

FISCAL CENTRALIZATION VS. DECENTRALIZATION ON ECONOMIC GROWTH AND WELFARE: AN OPTIMAL-CONTROL APPROACH

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ABSTRACT. In this paper, we study the economic growth and social welfare in an endogenous growth model with spillovers of public goods, leviathan taxation and imperfectly flow capital in heterogeneous economies. We show that the effect of spillovers and capital flow on economic growth and welfare is different for well endowed region and poorly endowed region under fiscal centralization and fiscal decentralization. We also show that a decentralized system dominates a centralized system in terms of economic growth no matter whether the region is well or poorly endowed. However, the difference between a decentralized system and a centralized system is ambiguous in social welfare. It is dependent on the degree of spillovers and capital flow no matter whether the region is well or poorly endowed.

1. Introduction. In this paper, we study the tradeoff between fiscal centralized and fiscal decentralized systems for economic growth and social welfare with spillovers of public goods and imperfect flow capital. We assume that the provision of local public goods, such as roads, parks, and airports, can benefit the households in other regions. We assume that the regions are differently endowed, namely they may be different in natural resources, geographical advantages, inherited human capital, etc. So the regions, better endowed than others with characteristics, will be more attractive to investors, and thus symmetric equilibrium will not exist. Under fiscal centralization, we assume that the central government may allocate different levels of local public goods to different regions. The effective tax rate can be different in different regions for the system of tax rebates and tax subsidy. Under fiscal decentralization, the worse-endowed regions will actually have less business-friendly

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policies in equilibrium under capital flow. The governments may spend a large share of the budget on non-productive public goods or on their own consumption in these regions. By contrast, the better-endowed regions will invest more in productive public goods. We develop an endogenous growth model to analysis the effects of public goods spillovers and the capital flow on economic growth and welfare under fiscal centralization and fiscal decentralization. We will show that fiscal centralization internalizes spillovers across regions and coordinates the fiscal policy by tax credits and deductions. So the central government provides a relatively high level of public goods, however the economy is vulnerable to excessive leviathan taxation due to the lack of tax competition under fiscal centralization. By contrast, the local governments are constrained in leviathan taxation due to the lack of tax competition, and they may fail to internalize spillovers and may provide an insufficient level of public goods. So the economic growth and welfare under fiscal centralization and fiscal decentralization are closely related with the degree of spillovers and capital flow.

Brennan and Buchanan (1980)[4] gave the idea that the Leviathan can be tamed via tax competition. Edwards and Keen (1996) [11] analyzed the welfare effects of tax competition versus tax coordination in a static framework when capital is perfectly mobile, and derive the result that competition indeed increases the pressure on the state to use its tax revenues more efficiently. Rauscher (2000) [16] also gave the similar results. Brueckner(2006) [5] considered a growth model with overlapping generations of households, and the economic growth is shown higher under fiscal federalism by assuming that governments are benevolent. Several previous papers analyzed asymmetric tax competition. Bucovetsky (1991) [6] presented a model in which smaller countries have lower equilibrium tax rates because the benefit from capital has a larger per capital impact than it does in larger countries. But the assumption of public goods spillovers is absent in those papers. Besley and Smart (2002) [3] introduced asymmetric information about the type of incumbent officials, where type denotes the officials relative preference for public goods and rents, and the intensity of capital competition affects how officials allocate funds between public goods and rents. They have had the conclusion that competition for capital is most likely to increase voter welfare no matter the officials are benevolent or they are predatory. Rauscher (2005) [18] addressed the effect of tax competition on economic growth in which a wasteful Leviathan state sets taxes and productive input. He gave the result that an increase in the intensity of inter-districtal competition may be growth-enhancing or growth-decelerating. The Leviathans elasticity of inter-temporal substitution was one of the decisive parameters determining growth effect of increased capital flow. There is also a significant body of literature comparing centralized and decentralized policy-making. Dating back to Tiebout (1956)[19], the author saw the advantages of decentralization as stemming from the citizens across local regions flow. In the consideration of public goods spillovers, Oates (1972) [15] gave the result that, when regions are homogeneous, the centralization dominates decentralization in terms of public goods surplus whenever spillovers are present. When regions are not identical, and there are no spillovers while centralization is better, the decentralization dominates in the terms of public goods surplus when spillovers maximal. He also showed that surplus under decentralization decorous as spillovers increases and there is a critical level of spillovers above which centralization dominates. Besley and Coate (2003) [2] gave a viewpoint different to Oates (1972)[15]. They derived the result that with identical regions,

decentralization dominates when spillovers are small and centralization dominates only when spillovers are complete. But their analysis is limited to static models in the absence of tax competition.

Chu and Yang (2012) [10] examined the relative merits of centralization and decentralization fiscal systems for economic growth and social welfare in an endogenous growth model with spillovers of public goods, Leviathan taxation, and mobile capital. But their analysis were done only in the case of symmetric regions. Calabrese and Epple (2012) [8] use a multi-community model with heterogeneous households and flexible housing supplies to examine the welfare effects provision of public goods. The calibration of the model draws a different conclusion with Tiebout (1956) [19] that inefficiencies with decentralization and property taxation are larger, while in property tax equilibrium, centralization is frequently more efficient. Voigt and Blume (2012) [20] use seven aspects of federalism and decentralization to explain differences in fiscal policy, government effectiveness, economic productivity and happiness. The results show that different aspects of federalism impact on the outcome variables to different degrees. Cerniglia and Longaretti (2013) [9] use a model with human capital to research on the relationship between federalism and economic growth when agents are heterogeneous. The results in this paper show that federalism allows education-related public goods to be tailored to the local regions, which can increase human capital accumulation, and in turn leads to promote economic growth.

2. Model. Without loss of generality, we assume there are two geographical regions. One is called domestic region, the other is called foreign region. All variables of foreign region is indexed a superscript *. Each region has a continuum of citizens with a mass of unity .

Our model may be viewed as a complement to Chu and Yang(2012) [10] in the sense that (i) Chu and Yang only considered the non-productive public expenditures in their model, while our analysis involves the productive public expenditures; (ii) Chu and Yang examine the relative merits of fiscal centralization and fiscal decentralization systems for economic growth and social welfare only in symmetric regions, we address our analysis in technologically different economies.

2.1. Households. There are two differently endowed regions. They may be different in natural resources, geographical advantages, inherited human capital etc. There is perfect competition in markets and single region, which do not have market power vis-à-vis the other region. The households take policies announced by governments as given. There are three factors of production: capital, labor and productive public expenditure provided by governments, denoted by $K_t(K_t^*)$, $L_t(L_t^*)$, $G_{2t}(G_{2t}^*)$, respectively. The superscript * represents foreign variables. Following Barro (1990) [1], production is carried out according to

$$Y_t = AK_t^\alpha G_{2t}^{1-\alpha} L_t^{1-\alpha}$$

The two regions are assumed to have equal populations, which we normalize to unity. Denote $g_{2t} = G_{2t}/K_t$, then the production function can be rewritten as

$$Y_t = Ag_{2t}^{1-\alpha} K_t L_t^{1-\alpha} = f(K_t, g_{2t})$$

There is a continuum of identical households in each region. The lifetime utility of households in each region is represented by

$$U = \int_0^{\infty} [\ln C_t + (1-s)\ln G_{1t} + s\ln G_{1t}^*] e^{-\rho t} dt \quad (1)$$

where $\rho > 0$ is the common subjective discount rate, C_t is the level of consumption at time t . $G_{1t}(G_{1t}^*)$ is the consumptive public expenditure provided by the domestic (foreign) government which, we assume, can be completely transferred into public goods. The parameter $s \in [0, 0.5]$ indexes the degree of positive spillovers. When $s = 0$, the households only care about the public goods in their own region, when $s = 0.5$, they care about the public goods in both region. Given K_0 , the households decide how much to consume and how much to invest at each point of time to maximize (1) subject to the following capital accumulation equation:

$$\dot{K}_t = Y_t - C_t - \tau_t K_t + m(f_K - \tau_t - \nu^*)\varphi(K_t) \quad (2)$$

where a dot above a variable denotes its time derivative, τ_t is the indexes tax rate that the government levies on each unit of capital, and m is the parameter measuring the degree of capital mobility. Here we choose a way following Rauscher (2005) [18] to introduce a measure of capital flow into the model. The capital accumulation equation is augmented by a flow term which is economically intuitive and reasonable. A region attracts capital from the other region if the rate of return to investment at home $f_k - \tau_t$ is larger than abroad $f_t^* - \tau_t^*$ (denoted by ν^*). The local government may try to attract additional capital by reducing the tax rate or by improving the productive public expenditures under fiscal decentralization. Under fiscal centralization, the central government is assumed to coordinate policy in two regions to maximize the joint pay off in both regions. Let $m \in [0, +\infty]$ be the adjustment parameter measuring the flexibility of capital. If $m = 0$, the economy is autarchic and capital does not move, if $m = +\infty$, the capital can move perfectly. Because of various reasons and policies in reality, the capital always moves imperfectly. Following Rauscher (2005) [18] we set $\varphi(K_t) = K_t$. Denote $c_t = C_t/K_t$ as the share of capital consumed by the households, $g_{1t} = G_{1t}/K_t$ as the share of capital provided as consumptive public expenditure, then (2) can be rewritten as

$$\dot{K}_t = [Ag_{2t}^{1-\alpha} - c_t - \tau_t + m(Ag_{2t}^{1-\alpha} - \tau_t - \nu^*)]K_t \quad (3)$$

2.2. The governments. There is a government in each region. It is assumed that the government in each region is identical to the households. They are not completely benevolent or selfish. They pay some attention to the households welfare and their own interest at the same time. Following Chu and Yang(2012) [10], the lifetime utility of the government in each region is given by

$$V = (1-L)U + L \int_0^{\infty} e^{-\rho t} \ln R_t dt \quad (4)$$

where $L \in [0, 1]$ indexes the exogenous degree to which the governments are rent seeking. When $L = 0$, the governments are completely benevolent, while for $L = 1$, the governments are completely selfish. The higher the governments accountability in various political institutions is, the lower the L should be. We can see the similar government preferences model by Edwards and Keen (1996)[11], Rauscher (1998,2000)[16, 17], Liu et al.[13], Lockwood (2006)[14] and Huang et al.[12]. The complex and multifaceted set of wasteful activities is operationalized in our analysis by assuming that the governments extract R_t from the tax revenue for their own

self-interested purpose at time t . Note that R_t is not a budget surplus. To the public sector employees it is a rent; to the voters it is a waste of resources. The budget is balanced in every period.

$$T_t = G_{1t} + G_{2t} + R_t$$

Denote $r_t = R_t/K_t, \tau_t = T_t/K_t$, the budget equation can be rewritten as

$$\tau_t = g_{1t} + g_{2t} + r_t \tag{5}$$

Given the households' best response, the government in each region chooses a capital tax rate τ_t and the share of capital allocated to public goods G_{1t} and productive public expenditure G_{2t} to maximize (4) subject to the capital accumulation (3) and (5), and the instantaneous balanced budget constraint. It is somewhat different under fiscal centralization or fiscal decentralization. We will discuss this difference in technologically identical economies and technologically different economies, respectively, in the following section.

3. Fiscal centralization and fiscal decentralization. As early as 1928, the British mathematician and economist Frank Ramsey published a sophisticated society's optimal saving model. We take the Ramsey approach in which governments move first and, given the policy chosen by the governments, the households make their best response. In the case of fiscal centralization, the governments from local regions form a central government to coordinate or harmonize their fiscal policy to maximize the joint payoff $V + V^*$. In the case of fiscal decentralization, the government in each region chooses their policy independently and simultaneously at each point of time. In this case, they fail to internalize spillovers of public goods across regions and set tax rates non-cooperatively. We will discuss the details in different economies.

3.1. Fiscal centralization. Because the two regions are different in technology and endowment, the marginal benefit of capital in each region is different. So there will be tax rebates from central government to "poorly endowed" region. Here we denote $\tau_t(\tau_t^*)$ as the net tax rate of rebates. In the case of fiscal centralization, the central government internalizes spillovers of public goods across regions and coordinates the policies of the two regions to maximize the joint payoff. It is a two-stage game. We solve the problem in two stages. In the first stage, taking the path of the $G_{1t}, G_{1t}^*, G_{2t}, G_{2t}^*, \tau_t, \tau_t^*$ as given, the households choose the path of c_t to maximize (1) subject to (3). Taking the households best response as given, the central government chooses the paths of $G_{1t}, G_{1t}^*, G_{2t}, G_{2t}^*, R_t, R_t^*, \tau_t, \tau_t^*$ to maximize the joint payoff $V + V^*$ subject to the households best response, the capital accumulation (3) and the instantaneous balanced-budget condition (5).

Lemma 1. *In heterogeneous economies, under fiscal centralization, the optimal outcomes of the two regions in the Stackelberg game respectively are*

$$c^c = c^{*c} = \rho \tag{6}$$

$$g_1^c = g_1^{*c} = \frac{1-L}{2-L}\rho \tag{7}$$

$$g_2^c = [A(1-\alpha)]^{1/\alpha}, \quad g_2^{*c} = [A^*(1-\alpha)]^{1/\alpha}$$

$$\tau^c = \frac{\rho}{2-L} + [A(1-\alpha)]^{1/\alpha}, \quad \tau^{*c} = \frac{\rho}{2-L} + [A^*(1-\alpha)]^{1/\alpha}$$

so

$$\gamma^c = \frac{\dot{K}^c}{K^c} = \alpha(1-\alpha)^{1/\alpha-1}[A^{1/\alpha} + m(A^{1/\alpha} - A^{*1/\alpha})] - [1 + \frac{1}{2-L}]\rho \quad (8)$$

$$\gamma^{*c} = \frac{\dot{K}^{*c}}{K^{*c}} = \gamma^c + \Gamma$$

where $\Gamma = (2m+1)\alpha(1-\alpha)^{1/\alpha-1}(A^{*1/\alpha} - A^{1/\alpha})$.

Obviously, if the domestic region is a poorly-endowed one (i.e. $A^* > A$), then the higher degree of the capital mobility is, the lower the domestic economic growth rate will be. Given the log utility function, households in both regions consume a fixed share $\frac{1-L}{2-L}\rho$ of capital. Thus the policies are time-consistent (Chu and Yang (2012)[10]). The central government transfers a share of capital as public goods provision. Obviously, it is decreasing in L . The central government provides a fixed share $[A(1-\alpha)]^{1/\alpha}([A^*(1-\alpha)]^{1/\alpha})$ of capital as productive public expenditure in domestic (foreign) region. We can see that they are only dependent on production technology and the output elasticity of capital (i.e. α). Without loss of generality, we shall set $K_0 = 1$. Substituting (6) (7) and γ^c, γ^{*c} into (1), then the households' lifetime utility under fiscal centralization can be expressed as

$$\rho U^c = \ln \rho + \ln g_1^c + 2\gamma^c/\rho + s \ln K_0^* + s\Gamma/\rho \quad (9)$$

3.2. Fiscal decentralization. In the case of fiscal decentralization, there is no fiscal coordination between local governments. The solution is given by the Markov perfect equilibrium and the optimal control principle. In the first stage, the representative households take $G_t, G_t^*, G_{2t}, G_{2t}^*, R_t, R_t^*, \tau_t, \tau_t^*$ as given, then choose c_t to maximize (1) subject to (3). In the second stage, taking $c_t, G_{1t}^*, G_{2t}^*, R_t^*, \tau_t^*$ as given, the domestic government chooses $G_{1t}, G_{2t}, R_t, \tau_t$ to maximize (4) subject to (3) and (5).

Lemma 2. *In technologically different economies, under fiscal decentralization, the optimal outcomes in this two-stage game are*

$$c^d = c^{*d} = \rho \quad (10)$$

$$g_1^d = g_1^{*d} = \frac{(1-L)(1-s)}{(1+m)[1+(1-L)(1-s)]}\rho \quad (11)$$

$$g_2^d = [A(1-\alpha)]^{1/\alpha}, \quad g_2^{*d} = [A^*(1-\alpha)]^{1/\alpha}$$

$$\tau^d = \frac{1-s+Ls}{(1+m)[1+(1-L)(1-s)]}\rho + [A(1-\alpha)]^{1/\alpha}$$

$$\tau^{*d} = \frac{1-s+Ls}{(1+m)[1+(1-L)(1-s)]}\rho + [A^*(1-\alpha)]^{1/\alpha}$$

so

$$\gamma^d = \alpha(1-\alpha)^{1/\alpha-1}[A^{1/\alpha} + m(A^{1/\alpha} - A^{*1/\alpha})] + [1 + \frac{1-s+Ls}{(1+m)[1+(1-L)(1-s)}]\rho \quad (12)$$

$$\gamma^{*d} = \gamma^d + \Gamma \quad (13)$$

Again, the households in both regions consume a fixed share ρ of capital. We can see that if $s = m = 0$. Decentralization is equivalent to centralization if spillovers and capital flow are absent. The share of consumption public expenditures in domestic region is the same as that in foreign region, so it is the government's consumption. The shares of productive public expenditures are the same as that under fiscal centralization in both regions. They are only dependent on production

technology and the output elasticity of capital. Obviously, if $A^* > A$, the economic growth rate is increasing in m . Without loss of generality, we shall set $K_0 = 1$. Substituting (10), (11) and (12),(13) into (1), we can obtain the households' lifetime utility under fiscal decentralization

$$\rho U^d = \ln \rho + \ln g_1^d + 2\gamma^d/\rho + s \ln K_0^* + s\Gamma/\rho \quad (14)$$

4. Economic growth. From Lemma 1 and Lemma 2, the optimal household consumptions, the optimal consumption and productive public expenditures and the optimal tax rate under the fiscal decentralization and the fiscal centralization have been derived respectively. In addition, the corresponding economic growth rate and welfare are expressed analytically by using the results obtained from the lemmas above. In which fiscal condition the economic growth and welfare can be better? In the following sections, we introduce $\gamma^d - \gamma^c$ and $U^d - U^c$ to make comparisons in regard of economic growth and welfare under two different fiscal conditions.

Proposition 1. *Under fiscal centralization, the economic growth effects under centralization and decentralization are as follows:*

(i) γ^c and γ^d are both decreasing in the degree of the governments rent seeking (i.e. L).

(ii) If $A^* > A$, γ^c and γ^d are both decreasing in the degree of capital mobility (i.e. m); If $A^* < A$, γ^c and γ^d are both increasing in the degree of capital flow.

(iii) γ^c is independent of the degree of spillovers (i.e. s), while γ^d is increasing in s .

Proof. (i): Using (8) and (12), we have

$$\frac{\partial \gamma^c}{\partial L} < 0, \frac{\partial \gamma^d}{\partial L} < 0.$$

Obviously, γ^c and γ^d both decrease with respect to the degree of the governments rent seeking (i.e. L).

(ii): According to (8) and (12), we obtain

$$\frac{\partial \gamma^c}{\partial m} = \frac{\partial \gamma^d}{\partial m} = \alpha(1-\alpha)^{1/\alpha-1}(A^{1/\alpha} - A^{*1/\alpha})$$

So if $A^* > A$, we have

$$\frac{\partial \gamma^c}{\partial m} < 0, \frac{\partial \gamma^d}{\partial m} < 0,$$

γ^c and γ^d both decrease with respect to m ; if $A^* < A$, we have

$$\frac{\partial \gamma^c}{\partial m} > 0, \frac{\partial \gamma^d}{\partial m} > 0.$$

γ^c and γ^d are positive and are increase in m .

(iii): From (8), γ^c is independent of the degree of spillovers (i.e. s). Obviously from (12), we have

$$\frac{\partial \gamma^d}{\partial s} = \frac{-(1-L)^2}{[1+(1-L)(1-s)]^2}$$

so γ^d is increasing in s . □

Proposition 2. *Suppose the governments are not completely self-interested (i.e. $L \in [0, 1)$):*

(i) *In the absence of spillovers (i.e. $s = 0$) and capital flow (i.e. $m = 0$), under fiscal centralization, the economic growth is the same as that under fiscal decentralization.*

(ii) *In the presence of spillovers (i.e. $s > 0$), the economic growth under fiscal centralization strictly dominates that under fiscal decentralization.*

Proof. (i): Substituting $s = 0, m = 0$ to (8) and (12), we obtain $\gamma^c = \gamma^d$.

(ii): According to (8) and (12), we obtain

$$\gamma^d - \gamma^c = \frac{(1+m)(2-s+Ls-L) - (2-L)(1-s+Ls)}{(2-L)(1+m)[1+(1-L)(1-s)]} \rho.$$

For $m = 0$, we have

$$\gamma^d - \gamma^c = \frac{s(1-L)^2}{(2-L)[1+(1-L)(1-s)]} \rho > 0$$

so $\gamma^d - \gamma^c$ increase with respect to m ; when $m > 0$, one always has

$$\gamma^d - \gamma^c > 0.$$

□

We can explain proposition 1 below. For (i), obviously, the rent seeking of the governments is detrimental to economic growth. For (ii), the increasing degree of capital mobility is benefit for the economic growth of well-endowed region, while a disaster for poorly-endowed region. For (iii), because fiscal centralization internalizes spillover across region, the economic growth rate is independent of the degree of spillovers. While under fiscal decentralization, the spillovers of foreign public goods are benefit for domestic economic growth.

Proposition 2 delivers a clear message: decentralization dominates centralization in terms of economic growth. The intuition for this result is straightforward. First, tax competition under decentralization leads to a lower tax rate. Secondly, the internalization of spillovers under centralization reinforces the absence of tax competition and leads to a higher tax rate. Thirdly, the share of productive public expenditure under centralization is the same as that under decentralization. From lemmas 1 and lemmas 2, fiscal centralization is equivalent to fiscal decentralization in terms of economic growth when $m = 0$ and $s = 0$, or $m = 0$ and $L = 0$.

We set $\alpha = 0.3, A = 1, A = 1.2, L = 0.2$. Figure 1 (Figure 2) plots the economic growth against m along with the comparative of $s = 0$ and $s > 0$ in poorly-endowed (well-endowed) region. We can see that γ^c and γ^d are both decreasing (increasing) in m , which is given in proposition 1. Moreover, no matter it is in a poorly-endowed region or a well-endowed region, there always holds that the higher the degree of capital mobility is, the higher will be the growth rate of decentralization relative to centralization. As in Cai (2005)[7], the capital competition exacerbates initial inequalities, hinders economic development in the poorly-endowed units, while stimulate it in their better-endowed rivals.

5. Welfare. In the section of economic growth, we conclude that no matter whether the region is well or poorly endowed, with the increasing capital mobility, the economic growth rate under the fiscal decentralization is higher than that under the fiscal centralization. What rules are followed by the welfare under these two fiscal

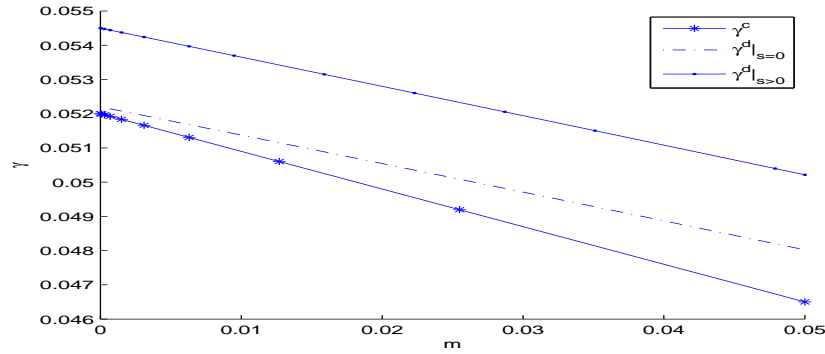


FIGURE 1. Growth effects in poorly-endowed region

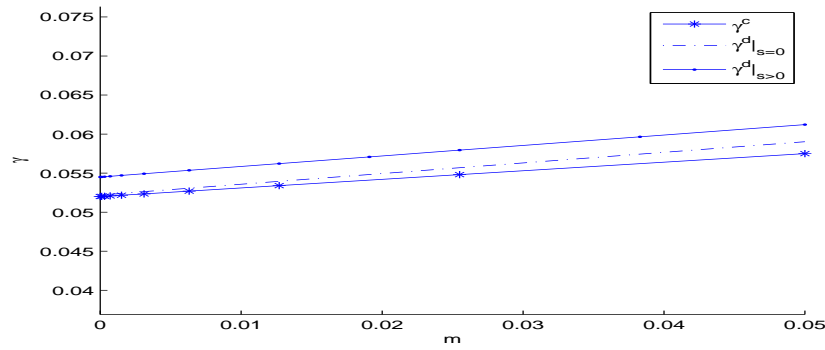


FIGURE 2. Growth effects in well-endowed region

conditions? Is it similar with the economic growth? In this section, we investigate the relation among the welfare, capital mobility and spillovers under two different fiscal conditions.

Proposition 3. *Suppose the governments are not completely self-interested (i.e. $L \in [0,1)$) and there are no spillovers (i.e. $s = 0$), then we have the following results for the welfare difference between fiscal centralization and decentralization (i.e. $U^d - U^c$)*

(i) *In the absence of capital mobility (i.e. $m = 0$), the welfare under fiscal centralization is the same as that under fiscal decentralization.*

(ii) *In the presence of capital mobility (i.e. $m > 0$), $U^d - U^c$ increases with m when $m < \frac{L}{2-L}$ (denoted by \tilde{m}), and $U^d - U^c$ decreases with m when $m > \tilde{m}$. There exists a threshold degree of capital mobility (denoted by \check{m} , $\check{m} > \tilde{m}$). When $m > \check{m}$, the welfare under fiscal centralization strictly dominates that under fiscal decentralization, but the case is opposite when $m < \check{m}$.*

Proof. Using (9) and (14), we obtain

$$\begin{aligned} \rho(U^d - U^c) &= \ln \frac{(2-L)(1-s)}{(1+m)[1+(1-L)(1-s)]} \\ &\quad + \frac{2[(1+m)(2-s+Ls-L) - (2-L)(1-s+Ls)]}{(2-L)(1+m)[1+(1-L)(1-s)]} \end{aligned}$$

So when $s = 0$, we have

$$\rho(U^d - U^c) = \ln \frac{1}{1+m} + \frac{2m}{(2-L)(1+m)}$$

(i): When $m = 0$, we obtain $\rho(U^d - U^c) = 0$, that is $U^d = U^c$.

(ii): When $L \in (0, 1)$, we obtain

$$\frac{\partial \rho(U^d - U^c)}{\partial m} = \frac{L - 2m + mL}{(1+m)^2(2-L)}$$

when $m > \frac{L}{2-L}$, we have

$$\frac{\partial \rho(U^d - U^c)}{\partial m} < 0$$

Therefore, $U^d - U^c$ decreases in m ; when $m < \frac{L}{2-L}$, we have

$$\frac{\partial \rho(U^d - U^c)}{\partial m} > 0$$

and thus $U^d - U^c$ increases in m , and we also have

$$\rho(U^d - U^c)|_{m=\tilde{m}} > 0.$$

Hence there must exist $\tilde{m} > \tilde{m}$ to uphold $U^d - U^c = 0$. \square

We explain proposition 3 below. For (i), in the absence of both capital mobility and spillovers (i.e. $s = m = 0$), the welfare under fiscal centralization and fiscal decentralization are equivalent. For (ii), in the absence of tax competition under fiscal centralization, Leviathan governments may choose higher tax rate relative to the optimal tax rate for households. So tax competition can be used to discipline governments and lower the tax rate. The optimal degree of capital is \tilde{m} . The effect of m on $U^d - U^c$ is hump-shaped. The negative effect of fewer public goods dominates the positive effects of a higher growth rate if $m > \tilde{m}$. \tilde{m} increases in L , which shows that the higher the degree to which the governments are rent seeking, the larger will be the role for tax competition. It means that stronger tax competition will be needed to enhance households welfare if the weight that the governments attach to their self-interest.

We set $\alpha = 0.3, A = 1, A^* = 1.2, L_1 = 0.2, L_2 = 0.5, s = 0$. Figure 3 plots $U^d - U^c$ against m , along with the effect of varying the value of L in the absence of spillovers. Just as proposition 3 (iii) displays, \tilde{m} increases in L , and so the curve will extend to the right as the degree of governments' rent-seeking increases.

The above analysis is confined to the case in which spillovers of public goods are absent ($s = 0$). We will now consider the more realistic case of $s > 0$, and give our results as follows.

Proposition 4. *Suppose the governments are not completely self-interested (i.e. $L \in [0, 1)$) and spillovers of public goods are present (i.e. $s > 0$), then we get the following results for the welfare difference between fiscal centralization and fiscal decentralization (i.e. $U^d - U^c$):*

(i) In the absence of capital mobility (i.e. $m = 0$), the welfare under fiscal centralization strictly dominates that under fiscal decentralization.

(ii) In the presence of capital mobility (i.e. $m > 0$), $U^d - U^c$ increases in m when $m < \frac{Ls+L-s}{1+(1-L)(1-s)}$ (denoted by \tilde{m}'), and $U^d - U^c$ decreases in m when $m > \tilde{m}'$. There exists a threshold degree of capital mobility (denoted by \check{m}' , $\check{m}' > \tilde{m}'$) such that when $m > \check{m}'$, the welfare under fiscal centralization strictly dominates that under fiscal decentralization, but the case is opposite when $m < \check{m}'$.

(iii) There is a critical value of s (denoted by \bar{s}) $0 < \bar{s} < \frac{1}{2}$ such that when $s > \bar{s}$, especially when $s = \frac{1}{2}$, the welfare under fiscal centralization always dominates that under fiscal decentralization.

Proof. (i): According to (9) and (14), when $m = 0$, we obtain

$$\rho(U^d - U^c) = \ln \frac{(2-L)(1-s)}{1+(1-L)(1-s)} + 2 \left[\frac{1}{2-L} - \frac{1-s+Ls}{1+(1-L)(1-s)} \right]$$

Differentiating it with respect to L yields

$$\frac{\partial \rho(U^d - U^c)}{\partial L} = \frac{L}{(2-L)^2} + \frac{(1-2s)[1+(1-L)(1-s)] + (1-s+Ls)(1-s)}{[1+(1-L)(1-s)]^2} > 0$$

Therefore $U^d - U^c$ increases in L . When $L = 1$, we obtain

$$\rho(U^d - U^c) = \ln(1-s) < 0$$

Hence $U^d - U^c$ is always negative when $m = 0$.

(ii): When $m > 0$, we obtain

$$\frac{\partial \rho(U^d - U^c)}{\partial m} = \frac{(L-s+Ls) - m[1+(1-L)(1-s)]}{(1+m)^2[1+(1-L)(1-s)]}$$

So when $m < \frac{L-s+Ls}{1+(1-L)(1-s)}$ (denoted by \tilde{m}'), we have

$$\frac{\partial \rho(U^d - U^c)}{\partial m} > 0$$

which means $U^d - U^c$ increases in m , when $m > \tilde{m}'$; $U^d - U^c$ decreases in m , when $m < \tilde{m}'$. We also have

$$\frac{\partial \tilde{m}'}{\partial L} = \frac{2}{[1+(1-L)(1-s)]^2} > 0, \quad \frac{\partial \tilde{m}'}{\partial s} = \frac{-2(1-L)^2}{[1+(1-L)(1-s)]^2} < 0$$

which means \tilde{m}' increases in L and \tilde{m}' decreases in s . Moreover, we have

$$\max \rho(U^d - U^c) = \rho(U^d - U^c)|_{m=\tilde{m}'} = \ln \frac{(2-L)(1-s)}{2(1-s+Ls)} + \frac{L}{2-L}$$

and

$$\frac{\partial \max \rho(U^d - U^c)}{\partial s} = \frac{-L}{(1-s+Ls)(1-s)} < 0,$$

$$\frac{\partial \max \rho(U^d - U^c)}{\partial L} = \frac{L(1+3s) - 4s}{(2-L)^2(1-s+Ls)}$$

which means $\max \rho(U^d - U^c)$ decreases in s . $\max \rho(U^d - U^c)$ increases in L when $L > \frac{4s}{1+3s}$, and $\max \rho(U^d - U^c)$ decreases in L when $L < \frac{4s}{1+3s}$. When $s = 0, L = 1$, it gets to $\max 1 - \ln 2 > 0$. So there must exist $\check{m}' > \tilde{m}'$ to uphold $U^d - U^c = 0$, and when $m > \check{m}'$, the welfare under fiscal centralization strictly dominates that under fiscal decentralization.

(iii): We already proved that $\max \rho(U^d - U^c)$ decreases in s , so there is a critical value of s (denoted by \bar{s}), here $0 < \bar{s} < \frac{1}{2}$. When $s > \bar{s}$, the welfare under fiscal centralization always dominates that under fiscal decentralization. When $s = \bar{s}$, we have

$$\max \rho(U^d - U^c) = \ln \frac{2 - L}{2(1 + L)} + \frac{L}{2 - L}.$$

When $L = 0$, it reaches the $\max \rho(U^d - U^c) = 0$, which means that for any $m \in [0, +\infty)$ and $L \in (0, 1]$, it always holds $U^d < U^c$. \square

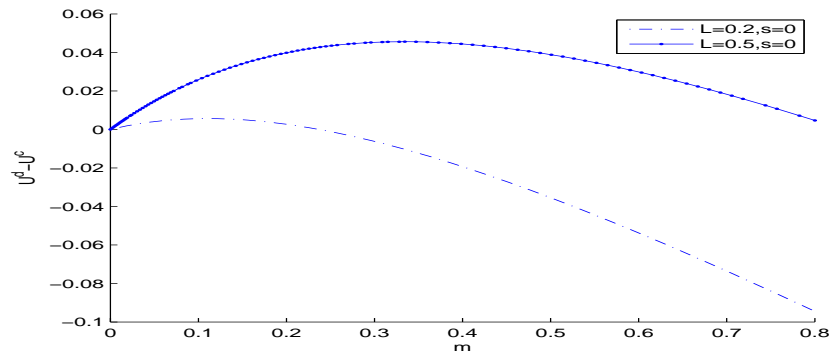


FIGURE 3. Welfare effects without spillovers

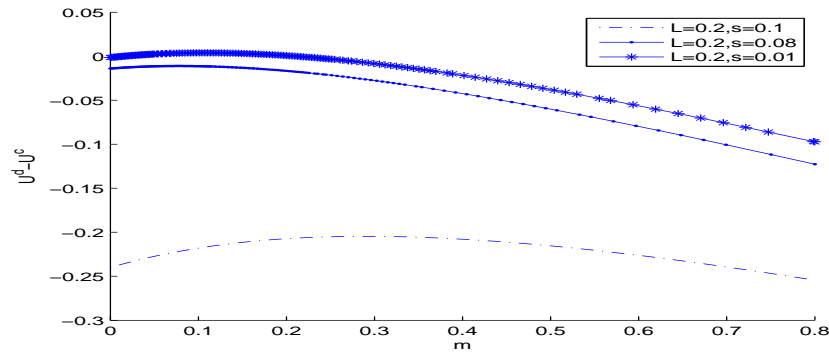


FIGURE 4. Welfare effects with spillovers

We set $\alpha = 0.3, A = 1, A^* = 1.2, L = 0.2, s_1 = 0.1, s_2 = 0.08, s_3 = 0.01$. Figure 4 plots $U^d - U^c$ against m , along with the effect of varying the value of s . As proposition 4 (iii) displays, under fiscal centralization, the welfare dominates that under fiscal decentralization. For example, when we set $s = 0.1$, there always holds $U^d - U^c < 0$.

From proposition 4, we know in the presence of spillovers and the absence of capital mobility, under fiscal centralization, the welfare strictly dominates that under

fiscal decentralization. The main reasons for this are listed as follows: centralization internalizes spillovers while decentralization ignores them. The presence of spillovers will reduce the welfare edge of decentralization relative to centralization when other things are equal. The presence of spillovers can modify the power of tax competition. From point (ii) of proposition 4, we know that when the degree of capital mobility falls within an intermediate range, under fiscal decentralization, the welfare dominates that under fiscal centralization. As shown in figure 4, when we set $s = 0.01$, the curve is hump-shaped. From the proof of proposition 4, we also see that the degree of capital mobility \tilde{m}' preferred by the households become higher when the degree to which the governments are rent seeking increases or the degree of spillovers decreases. The intuition is as follows. In the absence of tax competition under fiscal centralization, self-interest governments will always choose the highest tax rate. Employing tax competition can correct this excessive Leviathan taxation. However, lower degree of capital mobility is not sufficient to the welfare cost of fiscal decentralization relative to fiscal centralization due to the presence of spillovers. That is why only when m is sufficiently larger, we have $U^d > U^c$. On the other hand, the presence of spillovers exacerbates the under-provision of public goods. If the degree of spillovers is so larger that under fiscal decentralization, the households welfare becomes much lower than fiscal centralization, no tax competition can compensate for the welfare loss due to the larger degree of spillovers at this time.

6. Conclusions. In this paper, we have investigated capital mobility incorporating spillovers of consumption public expenditure and rent-seeking behavior of the governments under fiscal centralization and fiscal decentralization, respectively. We derive several results in this paper. Firstly, rent-seeking behavior of the governments is detrimental to economic and social welfare. Secondly, under fiscal centralization, economic growth is independent on spillovers. Under fiscal decentralization, economic growth increases as spillovers increases. Thirdly, in the poorly-endowed (well-endowed) region, the effect of capital mobility on economic growth is negative (positive). Fiscal decentralization always dominates centralization in terms of economic growth. Fourthly, social welfare difference between fiscal centralization and fiscal decentralization is ambiguously.

It is related to the degree of spillovers and capital mobility. Stronger tax competition will be needed to enhance households' welfare if the governments tend to be selfish. The presence of spillovers may modify the power of tax competition. For larger degree of spillovers, fiscal centralization always dominates decentralization in terms of welfare.

The model in this paper is simple and neglect many features in the real world. There are several potential extensions. Firstly, we can expand tax instruments for governments to include labor or consumption taxes. Secondly, we can consider more general utility or production functions. Thirdly, we can introduce partial decentralization in our model. We often observe that the proper approach in real world is to complement fiscal decentralization with central government intervention through intergovernmental grants, subsidies, or regulations. The approach lies in the attempt to combine the benefits of decentralization with the benefits of centralization. It would be interesting to analyze how different public goods should be provided by local governments as opposed to a central government. Nonetheless, we hope that

our model may serve as a useful approximation to the real world and enable us to explore the essence of our problem.

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Appendix. Proof of Lemma 1

As $G_{1t}, G_{1t}^*, G_{2t}, G_{2t}^*, \tau_t, \tau_t^*$ are given, the domestic households choose the share of capital c_t to maximize (1) subject to (3). The current-value Hamiltonian for the households is

$$H_t = \ln c_t K_t + \lambda_t [A g_{2t}^{1-\alpha} - \tau_t - c_t + m(f_k - \tau_t - v^*)] K_t,$$

where c_t is the control variable, K_t is state variable. The first-order conditions are

$$\frac{\partial H_t}{\partial c_t} = \frac{1}{c_t} - \lambda_t K_t = 0 \quad (\text{A1})$$

$$\dot{\lambda}_t = \rho \lambda_t - \frac{\partial H_t}{\partial K_t} = \rho \lambda_t - \frac{1}{K_t} - [A g_{2t}^{1-\alpha} - \tau_t - c_t + m(f_k - \tau_t - v^*)] K_t = 0 \quad (\text{A2})$$

$$\dot{K}_t = \frac{\partial H_t}{\partial \lambda_t} = -[A g_{2t}^{1-\alpha} - \tau_t - c_t + m(f_k - \tau_t - v^*)] K_t, \quad (\text{A3})$$

and the transversalis condition is

$$\lim_{t \rightarrow \infty} e^{-\rho t} \lambda_t K_t = 0 \quad (\text{A4})$$

multiplying (A2) by K_t and (A3) by λ_t and then adding together, we have

$$\dot{\lambda}_t K_t + \lambda_t \dot{K}_t = \rho \lambda_t K_t - 1$$

Multiplying $e^{-\rho t}$ on both sides and integrating with respect to time yields

$$\int_0^\infty e^{-\rho t} d(\lambda_t K_t) = \rho \int_0^\infty e^{-\rho t} \lambda_t K_t dt - \int_0^\infty e^{-\rho t} dt$$

Using integration by parts and combining (A4) yields

$$\lambda_t K_t = \frac{1}{\rho} \quad (\text{A5})$$

Combining (A1) and (A5) yields

$$c_t = \rho \quad (\text{A6})$$

From (A6), $c_t = \rho$ is predetermined and hence non-controllable. Using the same method, the representative households in the other region also choose the same share of the capital in their own region $c_t^* = \rho$ to maximize their utility. Now we solve the governments problem. Taking the households best response as given, the central government chooses $G_{1t}, G_{1t}^*, G_{2t}, G_{2t}^*, R_t, R_t^*, \tau_t, \tau_t^*$ to maximize $V + V^*$ subject to (A2) and (A4). The current-value Hamiltonian for the central government is

$$\begin{aligned} H_t = & (1-L)(\ln \rho K_t + \ln \rho K_t^* + \ln G_{1t} K_t + \ln g_{1t}^* K_t^*) + L(\ln r_t K_t + \ln y_t^* K_t^*) \\ & + \lambda_t [A g_{2t}^{1-\alpha} - \tau_t - c_t + m(A g_{2t}^{1-\alpha} - \tau_t - A^*(g_{2t}^*)^{1-\alpha} + \tau^*)] K_t \\ & + \lambda_t^* [A^*(g_{2t}^*)^{1-\alpha} - \tau_t^* - c_t^* + m(A^*(g_{2t}^*)^{1-\alpha} - \tau_t^* - A G_{2t}^{1-\alpha} + \tau)] K_t^* \\ & + \mu_t (\tau_t - G_{1t} - G_{2t} - r_t) K_t + \mu_t^* (\tau_t^* - g_{1t}^* - g_{2t}^* - r_t^*) K_t^* \end{aligned}$$

where μ_t and μ_t^* are the multipliers for the balanced-budget condition λ_t, λ_t^* is the Hamiltonian multiplier. Using the optimal control principle, we have the first-order conditions as follows

$$\frac{\partial H}{\partial G_{1t}} = \frac{1-L}{G_{1t}} - \mu_t K_t = 0 \quad (\text{A7})$$

$$\frac{\partial H}{\partial G_{2t}} = -\mu_t K_t + \lambda_t A(1-\alpha)(m-1)G_{2t}^{-\alpha} K_t - \lambda_t^* A(1-\alpha)mG_{2t}^{-\alpha} K_t^* = 0 \quad (\text{A8})$$

$$\frac{\partial H}{\partial r_t} = \frac{L}{r_t} - \mu_t K = 0 \quad (\text{A9})$$

$$\frac{\partial H}{\partial \tau_t} = \mu_t K_t - \lambda_t(m+1)K_t + \lambda_t^* m K_t^* = 0 \quad (\text{A10})$$

$$\frac{\partial H}{\partial g_{1t}^*} = \frac{1-L}{g_{1t}^*} - \mu_t^* K_t^* = 0$$

$$\frac{\partial H}{\partial g_{2t}^*} = -\mu_t^* K_t^* + \lambda_t(1-\alpha)mA^*(g_{2t}^*)^{-\alpha} K_t + \lambda_t^* A^*(1-\alpha)(m+1)(g_{2t}^*)^{-\alpha} K_t^* = 0$$

$$\frac{\partial H}{\partial r_t^*} = \frac{L}{r_t^*} - \mu_t^* K_t^* = 0 \quad (\text{A11})$$

$$\frac{\partial H}{\partial \tau_t^*} = \mu_t^* K_t^* + \lambda_t m K_t - \lambda_t^* m K_t^*(m+1) = 0$$

$$\dot{\lambda}_t = \rho \dot{\lambda}_t - \frac{\partial H_t}{\partial K_t} = \rho \dot{\lambda}_t - \frac{2-L}{K_t} \quad (\text{A12})$$

$$- \lambda_t [AG_{2t}^{1-\alpha} - \tau - c_t + m(AG_{2t}^{1-\alpha} - \tau - A^*(g_{2t}^*)^{1-\alpha} + \tau^*)]$$

$$\dot{\lambda}_t^* = \rho \dot{\lambda}_t^* - \frac{\partial H_t}{\partial K_t^*} = \rho \dot{\lambda}_t^* - \frac{2-L}{K_t^*}$$

$$- \lambda_t [A^*(g_{2t}^*)^{1-\alpha} - \tau^* - c_t^* + m(A^*(g_{2t}^*)^{1-\alpha} - \tau^* - AG_{2t}^{1-\alpha} + \tau)]$$

$$\frac{\partial H_t}{\partial \lambda_t} = \dot{K}_t = [AG_{2t}^{1-\alpha} - \tau - c_t + m(AG_{2t}^{1-\alpha} - \tau - A^*(g_{2t}^*)^{1-\alpha} + \tau^*)]K_t \quad (\text{A13})$$

$$\frac{\partial H_t}{\partial \lambda_t^*} = \dot{K}_t^* = [A^*(g_{2t}^*)^{1-\alpha} - \tau^* - c_t^* + m(A^*(g_{2t}^*)^{1-\alpha} - \tau^* - AG_{2t}^{1-\alpha} + \tau)]K_t^* \quad (\text{A14})$$

$$\frac{\partial H_t}{\partial \mu_t} = (\tau_t - G_{1t} - G_{2t} - r_t)K_t = 0 \quad (\text{A15})$$

$$\frac{\partial H_t}{\partial \mu_t^*} = (\tau_t^* - g_{1t}^* - g_{2t}^* - r_t^*)K_t^* = 0$$

The transversalis condition is (A4) and

$$\lim_{t \rightarrow \infty} e^{-\rho t} \lambda_t^* K_t^* = 0$$

Multiplying (A12) by K_t and (A13) by λ_t and adding them together, we have

$$\dot{\lambda}_t K_t + \lambda_t \dot{K}_t = \rho \dot{\lambda}_t K_t - (2-L) \quad (\text{A16})$$

Multiplying $e^{-\rho t}$ on both sides and integrating with respect to time yields

$$\int_0^\infty e^{-\rho t} d(\lambda_t K_t) = \rho \int_0^\infty e^{-\rho t} \lambda_t K_t dt - \int_0^\infty (2-L)e^{-\rho t} dt$$

For (A16), using integration by parts and combining (A4) yields

$$\lambda_t K_t = \frac{2-L}{\rho} \quad (\text{A17})$$

Combining (A7) and (A10) yields

$$g_1^c = \frac{1-L}{2-L}\rho$$

Combining (A8) and (A10) yields

$$g_2^c = [A(1-\alpha)]^{1/\alpha}$$

Combining (A10) and (A17) yields

$$r^c = \frac{L}{2-L}\rho$$

Combining (A7), (A8),(A9),(A15) and (A17) yields

$$\tau^c = \frac{1}{2-L}\rho + [A(1-\alpha)]^{1/\alpha}$$

Then we have

$$\gamma^c = \frac{\dot{K}_t}{K_t} = \alpha(1-\alpha)^{1/\alpha-1}[A^{1/\alpha-1} + m(A^{1/\alpha-1} - A^{*1/\alpha})] - (1 + \frac{1}{2-L})\rho$$

It is similar to solve the variables in the other region, but we do not line out here to minimize details.

Proof of Lemma 2. The solving process for households problem is similar to the solving process in fiscal centralization, and so we will not derive it here. Again, the domestic (foreign) households consume a fixed share ρ of $K_t(K_t^*)$, that is $c_t^d = c_t^{*d} = \rho$. Now we solve the domestic governments problem. Taking the households best response and $G_{1t}^*, G_{2t}^*, R_t^*, \tau_t^*$ as given, domestic government chooses $G_{1t}, G_{2t}, R_t, \tau_t$ to maximize (4) subject to (3) and (5). The current-value Hamiltonian for the central government is

$$\begin{aligned} H_t = & (1-L)(\ln\rho K_t + (1-s)\ln G_{1t}K_t + s\ln g_{1t}^*K_t^*) + L\ln r_t K_t \\ & + \lambda_t [A g_{2t}^{1-\alpha} - \tau - c_t + m(A g_{2t}^{1-\alpha} - \tau - A^*(g_{2t}^*)^{1-\alpha} + \tau^*)] K_t \\ & + \mu_t (\tau_t - G_{1t} - G_{2t} - r_t) K_t \end{aligned}$$

where μ_t is the multiplier for the balanced-budget condition and λ_t is the Hamiltonian multiplier. Using the optimal control principle, we have the first-order conditions

$$\frac{\partial H}{\partial G_{1t}} = \frac{(1-L)(1-s)}{G_{1t}} - \mu_t K_t = 0 \quad (\text{A18})$$

$$\frac{\partial H}{\partial G_{2t}} = -\mu_t K_t + \lambda_t A(1-\alpha)(m+1)G_{2t}^{-\alpha} K_t = 0$$

$$\frac{\partial H}{\partial \tau_t} = \mu_t K_t - \lambda_t(m+1)K_t = 0 \quad (\text{A19})$$

The conditions for $\frac{\partial H}{\partial r_t}$, $\dot{\lambda}_t$, $\frac{\partial H_t}{\partial \lambda_t}$ and $\frac{\partial H_t}{\partial \mu_t}$ are the same as those in (A9), (A12), (A13) and (A15). The transversalis condition is (A4). Multiplying (A12) by K_t and (A13) by λ_t and adding together, one has

$$\dot{\lambda}_t K_t + \lambda_t \dot{K}_t = \rho \lambda_t K_t - [1 + (1-L)(1-s)] \quad (\text{A20})$$

Multiplying $e^{-\rho t}$ on both sides and integrating with respect to time yields

$$\int_0^\infty e^{-\rho t} d(\lambda_t K_t) = \rho \int_0^\infty e^{-\rho t} \lambda_t K_t dt - \int_0^\infty e^{-\rho t} [1 + (1-L)(1-s)] dt$$

For (A20), using integration by parts and combining (A4) yields

$$\lambda_t K_t = \frac{1 + (1 - L)(1 - s)}{\rho} \quad (\text{A21})$$

Combining (A18),(A19) and (A21) yields

$$g_1^d = \frac{1 + (1 - L)(1 - s)}{(m + 1)[1 + (1 - L)(1 - s)]} \rho$$

Combining (A8) and (A10) yields

$$g_2^d = [A(1 - \alpha)]^{1/\alpha}$$

Combining (A9) and (A10) yields

$$r^d = \frac{1}{(m + 1)[1 + (1 - L)(1 - s)]} \rho$$

Combining (A11), (A14),(A15) and (A21) yields

$$\tau^d = \frac{1 - s + Ls}{(1 + m)[1 + (1 - L)(1 - s)]} \rho + [A(1 - \alpha)]^{1/\alpha}$$

Then we have

$$\begin{aligned} \gamma^d = \frac{\dot{K}_t}{K_t} &= \alpha(1 - \alpha)^{1/\alpha - 1} [A^{1/\alpha - 1} + m(A^{1/\alpha - 1} - A^{*1/\alpha})] \\ &\quad - \left[1 + \frac{1 - s + sL}{(1 + m)[1 + (1 - L)(1 - s)]} \right] \rho \end{aligned}$$

It is similar to solve the variables in the other region, and so we do not line out here to minimize the details.

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