The Impact of Capital Tax Competition on Public Input Provision in the Presence of Intersectoral Substitutability and Interindustry Factor Mobility

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1. Introduction

The impact of competition for business capital on local public expenditure has been an important subject of the literature on capital tax competition. That literature argues that when a tax on mobile capital is imposed to finance local public expenditure, local public service levels are set inefficiently low. The reason is that local governments keep tax rates low to prevent capital outflows. As a result, local tax revenue is insufficient to support efficient levels of public services.[2] While most of the studies in the literature focuses on public goods benefiting residents, there are several recent papers which analyze the impact of capital tax competition on the provision of public inputs into the production process. The analysis of public inputs is somewhat complex because such inputs directly increase the productivity of capital. This raises the possibility that public inputs are overprovided even if the sole source of local tax revenue is a business capital tax [e. g., Noiset (1995), Noiset and Oakland (1995), and Bayindir-Upmann (1998)]. On the other hand, my recent two papers [Matsumoto (1998, 1999a)] show that the possibility of overprovision is of limited importance. As long as production technology is characterized by linear homogeneity, capital-tax financing of public inputs decreases business investment, which implies that local governments, competing for capital, have an incentive to underprovide public inputs.[3]

In the previous tax competition analyses of local public inputs, local production processes are aggregated into a single production technology. (In other words, those analyses are based on single-industry models such as Zodrow and Mieszkowski (1986).) This paper presents a full examination of the distortionary impacts of public inputs under capital taxation, which arise from intersectoral substitutability and interindustry factor mobility within jurisdictions. For this purpose, I assume a more complex production structure, where the private production sector is disaggregated into traded and nontraded goods. In addition, the public sector, which produces public inputs, is introduced. The model structure follows Wilson's (1986) analysis of public goods.[4] In this framework, whether capital tax competition leads to underprovision of public inputs is not so clear. Still, an interesting sufficient condition for underprovision is obtained which is directly comparable to Wilson (1986). As in his analysis of public goods, a higher substitutability between private factors will imply public input underprovision unless factor-intensities differ considerably among industries.

The model is specified in Section 2. Section 3 derives the second-best rule for public input provision under capital tax distortion, and analyzes the direction of welfare-improving policy changes made by all jurisdictions from equilibrium. By decomposing the impact of capital-tax financing of public inputs on business investment, Section 4 identifies how tax competition distorts public input provision. Concluding remarks are given in Section 5.

2. The model

The basic structure of the model is based on Wilson (1986). Consider a national economy with a large number of identical competitive jurisdictions. There are two private industries within local jurisdictions: the national good industry and the local good industry. The national good is traded across jurisdictions. The local good is consumed where it is produced. Private production is carried out using private factors and a local public input. The public input is produced with private factors only. There are two private factors in the economy: capital and labor. These factors are mobile across industries in each jurisdiction. Although capital is mobile across jurisdictions, migration is precluded. The local supply of labor is exogenous. The total capital stock is exogenous to the economy.

Production technology is described by

$$X^i = g^i(b) f^i(L^i,\ K^i)\ (i=1,\ 2), \tag{1}$$

$$b = f^b(L^b,\ K^b), \tag{2}$$

where X^1 is the national good, X^2 is the local good, L^i and K^i are, respectively, labor and capital employed by industry i, and b is the public input. Private production technology is separable between private factors and b.[5] It is assumed that $g^{i\prime} = dg^i(b)/db > 0$. In addition, $f^i(L^i,\ K^i)$ exhibits constant returns to scale. This means that b has the character of "factor-augmenting" public inputs, which has been frequently analyzed in the literature on public input provision.[6]

Public expenditure is financed by a uniform tax on local capital stock. Given the tax rate, b, and market prices, competitive firms choose the amount of factors to maximize their profits. With b being factor-augmenting, the usual zero-profit conditions hold in equilibrium. The public sector minimizes production costs evaluated at market prices.[7] The conditions for profit maximization and cost minimization can be expressed in terms of the unit-cost functions:

$$1 = C^1(W,\ r,\ b), \tag{3}$$

$$P = C^2(W,\ r,\ b), \tag{4}$$

$$C^b = C^b(W,\ r), \tag{5}$$

where $C^i(\cdot)$ is the unit-cost function, W is the wage rate, r is the rental rate, and P is the relative price of the local good. The national good is chosen as a numeraire. Under capital taxation,

$$r = \rho + t, \tag{6}$$

where t is the capital tax rate and ρ is the net return on capital. Competitive jurisdictions take ρ as given because of capital mobility. Note from (1) and (2) that the unit-cost functions are linearly homogeneous in factor prices.[8)] The factor constraints in a single jurisdiction are

$$K^1+K^2+K^b=K, \tag{7}$$

$$L^1+L^2+L^b=L, \tag{8}$$

$$K^i=C_r^i(W,\ r,\ b)X^i \quad (i=1,\ 2), \tag{9}$$

$$L^i=C_W^i(W,\ r,\ b)X^i \quad (i=1,\ 2), \tag{10}$$

$$K^b=C_r^b(W,\ r)b, \tag{11}$$

$$L^b=C_W^b(W,\ r)b, \tag{12}$$

where K is local capital stock and L is the fixed supply of local labor. Subscripts in (9)-(12) denote partial derivatives (e. g., $\partial C^i / \partial r=C_r^i$).

Each jurisdiction has a single immobile resident. All residents in the economy are identical in all respects. Each resident supplies L and has the same share of capital stock. Let K^* be the per capita endowment of capital. Residents maximize their utility U $(D^1,\ D^2)$ subject to $D^1+PD^2=WL+\rho K^*$, where D^i is the consumption of good i. The equilibrium conditions for good markets are

$$X^2=D^2, \tag{13}$$

$$X^1-D^1+\rho(K^*-K)=0, \tag{14}$$

$$D^i=D^i(P,\ WL+\rho K^*) \quad (i=1,\ 2), \tag{15}$$

where (15) is the demand function for good i. The utility function is assumed to be homothetic, so that D^1 / D^2 is a function of P. Equation (13) is the market-clearing condition for the local good. Equation (14) represents the balance of trade condition, showing that the national good is traded in exchange for mobile capital.

The system consisting of (3), (4), and (6)-(15) includes fifteen equations and seventeen variables; W, r, ρ, t, b, P, K^i, K, L^i, X^i, and D^i. The public budget constraint, $C^b(W,\ r)b=tK$, can be derived from these equations, which corresponds to the Walras law. For any fixed ρ, this system describes the equilibrium conditions for local economies. The market-clearing condition for the national capital market determines ρ. It is assumed that taking ρ as given, local governments maximize their resident's utility. Since all jurisdictions were assumed to be identical, this paper focuses only on symmetric equilibrium in which $X^i=D^i$ and $K^*=K$. But, ex ante, each jurisdiction perceives that the local supply of capital is elastic at a given ρ. The perceived impact of local public policies on K influences decentralized decision-making.

3. Second-best expenditure rule and welfare-improving policy changes

Suppose that the economy is in equilibrium where all jurisdictions set their policy variables to maximize their resident's utility and all market-clearing conditions are satisfied. In such an equilibrium, a small change in a given jurisdiction's policy variables does not affect the utility of the jurisdiction's resident. To show this in the context of the present model, let $V^*(\rho,\ t(b),\ b)$ be the equilibrium utility of residents, where t(b) is the balanced-budget relation between b and t at a given ρ. In equilibrium, a change in b in a given jurisdiction has no welfare impact, because optimization implies that

$$(\partial V^* / \partial t)(dt / db) + \partial V^* / \partial b = 0. \quad (16)$$

Making use of this nature of equilibrium yields the first-order condition for b under capital tax distortion.

Consider the impact of a marginal change in b. Profit maximization and cost minimization imply that this policy change alters L^i, K^i, and X^i according to

$$dX^1 = WdL^1 + rdK^1 + g^{1\prime}f^1 db, \quad (17)$$

$$PbX^2 = WdL^2 + rdK^2 + Pg^{2\prime}f^2 db, \quad (18)$$

$$C^b db = WdL^b + rdK^b. \quad (19)$$

Summing up (17)-(19) and using (7) and (8) gives

$$dX^1 + PdX^2 + C^b db = rdK + (g^{1\prime}f^1 + Pg^{2\prime}f^2)\, db. \quad (20)$$

From (13) and (14), the change in X^i satisfies

$$dD^2 = dX^2, \quad (21)$$

$$dD^1 = dX^1 - \rho dK. \quad (22)$$

Equation (22) holds because a single jurisdictions policy has no impact on ρ. In terms of consumption, (16) is equivalent to the condition that $dD^1 + PdD^2 = 0$. (Utility does not change). Thus, from (21) and (22), the following condition must be held in equilibrium:

$$dX^1 + PdX^2 - \rho dK = 0. \quad (23)$$

Equations (20) and (23) yield the second-best provision rule for b set by local governments:

$$g^{1\prime}f^1 + Pg^{2\prime}f^2 - C^b = -t\Delta_{b,t}K, \quad (24)$$

where

$$\Delta_{b,t}K = (\partial K / \partial t)(dt / db) + \partial K / \partial b. \quad (25)$$

In (24), capital-tax financing of b on K is denoted as $\Delta_{b,t}K$.

Note that the RHS of (24) is the distortionary impact of the capital tax. With a lump-sum tax, the amount of b would be set such that $g^{1\prime}f^1 + Pg^{2\prime}f^2 = C^b$; that is, the sum of the marginal products of b over industries equals the marginal cost of providing b. Equation (24) shows that public expenditure is inefficient under capital tax distortion. As the tax competition literature argues, the resultant inefficiency can be explained in terms of fiscal externalities due to capital mobility.[9] Local governments regard any policy-induced changes in local capital stock as distortionary costs or benefits due to capital tax competition. Given that the total capital stock is constant, however, the induced capital movements are not distortions from the viewpoint of the entire economy, because other jurisdiction's tax revenues increase or decrease. These external impacts are ignored in decentralized decision-making. In this paper, if $\Delta_{b,t}K < (>) 0$, a rise in a single jurisdiction's b generates a positive (negative) externality on other jurisdictions by increasing (decreasing) their capital tax revenues, implying that the amount of b is inefficiently low (high). This argument of fiscal externalities is closely related to the direction of welfare-improving changes in public expenditure. This relation reflects the fact that any public policy creating positive externalities should be encouraged, and vice versa. To demonstrate, the rest of this section clarifies the welfare impact of a coordinated change in all jurisdiction's public inputs from equilibrium. As argued before, my study focuses on symmetric equilibrium, where capital stock is uniformly distributed among all jurisdictions. (K equals the per capita endowment of capital, K^*).

LEMMA.

Starting from a symmetric equilibrium, a coordinated increase in b *made by all jurisdictions improves welfare if, and only if,* $\Delta_{b,t}K<0$.

Proof. Given that the initial equilibrium is symmetric, a coordinated policy change leaves local capital stock unchanged at $K=K^*$. In addition, recall that $X^i=D^i$ at any symmetric allocation. These imply that when all jurisdictions uniformly change their policies, the resultant change in K, X^i, and D^i must satisfy

$$\delta K=0\ ;\ \delta X^i=\delta D^i, \tag{26}$$

where δ be the symbol of differentiation in the case of coordinated policy change.

Once (26) is taken into account, the remaining procedure is similar to (17)-(23). Since factor prices equal marginal products, the change in L^i and K^i satisfies

$$\delta X^1=W\delta L^1+r\delta K^1+g^{1\prime}f^1\delta b, \tag{27}$$

$$P\delta X^2=W\delta L^2+r\delta K^2+Pg^{2\prime}f^2\delta b, \tag{28}$$

$$C^b\delta b=W\delta L^b+r\delta K^b. \tag{29}$$

It can be shown from (26)-(29) that

$$(\delta D^1+P\delta D^2)\ /\ \delta b=g^{1\prime}f^1+Pg^{2\prime}f^2-C^b. \tag{30}$$

In terms of consumption, (30) is the welfare impact of a coordinated rise in b, with t adjusting to maintain the public budget constraint. Since (24) holds in equilibrium, (30) is positive if, and only if, $\Delta_{b,t}K<0$. Q. E. D.

This lemma is analogous to Wilson's (1986, p. 303) necessary and sufficient condition for the existence of tax competition (public good underprovision). In his analysis and this paper, a coordinated increase in public expenditure made by all jurisdictions improves welfare if, and only if, a single jurisdiction's capital-tax financing of expenditure reduces local capital stock, in which case the marginal benefit of expenditure exceeds the marginal cost ($g^{1\prime}f^1+Pg^{2\prime}f^2>C^b$ in this paper). This result accords with that derived from the fiscal externality theory, which relates expenditure inefficiency under capital taxation to policy-induced capital movements.

4. The impact of capital-tax financing of public inputs on investment

Following Section 3, this section derives $\Delta_{b,t}K$ in terms of elasticity and share parameters. The derived formula is used to clarify how capital tax competition affects public input provision when intersectoral substitutability and interindustry factor mobility are taken into account. The relevant parameters are defined in the following table :

λ^{mp}	the private sector's share of a jurisdictions total supply of factor [e. g., $\lambda^{KP}=(K^1+K^2)\ /\ K$]
λ^{mb}	the public sector's share of a jurisdictions total supply of factor m (e. g., $\lambda^{mb}=K^b\ /\ K$)
λ_i^{mp} i=1, 2	industry i's share of the amount of factor m employed by the private sector (e. g., $\lambda_i^{KP}=K_i\ /\ (K^1+K^2)$; $\Sigma_i^2\lambda_i^{KP}=1$)
θ^{mi}	factor m's income share in industry i (e. g., $\theta^{K2}=rC_1^2\ /\ P$; $\theta^{Ki}+\theta^{Li}=1$)

σ^i	industry i's elasticity of factor substitution between private factors
ε	the elasticity of substitution between private goods in consumption

The difference between λ_i^{LP} and λ_i^{KP} or between θ^{L1} and θ^{L2} (θ^{K1} and θ^{K2}) indicates the factor-intensity ranking in the private sector. If $\lambda_2^{KP} > \lambda_2^{LP}$, then $\theta^{L1} > \theta^{L2}$ ($\theta^{K1} < \theta^{K2}$), so that the local good is more capital intensive than the national good.[10)]

To begin with, the following proposition presents the final result. Hereafter, a hat denotes a percentage change (e. g., $\hat{K} = dK / K$)

PROPOSITION.

The sign of $\Delta_{b,t}K$ *coincides with that of*

$$\sigma(\hat{W} - \hat{r}) / \hat{b} + (\lambda_2^{KP} - \lambda_2^{LP})(1 - \varepsilon)(\eta^1 - \eta^2) + (\lambda^{Kb} / \lambda^{KP} - \lambda^{Lb} / \lambda^{LP}), \tag{31}$$

where $\eta^i = (g^{i\prime} / g^i) b$,

$\sigma = \sum_i^2 (\lambda_i^{KP} \theta^{Li} + \lambda_i^{LP} \theta^{Ki}) \sigma_i + (\lambda^{Kb} \theta^{Lb} / \lambda^{KP} + \lambda_i^{Lb} \theta^{Kb} / \lambda^{LP}) \sigma^b + (\lambda_2^{KP} - \lambda_2^{LP})(\theta^{L1} - \theta^{L2}) \varepsilon > 0$, *and*

$$(\hat{W} - \hat{r}) / \hat{b} = [PX^2(\eta^1 - \eta^2) - WL\eta^1] / (rK^P \theta^{L1} + WL^b \theta^{K1}). \tag{32}$$

Proof. Let K^P and L^P be, respectively, K and L employed by the private sector (e. g., $K^P = K^1 + K^2$). Equations (7) and (8) imply that

$$\hat{K} = \lambda^{KP} \hat{K}^P + \lambda^{KP} \hat{K}^b, \tag{33}$$

$$0 = \lambda^{LP} \hat{L}^P + \lambda^{Lb} \hat{L}^b. \tag{34}$$

The change in L^P and K^b is given by (11), (12), and (34):

$$\hat{L}^P = -(\lambda^{Lb} / \lambda^{LP})(\hat{C}_W{}^b + \hat{b}), \tag{35}$$

$$\hat{K}^b = \hat{C}_r{}^b + \hat{b}. \tag{36}$$

From (9), (10), (13), and (14), $K^P = \sum_i^2 C_r{}^i D^i + \rho C_r{}^1 (K - K^*)$ and $L^P = \sum_i^2 C_W{}^i D^i + \rho C_W{}^1 (K - K^*)$. Differentiating these equations and applying the initial symmetry conditions, $X^i = D^i$ and $K^* = K$, yields

$$\hat{K}^P - \hat{L}^P = \sum_i^2 (\lambda_i^{KP} \hat{C}_r{}^i - \lambda_i^{LP} \hat{C}_W{}^i) + (\lambda_2^{LP} - \lambda_2^{KP})(\hat{D}^1 - \hat{D}^2) + [\theta^{K1} / rK^P - \theta^{L1} / WL^P] \rho K \hat{K}. \tag{37}$$

Since the utility function was assumed to be homothetic, the change in D^i in (37) satisfies

$$\hat{D}^1 - \hat{D}^2 = \varepsilon \hat{P}.$$

The separability of private production technology in (1) implies that $\partial C^i / \partial b = -C^i g^{i\prime} / g^i$, $\partial C_W{}^i / \partial b = -C_W g^{i\prime} / g^i$, and $\partial C_r{}^i / \partial b = -C_r{}^i g^{i\prime} / g^i$, where $i = 1, 2$ (see Note 8). From the linear homogeneity of the unit-cost functions with respect to factor prices, one has

$$\hat{C}_r{}^i = \theta^{Li} \sigma^i (\hat{W} - \hat{r}) - \eta^i \hat{b} \quad (i = 1,\ 2), \tag{39a}$$

$$\hat{C}_W{}^i = -\theta^{Ki} \sigma^i (\hat{W} - \hat{r}) - \eta^i \hat{b} \quad (i = 1,\ 2), \tag{39b}$$

$$\hat{C}_r{}^b = \theta^{Lb} \sigma^b (\hat{W} - \hat{r}), \tag{39c}$$

$$\hat{C}_W{}^b = -\theta^{Kb} \sigma^b (\hat{W} - \hat{r}). \tag{39d}$$

Substituting (35)-(39) into (33) and manipulating terms gives

$$[1 - (\theta^{K1} \rho / r) + (\theta^{L1} \rho K^P / WL^P)] \hat{K} / \lambda^{KP} = \tag{40}$$

$$[\textstyle\sum_i^2 (\lambda_i^{KP} \theta^{Li} + \lambda_i^{LP} \theta^{Ki}) \sigma^i + (\lambda^{Kb} \theta^{Lb} / \lambda^{KP} + \lambda^{Lb} \theta^{Kb} / \lambda^{LP}) \sigma^b](\hat{W} - \hat{r}) + (\lambda_2^{KP} - \lambda_2^{LP})(\eta^1 - \eta^2) \hat{b}$$

$$+(\lambda_2^{LP}-\lambda_2^{KP})\varepsilon\hat{P}+(\lambda^{Kb}/\lambda^{KP}-\lambda^{Lb}/\lambda^{LP})\hat{b}.$$

The bracketed term on the LHS is positive. The change in W and P is given by (3) and (4):

$$0=\theta^{L1}\hat{W}+\theta^{K1}\hat{r}-\eta^1\hat{b}, \tag{41}$$

$$\hat{P}=\theta^{L2}\hat{W}+\theta^{K2}\hat{r}-\eta^2\hat{b}, \tag{42}$$

From (41) and (42), one has

$$\hat{P}=(\theta^{L2}-\theta^{L1})(\hat{W}-\hat{r})+(\eta^1-\eta^2)\hat{b}, \tag{43}$$

Substituting (43) into the RHS of (40) yields (31).

To derive (32), one must know the change in t when b is increased (or equivalently, the change in r, since ρ is exogenous to jurisdictions). This can be obtained from the first-order condition for each jurisdiction's optimization; that is, (16). To see this, it is helpful to use the indirect utility function of residents. Let $\phi(P, WL+\rho K^*)$ be that function. The absence of utility change means that $(\partial\phi/\partial P)\,dP+(\partial\phi/\partial y)\,dy=0$, where $y=WL+\rho K^*$. Applying Roy's identity to this equation,

$$PX^2\hat{P}=WL\hat{W}, \tag{44}$$

since $X^2=D^2$ in equilibrium. Inserting (41) and (42) into (44) yields

$$\hat{r}/\hat{b}=[(WL^1+WL^b)\eta^1+PX^2\theta^{L1}\eta^2]/(rK^P\theta^{L1}+WL^b\theta^{K1}). \tag{45}$$

Equation (45), together with (41), gives

$$(\hat{W}-\hat{r})/\hat{b}=[\eta^1(rK^P-WL^b)\theta^{L1}-WL^1\eta^1-PX^2\theta^{L1}\eta^2]/\theta^{L1}(rK^P\theta^{L1}+WL^b\theta^{K1}). \tag{46}$$

Since $rK^P-WL^b=X^1+PX^2-WL$ and $X^1\theta^{L1}=WL^1$, the numerator of (46) equals that of (32) multiplied by θ^{L1}. Q. E. D.

With the negative sign of (31), public input underprovision occurs, as shown in Section 3. The expression in (31) consists of three terms. The first term captures the change in K arising from the impact of public input provision on the wage-rental ratio. The second term is due to the impact of the provision on private consumption and production at a given wage-rental ratio. Given market prices, the third term represents the impact of a change in the public output level on factor allocation between private and public production. In the following, these three terms are called the factor substitution effect, the cost-reducing effect, and the output effect, respectively.[11)]

The sign of the factor substitution effect is negative when the wage-rental ratio declines as a result of increasing b. In this case, K decreases not only because each industry uses a more labor intensive technology, but also because an intersectoral substitution toward the more labor intensive good follows. The magnitude of these impacts on K is represented by σ, which is the so called aggregate elasticity of factor substitution. Whether W / r falls or rises depends on the relative strength of the impact of an increase in the public input supply and the impact of a balanced-budget rise in the capital tax rate. The additional b increases W through the zero-profit condition for the national industry.[12)] On the other hand, the rise in the tax rate increases r [see (45)], causing W to decline in order to keep the zero-profit condition for the national industry. The overall impact of these forces is described by (32). It shows that W / r decreases if $\eta^1 \leqq \eta^2$ or $PX^2 \leqq WL$, in which cases the factor substitution effect contributes to underprovision of b.

Given the wage-rental ratio, a one percent rise in b reduces the cost of producing one unit of X^i by η^i percent. This creates the cost-reducing effect, which affects the demand for private factors and private goods. The resultant impact on K depends on the difference between η^1 and η^2, and the factor-intensity ranking in the private sector. From (39a, b), a one percent rise in b reduces the demand for factors per unit of X^i by η^i percent. Moreover, (43) shows that the rise in b affects the demand for goods by altering the relative price of the local good by $(\eta^1 - \eta^2)$ percent. If η^i of the more capital intensive good is larger than that of the labor intensive good, the impact through factor demands decreases K because the demand for capital in private industries declines. Under the same condition, however, the impact through good demands implies that an intersectoral substitution toward the capital intensive good increases K. As the second term of (31) shows, the relative strength of these impacts depends on ε.

A rise in the public output level entails a reallocation of private factors, creating the output effect. My explanation of this effect is essentially equivalent to that of Wilson's (1986) output effect. If the level of public production increases while market prices and K stay fixed, private factors must be reallocated from the private sector to the public sector. This affects X^i in a fashion similar to the Rybczynski theorem. But, the constancy of market prices implies that D^i does not change.[13] To restore the market-clearing conditions for private goods, K must alter. Whether K rises or falls depends on the sign of $(\lambda^{Kb} / \lambda^{KP} - \lambda^{Lb} / \lambda^{LP})$; that is, the factor-intensity ranking between the private sector and the public sector. If the public sector is more labor intensive, the sign of the output effect is negative, thereby contributing to underprovision of b.

Although the sign of $\Delta_{b,t}K$ is generally ambiguous, clear-cut results occur from (31) and (32) when b has an equiproportional impact on private industries $(\eta^1 = \eta^2)$. In this case, the factor substitution effect is negative and the cost-reducing effect vanishes. As a result, capital tax competition causes public input underprovision if the public sector is more labor intensive than the private sector; that is $\lambda^{Kb} / \lambda^{KP} < \lambda^{Lb} / \lambda^{LP}$. Interestingly, Wilson (1986, Proposition 1) obtains the same sufficient condition for underprovision of public goods.[14] Note also that, with equal factor-intensities among industries $(\lambda_2^{KP} = \lambda_2^{LP}$ and $\lambda^{Kb} / \lambda^{KP} = \lambda^{Lb} / \lambda^{LP})$ and $\eta^1 = \eta^2$, the present model is effectively reduced to a single-industry model. Due to the factor substitution effect, the amount of b is too low under capital tax competition. This result is consistent with public input underprovision in Matsumoto (1998, 1999a).

In the case where $\eta^1 \neq \eta^2$, strong results cannot be derived as to expenditure inefficiency. Still, (31) and (32) give a useful insight. Recall that, regardless of η^i, the factor substitution effect is negative if $PX^2 \leqq WL$. This condition is plausible since spending on nontraded goods (e. g., housing) is significantly below noncapital income in developed countries. Accordingly, if capital tax competition resulted in underprovision of public inputs in the present model, it would be implied from the higher elasticity of substitution in consumption and production (σ).

5. Concluding remarks

This paper has investigated the impact of capital tax competition on public input provision. While the previous tax competition studies of public inputs are based on single-industry models, this paper allowed for intersectoral substitutability and interindustry factor mobility within local jurisdictions. In this complex framework, whether capital taxation leads to underprovision of public inputs cannot be easily seen without detailed information on technology and preferences. Despite this limitation, I have identified that, as in Wilson's (1986) analysis of public goods, public input underprovision would occur under capital tax distortion if substitutability between mobile and immobile factors would be sufficiently high. Of particular interest is that if public inputs have equiproportional impacts on private industries, Wilson's (1986, Proposition 1) sufficient condition for public goods to be underprovided extends to the analysis of public input provision.

Notes

1. This paper is based on Chapter 5 in my thesis entitled *"Tax competition and Public Input provision (Kobe University, 1999)."* I wish to thank Mototsugu Fukushige, Jun Iritani, and Tetsuya Kishimoto for helpful comments.
2. See, for example, Zodrow and Mieszkowski (1986); Wilson (1986); Wildasin (1989); Bucovetsky and Wilson (1991); Hoyt (1991); Braid (1996); Keen and Marchand (1997). My thesis (Chapter 1) includes a review of the previous studies of tax competition.
3. Potential overprovision of public inputs in Noiset (1995), Noiset and Oakland (1995), and Bayindir-Upmann (1998) is based on the idea that the negative impact of capital taxation on business investment may be dominated by the positive impact of public input provision on investment, so that capital-tax financing of public inputs may increase local capital stock. But, Matsumoto (1998, 1999a) proves that this possibility does not exist under constant returns to scale production technology.
4. In this paper, my attention is focused only on the overall level of public input provision. In my thesis (Chapter 5), the present multiple-industry model is used to investigate the impact of tax competition on the mix of industry-specific public inputs.
5. This kind of separable production technology is used by Feehan (1998) and Matsumoto (1995) to examine the optimal supply rules for public inputs in the presence of distortionary taxes.
6. Feehan (1989) reviews alternative specifications of public inputs which are based on the degree of homogeneity of the production functions. If production technology exhibits constant returns to scale in private factors only, public inputs are called "factor-augmenting." In addition to factor-augmenting public inputs, Matsumoto (1998) includes a tax competition study of "firm-augmenting" public inputs under which production technology exhibits constant returns to scale in all factors, including public inputs.
7. Wilson (1986) investigates the case where the public sector minimizes production costs evaluated at second-best shadow factor prices set by local governments. He shows that production technology used by the public sector is too capital intensive under capital taxation.
8. From (1), $C^i(W, r, b) = c^i(W, r) / g^i(b)$, where c^i is linearly homogeneous.

9. See, for example, Wilson (1986) and Wildasin (1989).

10. If $\lambda_2^{KP} > \lambda_2^{LP}$, then $K^2(L^1+L^2) > L^2(K^1+K^2)$, implying that $K^2/L^2 > K^1/L^1$. If $\theta^{L1} > \theta^{L2}$, then $\theta^{K2}/\theta^{L2} > \theta^{K1}/\theta^{L1}$, since $\theta^{Li}+\theta^{Ki}=1$.

11. My definition of the factor substitution effect and the output effect is based on that of Wilson's (1986) study of public good provision.

12. From the viewpoint of a single jurisdiction, the demand for the national good is infinitely elastic at a given national price. This feature of the model implies that, once t and b are given, W is determined only by the zero-profit condition for the national industry.

13. Since factor prices are hypothetically fixed in the consideration of the output effect, this effect does not affect utility (D^i does not change), so that it eventually alters X^i and K according to (23). This fact implies that the change in K to maintain the market-clearing condition for the local good restores the balance of trade condition at the same time.

14. Wilson (1986, Proposition 2) derives another necessary and sufficient condition for public good underprovision, which is satisfied if the elasticities of substitution in production and consumption are sufficiently high.

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