therefore, suppose the latter positive effect dominates the former negative effect (i.e. $[\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}} > \frac{\Psi(\psi,\lambda)}{\xi}$), fiscal decentralization is more desirable than fiscal centralization for economic growth.

From (22), comparing the growth rate in the decentralized regime with that in the centralized regime, we obtain the following proposition 1. In the proposition 1, we denote the value of ψ (λ) which satisfies $\frac{\Psi(\psi,\lambda)}{\xi} = [\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}}$ as $\hat{\psi}$ ($\hat{\lambda}$).

Proposition 1 . *Comparing the growth rate in the decentralized regime with that in the centralized regime, the following statements hold:*

(1) When $[\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}} < \frac{\Psi(1,\lambda)}{\xi}$,

  i) suppose $\psi \in [0, \hat{\psi})$, *then the relation* $G^C > G^D$ *holds.*

  ii) suppose $\psi \in (\hat{\psi}, 1]$, *then the relation* $G^C < G^D$ *holds.*

(2) When $\frac{\Psi(\psi,0)}{\xi} < [\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}} < \frac{\Psi(\psi,1)}{\xi}$,

  i) suppose $\lambda \in [0, \hat{\lambda})$, *then the relation* $G^C < G^D$ *holds.*

  ii) suppose $\lambda \in (\hat{\lambda}, 1]$, *then the relation* $G^C > G^D$ *holds.*

Proof of Proposition 1 is shown in Appendix E and F. Proposition 1-1 indicates that growth rate in the decentralized regime is higher (lower) than that in the centralized regime, if the degree of selfishness ψ of central government bureaucrats is sufficiently high (low) to satisfy $\psi \in (\hat{\psi}, 1]$ ($\psi \in [0, \hat{\psi})$). As stated in section 3-1, the share of tax revenue devoted to productive government expenditure $\Psi(\psi, \lambda)$ in the centralized regime is negatively related to the degree of selfishness ψ of central government bureaucrats. Therefore, when the value of ψ is large (small), the share of tax revenue devoted to the productive government expenditure becomes low (high). Conseuquently, the lack of expenditure competition provides substantial (unsubstantial) negative impacts upon per-capita output growth rate G^C in the centralized regime. Therefore, the relation $G^C < G^D$ ($G^C > G^D$) is more likely to hold, when the value of ψ is sufficiently large (small).

Proposition 1-2 indicates that growth rate in the decentralized regime is higher (lower) than that in the centralized regime, if the relative political power of the young to the old is sufficiently low (high) to satisfy $\lambda \in [0, \hat{\lambda})$ ($\lambda \in (\hat{\lambda}, 1]$). As stated in section 3-1, the share of tax revenue devoted to productive government expenditure $\Psi(\psi, \lambda)$ in the centralized regime is positively related to the relative political power of the young λ. Therefore, when the value of λ is small (large), the share of tax revenue devoted to the productive government expenditure becomes low (high). Conseuquently, the lack of expenditure competition provides substantial (unsubstantial) negative impacts upon per-capita output growth rate G^C in the centralized regime. Therefore, the relation $G^C < G^D$ ($G^C > G^D$) is more likely to hold, when the value of λ is sufficiently small (large).

These results of proposition 1 suggest that fiscal decentralization is more desirable than fiscal centralization for economic growth, when the degree of selfishness of central government bureaucrats ψ is high, and the relative political power of the young to the old λ is low, because the share of tax revenue devoted to productive government expenditure is low in the centralized regime. Numerical simulation result in Figure 3 confirms these results. [13] In the figure, the value of lambda expresses the value of λ, and the value of psi expresses the value of ψ. Then, the region where the value of z-axes is 1 (0) expresses the parameters in which the relation $G^C < G^D$ ($G^C > G^D$) holds. We can confirm that the relation $G^C < G^D$ is likely to hold when the value of ψ is high and the value of λ is low.

4.2 Welfare

Next, by utilizing (17) and (21), we briefly compare the welfare level of individuals in the decentralized regime with that in the centralized regime. As discussed in section 3 and 4, v_t^D in (17) (v_t^C in (21)) expresses the welfare level of individuals in generation t which is attained when the economy employs the decentralized regime in period 0 and maintains it for all subsequent

[13] We set the baseline parameterization of the model as follows; $\alpha = 0.35$, $\gamma = 0.6$, $\xi = 0.9$, A=4.5. Then, given these values, we increase the value of λ and ψ from 0 to 1 in increments of 0.01.

periods. From (17) and (21), we have the following relationship

$$v_t^D \geq v_t^C \Leftrightarrow G^D \geq G^C. \tag{23}$$

From (23), comparing the welfare level of individuals in generation t in the decentralized regime with that in the centralized regime, we obtain the following proposition 2.

Proposition 2 . *The growth-maximizing fiscal regime is also welfare-maximizing for any generation.*

Proposition 2 is easily confirmed from (23). Therefore, together with the reuslts of Proposition 1, we can find that fiscal decentralization is more desirable than fiscal centralization for welfare of individuals, when the degree of selfishness of central government bureaucrats is high, and the relative political power of the youg to the old is low.

5 Concluding Remarks

This paper studyed the implications of different fiscal regimes (i.e. centralized vs decentralized) for economic growth and welfare. We showed that fiscal decentralization is more desirable than fiscal centralization for economic growth, when the degree of selfishness of central government bureaucrats is high, and the relative political power of the young to the old is low. We also showed that the growth-maximizing fiscal regime is also welfare-maximizing.

In this paper, we employ several restrictive assumptions or specifications to obtain intuitive analytical results. In particular, politicians and bureaucrats decide their level of tax and public expenditure without accounting for the effects that their choices influence the evolutions of capital. However, to understand the relationship between fiscal decentralization and growth in more depth, this assumption might be too restrictive. Therefore, extending our analysis using dynamic game framework must be a promising direction for future research.

References

[1] Akai, N. and M. Sakata, (2002). " Fiscal Decentralization Contributes to Economic Growth: Evidence from State-Level Cross-Section Data for the United States", *Journal of Urban Economics* 52, 93–108.

[2] Arikan, G.G.,(2004). "Fiscal decentralization : A remedy for corruption ?", *International Tax and Public Finance* 11,175–194.

[3] Barro, R.J., (1990). "Government spending in a simple model of endogenous growth", *Journal of Political Economy* 98, S103–S125.

[4] Becker, D. and M. Rauscher,(2007). " Fiscal Competition in Space and Time: An Endogenous-Growth Ap-proach", mimeo, University of Rostock.

[5] Brennan, G. and J.M. Buchanan, (1980). The Power to Tax, Cambridge University Press, Cambridge.

[6] Davoodi, H. and H. Zou, (1998). "Fiscal Decentralization and Economic Growth: A Cross-Country Study", *Journal of Urban Economics* 43, 244–257.

[7] Diamond, P.A., (1965). "National Debt in a Neoclassical Growth Model", *American Economic Review* 55, 1126–1150.

[8] Edwards, J. and M. Keen,(1996). "Tax competition and Leviathan", *European Economic Review* 40, 113 –134.

[9] Feld, L.P., T. Baskaran and J. Schnellenbach, (2008). "Fiscal Federalism, Decentralization and Economic Growth: A Meta-analysis", paper presented at 64th congress of the international Institute of public finance.

[10] Futagami, K., Morita, Y. and A. Shibata, (1993). "Dynamic Analysis of an Endogenous Growth Model with Public Capital", *Scandinavian Journal of Economics* 95, 607–625.

[11] Gradstein, M. and M. Kaganovich, (2004). "Aging population and education finance", *Journal of Public Economics* 88, 2469–2485.

[12] Glomm, G. and B. Ravikumar, (1994). "Public investment in infrastructure in a simple growth model", *Journal of Economic Dynamics and Control*18, 1173-1187

[13] Hoyt, W. H.,(1991). "Property taxation, Nash equilibrium, and market power", *Journal of Urban Economics* 30, 123–131.

[14] Lin, J.Y. and Z. Liu, (2000). "Fiscal Decentralization and Economic Growth in China", *Economic Development and Cultural Change* 49, 1–23.

[15] Lindbeck, A. and J. Weibull, (1987). "Balanced-budget redistribution as the outcome of political competition", *Public Choice* 52, 273-297.

[16] Ono, T., (1997). "The Political Economy of Environmental Taxes with an Aging Population", *Environmental and Resource Economics* 30, 165–194.

[17] Rauscher, M., (2005), "Economic Growth and Tax-Competing Leviathans", *International Tax and Public Finance* 12, 457–474.

[18] Rauscher, M., (2007), "Tax Competition, Capital Mobility and Innovation in the Public Sector", German Economic Review 8, 28–40.

[19] Sato, M. (2003) Tax competition, rent-seeking and fiscal decentralization, *European Economic Review* , 47,19–40

[20] Zhang, T. and H. Zou, (1998). " Fiscal Decentralization, Public Spending, and Economic Growth", *Journal of Public Economics* 67, 221–240.

[21] Wilson, J. D., (2005). "Welfare-improving tax competition ", *Journal of Urban Economics*57, 1-18.

Appendix A: Derivations of (13)

By substituting (9) into (10), the objective function of local government bureaucrats is rewritten as:

$$W_{i,t} = \psi ln(z_{i,t}) + (1-\psi)[\lambda ln(w_{i,t}) + (1-\lambda)(1-\gamma)ln(\rho_t)] + (1-\psi)\Delta$$

where $\Delta \equiv \lambda ln[\Gamma(\rho_{t+1})^{1-\gamma}] + (1-\lambda)ln[(c_{i,t-1})^{\gamma}(s_{i,t-1})^{1-\gamma}]$. Then, by substituting (6), (7) and (11) into the above equation, and differentiating it with $p_{i,t}$ and noting $k_{i,t} = k(\rho_t, p_{i,t}, \tau_{i,t})$, the first order condition for $p_{i,t}$ is given by:

$$\frac{\partial W_{i,t}}{\partial z_{i,t}}[(\tau_{i,t}F_p - 1) + \tau_{i,t}F_k\frac{\partial k_{i,t}}{\partial p_{i,t}}] + \frac{\partial W_{i,t}}{\partial w_{i,t}}(1-\tau_{i,t})F_p \geq 0$$

where $\frac{\partial W_{i,t}}{\partial z_{i,t}} = \frac{\psi}{\tau_{i,t}F - p_{i,t}}$, $\frac{\partial W_{i,t}}{\partial w_{i,t}} = \frac{(1-\psi)\lambda}{w_{i,t}}$, $\frac{\partial k_{i,t}}{\partial p_{i,t}} = -\frac{F_{kp}}{F_{kk}}$ from (6), and strict inequality holds when $p_{i,t} = \tau_{i,t}F(k_{i,t}, p_{i,t})$. Noting $F(k_{i,t}, p_{i,t}) = A(k_{i,t})^{\alpha}(p_{i,t})^{1-\alpha}$, the first order condition for $p_{i,t}$ is rewritten as:

$$\frac{\partial W_{i,t}}{\partial z_{i,t}}[\tau_{i,t}F - p_{i,t}] + \frac{\partial W_{i,t}}{\partial w_{i,t}}(1-\tau_{i,t})(1-\alpha)F \geq 0$$

where $\frac{\partial W_{i,t}}{\partial w_{i,t}} = \frac{(1-\psi)\lambda}{(1-\tau_{i,t})(1-\alpha)F}$. Then, rearranging above equation, we find

$$\frac{1}{p_{i,t}}[\psi + (1-\psi)\lambda] > 0.$$

Thus, noting the constraint for $p_{i,t}$ in (12), we obtain equation (13) as a corner solution.

Appendix B: Derivations of (14)

Equation (9) is rewritten as follows.

$$V_{i,t} = \lambda ln(w_{i,t}) + (1-\lambda)(1-\gamma)ln(\rho_t) + \Delta$$

where $\Delta \equiv \lambda ln[\Gamma(\rho_{t+1})^{1-\gamma}] + (1-\lambda)ln[(c_{i,t-1})^{\gamma}(s_{i,t-1})^{1-\gamma}]$. Then, by substituting (6), (7) and (13) into the above equation and differentiating it with $\tau_{i,t}$ and noting $k_{i,t} = k(\rho_t, p_{i,t}, \tau_{i,t})$, the first order condition for $\tau_{i,t}$ is given by:

$$\frac{\partial V_{i,t}}{\partial w_{i,t}}[-F + (1-\tau_{i,t})F_p\frac{dp_{i,t}}{d\tau_{i,t}}] = 0$$

where $\frac{\partial V_{i,t}}{\partial w_{i,t}} = \frac{\lambda}{w_{i,t}}$, $\frac{dp_{i,t}}{d\tau_{i,t}} \equiv \frac{\partial p_{i,t}}{\partial \tau_{i,t}} + \frac{\partial p_{i,t}}{\partial k_{i,t}}\frac{\partial k_{i,t}}{\partial \tau_{i,t}}$ and $\frac{\partial k_{i,t}}{\partial \tau_{i,t}} = \frac{F_k}{(1-\tau_{i,t})F_{kk}}$ from (6). Here $\frac{dp_{i,t}}{d\tau_{i,t}}$ is derived from (13). Then, noting $F(k_{i,t}, p_{i,t}) = A(k_{i,t})^{\alpha}(p_{i,t})^{1-\alpha}$, the first order condition for $\tau_{i,t}$ is rewritten as:

$$\frac{\partial V_{i,t}}{\partial w_{i,t}}[-F + (1-\tau_{i,t})(1-\alpha)F\frac{1}{p_{i,t}}\frac{dp_{i,t}}{d\tau_{i,t}}] = 0$$

where $\frac{\partial V_{i,t}}{\partial w_{i,t}} = \frac{\lambda}{(1-\tau_{i,t})(1-\alpha)F}$ and $\frac{dp_{i,t}}{d\tau_{i,t}} = \frac{1}{\alpha}\frac{p_{i,t}}{\tau_{i,t}}(1 - \frac{\alpha}{1-\alpha}\frac{\tau_{i,t}}{1-\tau_{i,t}})$. By substituting $\frac{dp_{i,t}}{d\tau_{i,t}}$ into the above equation, we obtain:

$$\frac{\partial V_{i,t}}{\partial w_{i,t}}\{-1 + \frac{1-\tau_{i,t}}{\tau_{i,t}}\frac{1-\alpha}{\alpha}[1 - \frac{\alpha}{1-\alpha}\frac{\tau_{i,t}}{1-\tau_{i,t}}]\} = 0$$

Then, rearranging above equation, we obtain equation (14).

Appendix C: Derivations of (18)

By substituting (9) into (10), the objective function of central government bureaucrats is rewritten as:

$$W_t = \psi ln z_t + (1-\psi)[\lambda ln w_t + (1-\lambda)(1-\gamma)ln\rho_t] + (1-\psi)\Delta$$

where $\Delta \equiv \lambda ln[\Gamma(\rho_{t+1})^{1-\gamma}] + (1-\lambda)ln[(c_{t-1})^{\gamma}(s_{t-1})^{1-\gamma}]$. Then, by substituting (7) and (11) into the above equation, and differentiating it with p_t and noting (6), the first order condition for p_t is given by:

$$\frac{\partial W_t}{\partial z_t}(\tau_t F_p - 1) + \frac{\partial W_t}{\partial w_t}(1-\tau_t)(F_p - F_{kp}k_t) + \frac{\partial W_t}{\partial \rho_t}(1-\tau_t)F_{kp} \geq 0,$$

where $\frac{\partial W_t}{\partial z_t} = \frac{\psi}{\tau_t F - p_t}$, $\frac{\partial W_t}{\partial w_t} = \frac{(1-\psi)\lambda}{w_t}$, $\frac{\partial W_t}{\partial \rho_t} = \frac{(1-\psi)(1-\lambda)(1-\gamma)}{\rho_t}$, and strict inequality holds when $p_{i,t} = \tau_{i,t}F(k_{i,t}, p_{i,t})$. Noting $F(k_t, p_t) = A(k_t)^{\alpha}(p_t)^{1-\alpha}$, the first order condition for p_t is rewritten as:

$$\frac{\partial W_t}{\partial z_t}[\tau_t(1-\alpha)F - p_t] + \frac{\partial W_t}{\partial w_t}(1-\tau_t)(1-\alpha)^2 F + \frac{\partial W_t}{\partial \rho_t}(1-\tau_t)(1-\alpha)F_k \geq 0$$

where $\frac{\partial W_t}{\partial w_t} = \frac{(1-\psi)\lambda}{(1-\tau_t)(1-\alpha)F}$ and $\frac{\partial W_t}{\partial \rho_t} = \frac{(1-\psi)(1-\lambda)(1-\gamma)}{(1-\tau_t)F_k}$. Then, rearranging above equation, we obtain equation (18).

Appendix D: Derivations of (19)

Equation (9) is rewritten as follows.

$$V_t = \lambda ln w_t + (1-\lambda)(1-\gamma) ln \rho_t + \Delta$$

where $\Delta \equiv \lambda ln \Gamma(\rho_{t+1})^{1-\gamma} + (1-\lambda) ln[(c_{t-1})^{\gamma}(s_{t-1})^{1-\gamma}]$. Then, by substituting (7) and (18) into the above equation and differentiating it with τ_t, the first order condition for τ_t is given by:

$$\frac{\partial V_t}{\partial w_t}[-(F - F_k k_t) + (1-\tau_t)(F_p - F_{kp}k_t)\frac{\partial p_t}{\partial \tau_t}] + \frac{\partial V_t}{\partial \rho_t}[-F_k + (1-\tau_t)F_{kp}\frac{\partial p_t}{\partial \tau_t}] = 0$$

where $\frac{\partial V_t}{\partial w_t} = \frac{\lambda}{w_t}$ and $\frac{\partial V_t}{\partial \rho_t} = \frac{(1-\lambda)(1-\gamma)}{\rho_t}$. In addition, $\frac{\partial p_t}{\partial \tau_t}$ is derived from (18) and satisfies $\frac{\partial p_t}{\partial \tau_t} = \frac{1}{\alpha}\frac{p_t}{\tau_t}$. Then, noting $F(k_t, p_t) = A(k_t)^{\alpha}(p_t)^{1-\alpha}$, the first order condition for τ_t is rewritten as:

$$[(1-\alpha)\frac{\partial V_t}{\partial w_t}F + \frac{\partial V_t}{\partial \rho_t}F_k](-1 + \frac{1-\tau_t}{\tau_t}\frac{1-\alpha}{\alpha}) = 0$$

where $\frac{\partial V_t}{\partial w_t} = \frac{\lambda}{(1-\tau_t)(1-\alpha)F}$ and $\frac{\partial V_t}{\partial \rho_t} = \frac{(1-\lambda)(1-\gamma)}{(1-\tau_t)F_k}$ Then, rearranging above equation, we obtain equation (19).

Appendix E: Proof of Proposition 1-1

From (18), the relations $\frac{\partial \Psi}{\partial \psi} < 0$, $\frac{\Psi(0,\lambda)}{\xi} = 1$ and $\frac{\Psi(1,\lambda)}{\xi} = \frac{1-\alpha}{\xi}$ hold. In addition, since $0 < T(\tau^D) < T(\tau^C)$, we find $[\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}} \in (0,1)$. Therefore,suppose the assumption $[\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}} < \frac{\Psi(1,\lambda)}{\xi}$ holds, we can depict the relationship between $\frac{\Psi(\psi,\lambda)}{\xi}$ and $[\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}}$ as shown in Figure 1. From Figure 1, we can confirm that the inequality $[\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}} < \frac{\Psi(\psi,\lambda)}{\xi}$ ($[\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}} > \frac{\Psi(\psi,\lambda)}{\xi}$) holds when $\psi \in [0,\hat{\psi})$ ($\psi \in (\hat{\psi},1]$). Therefore, noting (21), we can confirm that the proposition 1-1 holds.

Appendix F: Proof of Proposition 1-2

From (18), the relations $\frac{\partial \Psi}{\partial \lambda} > 0$, $\frac{\Psi(\psi,0)}{\xi} = \frac{1}{\xi}\frac{(1-\alpha)[\psi+(1-\psi)(1-\alpha)]}{\psi+(1-\psi)(1-\alpha)(1-\gamma)}$ and $\frac{\Psi(\psi,1)}{\xi} = \frac{1}{\xi}\frac{(1-\alpha)}{\psi+(1-\psi)(1-\alpha)}$ hold. In addition, since $0 < T(\tau^D) < T(\tau^C)$, we find $[\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}} \in (0,1)$. Therefore, suppose the assumption $\frac{\Psi(\psi,0)}{\xi} < [\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}} < \frac{\Psi(\psi,1)}{\xi}$ holds, we can depict the relationship between $\frac{\Psi(\psi,\lambda)}{\xi}$ and $[\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}}$ as shown in Figure 2. From Figure 2, we can confirm that the inequality $[\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}} > \frac{\Psi(\psi,\lambda)}{\xi}$ ($[\frac{T(\tau^D)}{T(\tau^C)}]^{\frac{\alpha}{1-\alpha}} < \frac{\Psi(\psi,\lambda)}{\xi}$) holds when $\lambda \in [0,\hat{\lambda})$ ($\lambda \in (\hat{\lambda},1]$). Therefore, noting (21), we can confirm that the proposition 1-2 holds.

Appendix G: Footenote 9

In this appendix, we briefly examine the case where central government bureaucrats (politicians in central government) consider the retal price of capital as ρ_t as given. In this case, the equilibrium productive government expenditure is given by

$$\begin{aligned} p_t &= \Psi_\rho(\psi,\lambda)\tau_t F(k_t,p_t), \\ &= [\Psi_\rho(\psi,\lambda)]^{\frac{1}{\alpha}}(\tau_t)^{\frac{1}{\alpha}}A^{\frac{1}{\alpha}}k_t, \end{aligned}$$

where

$$\Psi_\rho(\psi,\lambda)\begin{cases} =\xi & \text{if } \hat{\Psi}_\rho(\psi,\lambda)\geq\xi, \\ =\hat{\Psi}_\rho(\psi,\lambda) & \text{if } \hat{\Psi}_\rho(\psi,\lambda)\leq\xi, \end{cases}$$

and

$$\hat{\Psi}_\rho(\psi,\lambda) \equiv \frac{\psi(1-\alpha)+(1-\psi)\lambda}{\psi+(1-\psi)\lambda}.$$

In addition, equilibrium tax rate is given by

$$\tau_t = 1-\alpha \equiv \tau^C.$$

Therefore, we can easily confirm that the main implication of this paper does not alter significantly, even if we employ these alternative assumptions.

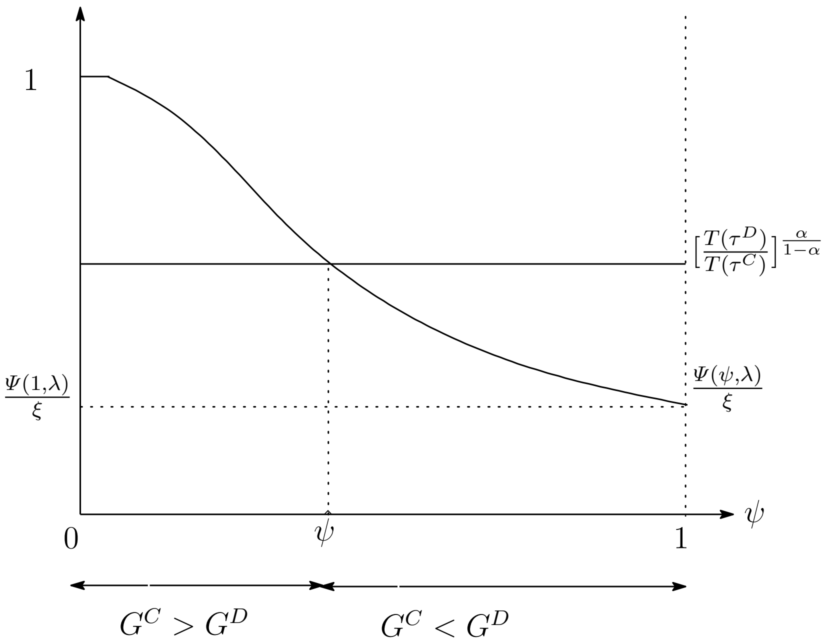

Figure 1: Threshold value of ψ

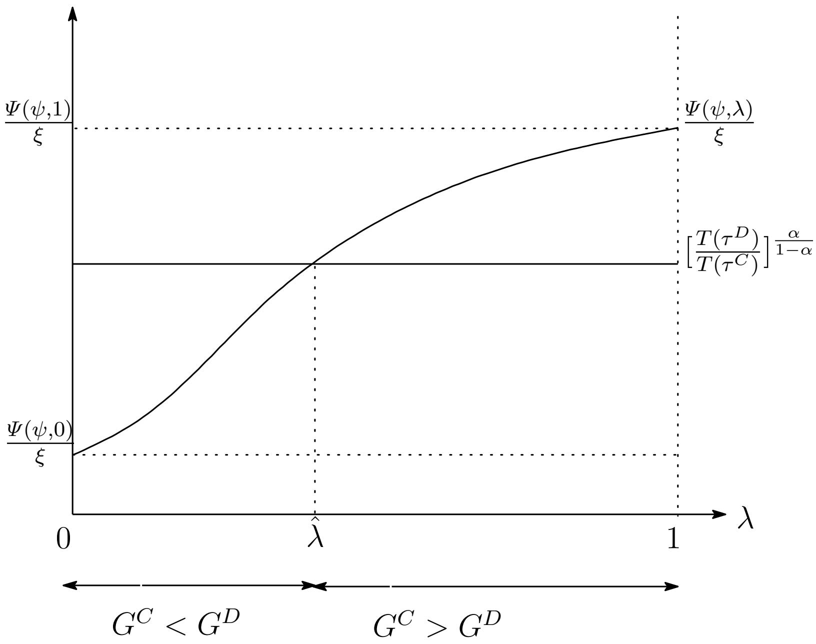

Figure 2: Threshold value of λ

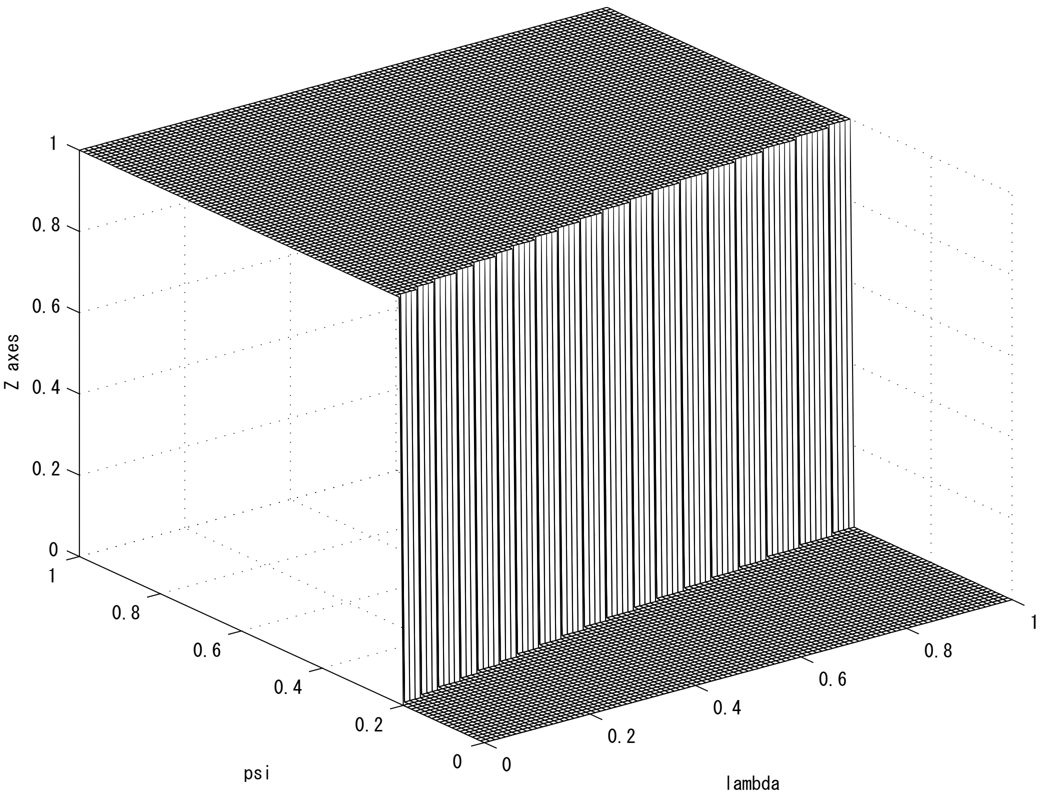

Figure 3: Decentralized vs Centralized