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Pigou, Tiebout, Property Taxation, and the Underprovision of Local Public Goods

GEORGE R. ZODROW* AND PETER MIESZKOWSKI*

Department of Economics, Rice University, Houston, Texas 77251

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Pigou's proposition that the use of distorting taxes rather than neutral head taxes reduces public service levels is examined in this paper. A simple model with a national system of competing local governments is utilized to demonstrate that the use of a distorting property tax on mobile capital decreases the level of residential public services. The case where public services are an intermediate producer good is also considered.

I. INTRODUCTION

A large literature on the efficiency properties of a system of competing local governments has concluded that global equilibria in a federal system are generally inefficient.

At least three strands of this literature can be distinguished. The first, emphasized by Williams [27] and Brainard and Dolbear [9], is that for some public services benefits provided by one community spillover to other communities. Since communities do not consider the benefits of spillover effects, there is a tendency for underprovision of local expenditures relative to the optimum.

The second strand focuses on the fiscal externality or fiscal migration effects of multigovernment systems. Buchanan and Goetz [11], Flatters *et al.* [14] and Stiglitz [23, 24] all argue that, in general, migration of population between a limited number of communities results in an inefficient equilibrium, as migrants do not take into account the fiscal externalities they create in migrating. Starrett [21] and Boadway [7] investigate how the tendency for underprovision or overprovision of local public goods in such models depends on the method of local taxation.

The third strand is the focus of our inquiry. It is the proposition, first advanced by Pigou [20], that the supply of public services is lower in

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situations where distortionary taxes are used relative to a first-best optimum where lump sum finance is used.[1]

Our work is most closely related to the analysis of Atkinson and Stern [3] on the validity of Pigou's proposition that public services are undersupplied when financed by distorting taxes. We adopt their methodology of varying exogenously the level of nondistorting head taxes which is "permitted" and observing the consequences for the optimal level of public service provision. Our focus is the effect of property tax finance in a national system of independent local governments.

Interestingly, for the case of distorting commodity taxes (when leisure is not directly subject to taxation) and a single public good, Atkinson and Stern [3, p. 124] show that a marginal reduction in the possibilities for lump sum taxation from the first-best head tax optimum leads to a fall in the optimal quantity of the public good. But they find the establishment of global results to be more difficult and are able to demonstrate that the level of public good provision is lower in the commodity tax case relative to the lump-sum tax case only for the special case of the Cobb–Douglas utility function. Similarly, Atkinson and Stiglitz [4, p. 494] point out that while marginal analysis suggests that "there may be a presumption that expenditure will be reduced," in general "global results cannot be deduced." Thus it appears the Pigou proposition is of limited validity for a national public good financed with distorting commodity taxes. In contrast, we are able to show for a model of a national system of independent local governments that the presumption of undersupply of local public goods with distorting property taxation is more general.

The "optimal property taxation" problem facing a jurisdictional government is similar to that examined at the national level by Atkinson and Stern [3]. We consider two types of local public goods. First, when local public goods are provided as public services to residents, we obtain unambiguous results without restrictions on individual utility functions—increased use of the distortionary property tax coupled with less reliance on a nondistortionary head tax always reduces local public expenditure, both globally and at the margin, regardless of the level of property taxation. Second, when local public goods are an input into the production process, we derive the

[1] The head tax local public goods equilibrium, which serves as a benchmark in our analysis, has been analyzed frequently in the local public finance literature. Primary proponents are Hamilton [15], Fischel [13], and White [26] who argue that the stratification of households and firms in homogeneous communities coupled with precise zoning requirements on the amount of housing or industrial capital used in a particular community transforms local property taxes into a set of nondistorting user charges. For the purposes of this paper, we explicitly reject this proposition on the grounds that zoning is not so precise that marginal capital use decisions are not distorted by the local property tax. Instead, we focus on the effects of the local property tax in a model without zoning.

conditions under which the same result obtains. Note that our analysis has a slightly different emphasis than that of Atkinson and Stern. They conduct a normative analysis of the optimal level of public services provided by an optimizing national government, while we assume that all local governments optimize in a similar fashion and conduct a positive analysis of the effects of such behavior in a national system of independent local governments.

II. UNDERPROVISION OF RESIDENTIAL PUBLIC SERVICES

Consider a national economy composed of N identical jurisdictions (indexed by $i = 1, \ldots, N$). Each jurisdiction has an identical supply of a fixed factor, hereafter referred to as land. The national capital stock ($\bar{K}$) is fixed, and capital is perfectly mobile across jurisdictions so that all capital earns the same net return (r). Land and capital are the only factors of production in the economy.

Output is produced in each jurisdiction by perfectly competitive firms who use a twice differentiable constant returns to scale production function

$$F(K), \qquad F_K > 0, \qquad F_{KK} < 0,$$

where K is the capital stock in a representative jurisdiction $i(NK = \bar{K})$ and the fixed land argument is suppressed.

Each community has the same number of identical residents.[2] Each resident owns an equal share of the land in the jurisdiction in which he resides and an equal share of the national capital stock, which is not necessarily invested in the jurisdiction of residence. There is no other source of individual income. Since all individuals in each jurisdiction are identical, we normalize the population in each community to be equal to one; all quantities thus are defined on a per capita basis.

Local public services (P) in representative jurisdiction i are modeled as public purchases of output which are financed either by a specific unit property tax on capital (T) or by a head tax assessed against all local residents (H); government budget balance requires

$$P = TK + H. \tag{1}$$

The "permitted" amount of lump sum taxation is assumed to be fixed exogenously at the same level for all communities. Local public services are treated as publicly provided private goods with no spillover effects (see Hamilton [16] for a justification) and are shared equally by all residents.

[2] We are obviously considering only allocative rather than distributive issues.

Note that our assumptions eliminate the spillover and fiscal externality problems frequently encountered in Tiebout-type models and discussed in the Introduction. Instead, we have a model of identical jurisdictions where the effects of reductions in the exogenous level of head taxation[3] on the amount of property taxation and on the level of local public services can be easily analyzed by examining a single representative jurisdiction.[4]

Interjurisdictional competition is modeled along Cournot–Nash lines, and each jurisdiction is assumed to be small relative to the national economy. The local government in each jurisdiction acts on the assumptions that all other jurisdictions do not respond to changes in its property tax rate and that its actions cannot affect the national net return to capital r.

Each local government acts to maximize the utility of a representative resident, where the utility function $U(C, P)$, identical for all individuals in the economy, is a strictly quasiconcave, twice differentiable function defined over consumption of private goods (C) and public goods; both goods are assumed to be normal. The level of private goods is determined from the private budget constraint

$$C = [F(K) - (r + T)K] + r(\bar{K}/N) - H, \tag{2}$$

where the first term is the return to land, the second is the return to capital, and the third reflects head taxes paid.

Substituting from (1) and (2), the optimization problem facing each local government is

$$\max_{T} U\{[F(K) - (r + T)K + r\bar{K}/N - H], TK + H\}, \tag{3}$$

where each government perceives r and H to be fixed and the first-order conditions for firm optimization require that

$$r + T = F_K(K). \tag{4}$$

Differentiating (4) yields the change in the local capital stock expected by

[3] Our approach of determining the effects of an exogenous change in the level of head taxation on the level of public services follows Atkinson and Stern [3].

[4] Note also that our assumptions of identical communities with publicly provided private goods permits us to avoid potential inefficiencies where Tiebout-type communities are inefficiently organized or inappropriately stratified by taste class. The work of Pestieu [19], Bewley [6], Stiglitz [24], and Brueckner [10] has shown that utility maximization or Cournot–Nash-type property value maximization can lead to a local optimum where each community is internally Pareto efficient but where coordinated rearrangement of the population could lead to a Pareto-superior outcome.

the local jurisdiction when it uses the property tax:

$$\phi = -dK/dT = -1/F_{KK} > 0. \tag{5}$$

This term represents the distortionary effect of the property tax; each community, acting in isolation, is concerned that higher property taxes will drive out capital and decrease its income from land rents.

Note first that if H were a local government choice variable (along with T) the first-order conditions would be

$$U_P/U_C = 1, \tag{6}$$

$$U_P/U_C = 1/\{1 - (T\phi/K)\} \tag{7}$$

where the subscripts denote partial derivatives of the utility function. Thus, the optimal property tax would be zero and head tax financed public services would be provided up to the point where the marginal rate of substitution equaled the marginal rate of transformation (equal to unity); the local government would prefer the head tax to the distortionary property tax which lowers land values.[5]

However, when the head tax is exogenously constrained to less than this level, the representative jurisdictional government's first-order condition for T is

$$U_P/U_C = 1/[1 - T\phi/K] > 1. \tag{8}$$

Thus, since the marginal rate of transformation between private and public goods is greater than one, (8) indicates underprovision of local services at the margin.

The next step in our argument is to determine the national effects which occur when each jurisdiction sets its property tax rates as specified by (8). The fixed national capital stock requirement implies that

$$N\,dK = 0 \tag{9}$$

so that, in the Cournot–Nash equilibrium when all jurisdictions act identically in response to an exogenous change in H, substituting from the result of differentiating (4) yields

$$dr = -dT. \tag{10}$$

Thus, we obtain a typical new view result—when all jurisdictions increase

[5]See Zodrow and Mieszkowski [28] for further discussion of the local choice between head tax and property tax finance.

the rate of property taxation of capital and the national capital stock is fixed, capital bears the full burden of the tax as the gross price of capital $(r + T)$ is unchanged in each jurisdiction. Accordingly, the capital stocks K, land prices, and the individual jurisdictional governments' perception of $\phi = -dK/dT$ are all unchanged in the Cournot–Nash equilibrium.

These results permit us to establish unambiguously the effect of a change in H—the "permitted" level of lump sum taxation—on local public service levels. Totally differentiating (8) for $dH > 0$ and substituting from (10) when $dK = d\phi = 0$ yields

$$\left[\alpha K - U_P/(KF_{KK})\right] dT = -\alpha\, dH, \tag{11}$$

where

$$\begin{aligned}
\alpha &= \alpha_1 + \alpha_2(1 - U_C/U_P) > 0,\\
\alpha_1 &= -\left[U_{CC} - 2(U_C/U_P) + U_{PP}(U_C/U_P)\right] > 0,\\
\alpha_2 &= -\left[U_{PP}(U_C/U_P) - U_{PC}\right] > 0,
\end{aligned}$$

and strict quasiconcavity of the utility function ensures $\alpha_1 > 0$, the normal goods assumption ensures that $\alpha_2 > 0$, and (8) ensures that $\alpha > 0$. Thus, dT/dH is unambiguously negative—reduced reliance on lump-sum taxation implies increased reliance on property taxation. Substituting from (11) into the result of differentiating (1) yields

$$\frac{dP}{dH} = \frac{U_P/(-F_{KK}K)}{\alpha K + U_P/(-F_{KK}K)} > 0. \tag{12}$$

Thus, reduction in the permitted head taxation in the economy causes a reduction in the level of local public services. Note that the derivation does not assume a zero initial property tax—it is valid for all values of T between $T = 0$ and the value of T when $H = 0$.

This situation is depicted in Fig. 1. The slope of the production possibilities frontier (AB) for a jurisdiction is negative one. With sole reliance on head tax finance, the slope of the indifference curve at utility U^H is negative one and P^H local public goods are provided. With sole reliance on property tax finance, the model is constructed so that simultaneous use of the property tax by all jurisdictions implies that the production possibilities frontier is unchanged (the tax has no "income effects" on the jurisdiction's "budget constraint") since each jurisdiction's capital stock is unchanged in the Cournot–Nash equilibrium and the marginal rate of transformation is still negative one. However, in the property tax equilibrium, the slope of the indifference curve is greater (in absolute value) than one [as shown in (8)]

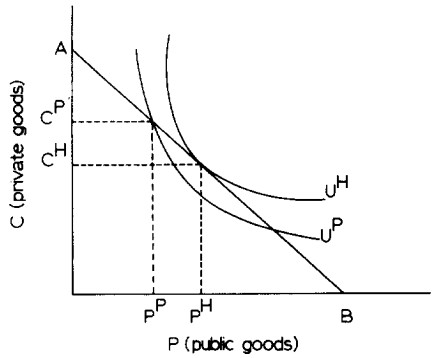

FIGURE 1

due to the perceived distortionary effect of the property tax. Due to the consumption distortion, the property tax equilibrium requires the intersection of AB and an indifference curve with slope greater than one in absolute value which can occur only at a lower level of public services ($P^P < P^H$) and at a lower level of utility ($U^P < U^H$).

III. UNDERPROVISION OF BUSINESS PUBLIC SERVICES

In this section, we consider a model similar to the one discussed in the previous section, but where all local public services go to business as an input into the production process.

In this case, the firm production function in each jurisdiction is

$$F(K, B), \qquad F_{KB} > 0, \qquad F_B > 0, \qquad F_{BB} < 0,$$

where B is the level of publicly provided services to business. The local government budget constraint in a representative jurisdiction is

$$TK + H = B, \tag{13}$$

while the first-order condition for firm optimization is

$$r + T = F_K(K, B). \tag{14}$$

The change in the capital stock in response to a change in the property tax perceived by each jurisdiction is obtained by combining the results of differentiating (13) and (14) to yield

$$\phi = \frac{-dK}{dT} = -\frac{1 - KF_{KB}}{F_{KK} + TF_{KB}} \tag{15}$$

which can be viewed as a function of K, B, and H. We assume that the model is stable in the sense that the marginal cost of diverting a unit of output to public services for firms (which is equal to unity) is greater than the associated increase in output due to the increased marginal productivity of capital (KF_{KB}); that is,

$$1 - KF_{KB} > 0. \tag{16}$$

We also assume the model is stable in the sense that each jurisdiction perceives that raising taxes will drive out capital ($\phi > 0$); otherwise, taxes would always be raised. This implies that

$$T < -F_{KK}/F_{KB}. \tag{17}$$

The optimization problem facing the government is simply

$$\max_T F(K, TK + H) - (r + T)K + r\bar{K}/N - H \tag{18}$$

since there is only one consumption good in this model. If the head tax were a choice variable, the first-order conditions would prescribe $T = 0$ and

$$F_B = 1; \tag{19}$$

thus, local governments would use only head tax finance and would purchase public services up to the point where the marginal product of services was equal to the marginal cost of unity. If the use of the head tax is constrained below this level, the first-order condition for T is

$$F_B = 1/[1 + (T/K)(dK/dT)] = 1/(1 - T\phi/K); \tag{20}$$

thus, $F_B > 1$ for $T > 0$, production is inefficient and, in contrast to the case analyzed in the previous section, there is an inward shift in the jurisdiction's production possibilities frontier (the tax has an "income effect" on each jurisdiction's "budget constraint"). Two propositions follow. First, if the local governments must rely solely on property tax finance ($H = 0$), there is an undersupply of public goods. This follows because the capital stock is fixed in each jurisdiction in the Cournot–Nash equilibrium and $F_B(K, B) > 1$ implies that B must be less in the property tax case than in the head tax equilibrium (where $F_B = 1$). Second, a marginal reduction in the permitted level of head taxation at the head tax optimum ($T = 0$, $F_B = 1$) reduces public services. To see this, differentiate (20) and evaluate at $T = 0$, $F_B = 1$ to yield

$$\frac{dT}{dH} = \frac{F_{BB}}{\phi/K - F_{BB}K} < 0. \tag{21}$$

Thus, a reduction in the head tax implies an increase in the property tax. Substituting into the result of differentiating (13) yields

$$\frac{dB}{dH} = \frac{\phi/K}{\phi/K - KF_{BB}} > 0. \tag{22}$$

Thus, a marginal reduction in the opportunities for head taxation at the head tax optimum unambiguously decreases public services provided to firms.

However, a theoretical ambiguity arises for reductions in H when $T > 0$ (i.e., along the path from the zero property tax equilibrium to the zero head tax equilibrium). The first-order condition (20) can be rewritten as

$$F_B T\phi = K(F_B - 1). \tag{23}$$

That is, the perceived marginal cost of raising the property tax—the erosion of the tax base which implies a reduction in output $F_B T\phi$—must equal the marginal gain—increased output due to higher services less the increase in the supply price of capital $[K(F_B - 1)]$. Thus, in deciding its tax policy, the community must balance the tax base erosion effect against the value of the additional revenues.

The theoretical ambiguity arises because the perceived deleterious effect of raising T on the tax base ($\phi = -dK/dT$) is a function of B which changes as H changes [see (15)]. The change in ϕ depends on the third derivatives of the production function which are theoretically ambiguous in sign. However, the possible outcomes can be classified as follows.

Dividing (23) by F_B yields

$$T\phi = K(F_B - 1)/F_B = \psi.$$

In the Cournot–Nash equilibrium, $dK = 0$ for all jurisdictions. Thus, ψ can be viewed as a function only of B, where

$$\frac{d\psi}{dB} = \frac{KF_{BB}}{(F_B)^2} < 0 \tag{24}$$

while $T\phi$ can be viewed as a function of B and H where

$$\left.\frac{\partial(T\phi)}{\partial H}\right|_B = \frac{F_{KK}(1 - KF_{KB})}{K(-F_{KK} - TF_{KB})^2} < 0 \tag{25}$$

and, although we know $\partial T/\partial B$ (holding H constant) is positive, $\partial(T\phi)/\partial B$

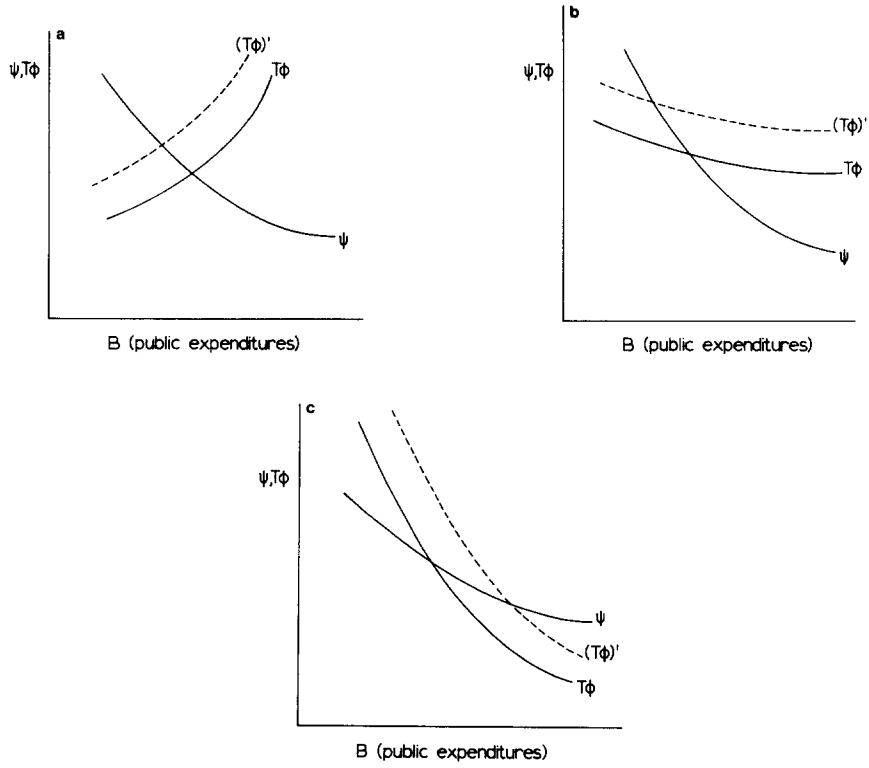

FIGURE 2

(holding H constant) is theoretically ambiguous.[6] The three possible outcomes are shown in Figs. 2a–c.

First, suppose $\partial\phi/\partial B$ is positive so that $\partial(T\phi)/B$ is positive—the perceived tax base erosion effect increases as the level of public services increases. In this case a decrease in the head tax H will lead to an unambiguous *decrease* in B, the level of expenditures on the publicly provided good. The intuition behind this result is as follows. In Fig. 2a, a decrease in H leads to an upward shift in the $T\phi$ curve, shown as $(T\phi)'$. Consequently, the tax base erosion effect is increased holding the value of B fixed, and the disequilibrium between $T\phi$ and ψ can be eliminated only by a decrease in B. A decrease in B increases the marginal product F_B (increasing ψ) and decreases $T\phi$ until equilibrium is reached.

[6] The second-order conditions for each jurisdiction's optimal tax rate specify a (negative) lower bound for $\partial(T\phi)/\partial B$ which is smaller than $d\psi/dB$; thus, $\partial(T\phi)/\partial B < d\psi/dB$ cannot be ruled out (see Fig. 2c).

In Fig. 2b, we illustrate a second case where the relationship between ϕ and B is negative and the slope of $T\phi$ is negative but less (in absolute value) than the slope of ψ. For this case, a decrease in H also leads to a decrease in B. The intuition is that while a decrease in B does not generate a decrease in the tax base erosion term $T\phi$, the increase in the marginal product F_B with respect to a decrease in B is sufficient to offset the increase in $T\phi$.

The third case is the counterintuitive possibility that a marginal decrease in H leads to a marginal increase in public expenditure; this case is presented in Fig. 2c. Here the decline in the perceived outflow of capital with respect to changes in the tax rate that follows from an increase in B is large enough that the slope of $T\phi$ is negative and larger in absolute value than the slope of ψ. Consequently, the disequilibrium between the value of ψ and the tax base erosion effect $T\phi$ that follows a decrease in the head tax cannot be eliminated through a decrease in B. A decrease in public expenditures will increase the marginal product of the producers' good and thus ψ; however, the increase in $T\phi$ for a unit decrease in B is even larger thus widening the difference between ψ and $T\phi$; hence an increase in B is required.

The case described in Fig. 2c is analogous to market situations where a downward sloping demand curve interacts with a more steeply declining supply curve (a decreasing cost industry) so that increases in quantity supplied at every price (an upward shift in the supply schedule) lead to decreases in equilibrium price. As this is a curiosum, it is tempting, by analogy, to characterize similarly the case depicted in Fig. 2c where an increase in the head tax leads to a decrease in public expenditure; nevertheless it can theoretically occur (locally) for small change in the head tax.

IV. COMBINING THE TWO MODELS

Although a full analysis of the case where local governments simultaneously provide public services to individuals and firms would be rather cumbersome and not offer much additional insight, the basic elements of the story are outlined briefly in this section. Using the previous notation, the government faces a budget constraint of

$$TK + H = B + P. \tag{26}$$

The optimization problem facing the representative jurisdictional government is

$$\max_{T,\,B} U\{[F(K, B) - (r + T)K + r\bar{K}/N - H], (TK + H - B)\}. \tag{27}$$

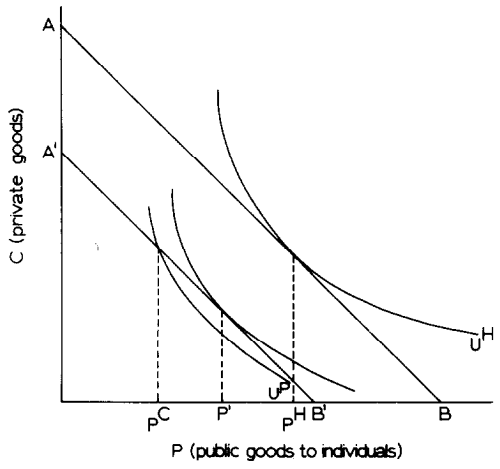

FIGURE 3

First-order conditions for T and B (when the government is constrained to use less head taxation than at the first-best optimum where $T = 0$, $U_P/U_C = 1$, $F_B = 1$) are

$$U_P/U_C = 1/(1 - T\phi/K) > 1, \tag{28}$$

$$F_B = \frac{1 + T_{KB}F_{BB}}{1 - (T\phi/K)}. \tag{29}$$

$F_B > 1$ is implied by (29) as long as the stability condition (16) is satisfied. This again implies that, in the property tax equilibrium ($H = 0$), public services to firms are underprovided relative to the head tax case. Moreover, public services to individuals are also underprovided in the property tax equilibrium, as shown in Fig. 3.

The level of individual public services in the head tax equilibrium is shown as P^H, where the slope of the indifference curve is equal to negative one, the slope of the production possibilities frontier AB. A shift to the property tax equilibrium ($H = 0$) implies an inward shift of the production possibilities frontier to $A'B'$—production is inefficient since $F_B > 1$, but given B, the marginal rate of transformation between C and P is still negative one. The inward shift of the production possibilities frontier implies a lower P ($P' < P^H$ is implied by the normal goods assumption), while the consumption distortion implies a further reduction in P ($P^C < P'$ as in Section II). Thus, the property tax equilibrium is characterized by a lower level of both public services than the head tax equilibrium.

Also, a marginal reduction in the permitted level of head taxation from the head tax equilibrium implies a reduction in the levels of both public services. To see this, differentiate (26), (28), and (29) and evaluate at $T = 0$, $F_B = 1$, $U_P/U_C = 1$ which yields

$$\frac{dB}{dH} = \frac{\alpha U_P(1 - KF_{KB})/(-KF_{KK})}{D} > 0, \tag{30}$$

$$\frac{dT}{dH} = \frac{\alpha U_C F_{BB}}{D} < 0, \tag{31}$$

$$\frac{dP}{dH} = \frac{U_P U_C F_{BB}/(KF_{KK})}{D} > 0, \tag{32}$$

where

$$D = \alpha U_P(1 - KF_{KB})/(-KF_{KK}) - \alpha U_C K F_{BB} + U_P U_C F_{BB}/(KF_{KK}) > 0. \tag{33}$$

However, the effect of changes in the permitted level of head taxation on public services provided to firms is theoretically ambiguous when $T > 0$ for the same reasons discussed at length in Section III. Accordingly, the effect of changes in H on the level of public service provision to individuals is also theoretically ambiguous when $T > 0$ (since the direction of the change in the production possibilities frontier is ambiguous).

V. CONCLUSION

In this paper, we have examined the level of public service provision in a simple fixed national capital stock, one production good model of a national system of independent local governments, without any strong restrictions on individual preferences. We have shown that, although the optimal property tax problem facing a single local government is similar to those studied earlier, calculating the national effects of property tax finance by all local jurisdictions provides sufficient information to obtain more general results.[7] In a model with all local public services provided to individuals, all marginal reductions in lump sum taxation (and thus any finite change)

[7]Note that it is the interaction between optimizing behavior by local governments and the national effects of universal use of the property tax that yields our results rather than just the fact that the actual capital supply elasticity to each jurisdition is zero under the Cournot–Nash assumption—in the Atkinson and Stern [3, p. 124] model, a zero factor supply elasticity implies that the public expenditure level is independent of the permitted level of head taxation.

result in lower levels of public service provision.[8] When local public services are instead provided to firms, the same result obtains as long as the perceived capital response to changes in property taxation does not fall too drastically as the level of public services increases.

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[8]As described above, this occurs due to the negative "fiscal externality" perceived by the government as raising property taxes drives out mobile capital. Note that a similar analysis could be applied in a very different model. Suppose that labor is mobile, communities use head taxes, and there are economies of scale in the provision of local public services. Then competing local governments would perceive a positive "fiscal externality" to using head tax finance (attracting residents and lowering per capita public service costs) and tend to oversupply local public services as in Starrett [21].

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