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LOCAL PUBLIC FINANCE: AN ALTERNATIVE PERSPECTIVE

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I Introduction

In fiscal models of multi-level government, local governments are commonly situated at the bottom level of a hierarchy in which the higher levels have responsibility for distributional equity (Oates 1972), save possibly when distributional preferences have a local dimension (Pauly 1973).

In applying this hierarchical structure to issues of local public finance, it is common to assume, explicitly or implicitly, that the higher level of government has acted in such a way that the marginal social value of a unit of income (or numeraire) is the same for everyone. With distribution thus taken care of outside their jurisdictions, local governments can be assigned the task of responding to local preferences with a Pareto-efficient package of government services, user charges and taxes (Wildasin 1986, for example). The first-order conditions that define these efficient outcomes are compelling as policy guidelines only if the assumption of equal marginal social values of income is accepted.

With a heterogeneous population in a local jurisdiction, the standard model prescribes a structure of prices and optimal service levels for excludable local goods that encourages political conflict over facility size, and the optimal provision of nonexcludable goods turns out to be the same whatever the distribution of the burden of paying for them, whether, for example, the burden is distributed equally among the population or assigned exclusively to one person. Provided certain commonly assumed technical conditions are met, the standard model leads further to the prescription that mixed-use facilities and heterogeneous jurisdictions are inefficient, and that segregated facilities and homogeneous jurisdictions are preferred by everyone. These matters are briefly reviewed in sections II and IV below.

There seems to be a substantial mismatch between the policy prescriptions of the standard model and the actual policy concerns that dominate our thinking about local, especially urban, jurisdictions. Local public transit, roads, publicly supported housing, local health care, recreational facilities and primary education are all examples of areas in which distributional issues are typically important, and typically local taxing, pricing and spending levels are recognized to have distributive as well as allocative importance. This distributive effect of local actions leads the better off to want to have their own jurisdictions or enclaves, which is consistent with the standard model, but when this happens the situation among the worse off worsens, which would not happen if the conduct of local public finance was consistent with the standard model. As well, metropolitan-wide solutions are increasingly sought for urban problems, implying that heterogeneity at the local level may have some merit.

The standard model can be adapted to respond to some of these policy concerns by introducing individually differentiated social marginal utilities of income (the social welfare weights used, for example, in Feldstein 1972 and discussed in Atkinson and Stiglitz 1980) to guide local fiscal decisions. This approach, which is discussed at the end of section II, would allow local policy to cope with the distributional implications of investment and pricing decisions, but unless the welfare weights were related in some way to the distributional objectives of a higher level of government, the multi-level fiscal model would no longer apply and the choice of weights would simply be arbitrary.

In this paper, an alternative approach is examined, one that bears some similarity to the differentiated-welfare-weight model except that the parameters that play the role of social welfare weights are explicitly linked to the redistributive policies of a higher-level government. Local jurisdictions are assumed to be time-constrained, not resource-constrained in numeraire terms, and the time cost of congestion associated with local public goods is taken into account. Residents are able to translate their limited time into goods at individually different rates (the inverses of their after-tax wage rates), and this after-tax time cost of goods is established by a higher government level through its redistribution policy.

The effect of modelling the local economy as time-constrained is to require that, in a welfare maximizing model, the marginal social utilities of time, not of income, are equal for everyone. In keeping with the assumptions underlying the standard model of local public finance, it is assumed in this alternative approach that the redistributive actions of the higher-level government have in fact achieved this equality of marginal social utilities of time. This, combined with the individually differentiated after-tax time cost of goods, means that optimal prices for excludable local goods entail some redistribution in a heterogeneous local community.

Aside from providing a transparent link between the distributional policies of higher government levels and local public finance, the alternative model has the politically attractive feature that, for at least some types of excludable goods, the distribution among residents of incremental benefits of facility investment is the same as the distribution of efficiently set user charges, so that political consensus over infrastructure size may be reached. Because redistribution is taking place within the local jurisdiction, some users benefit from mixed-use facilities while others would prefer segregation. Moreover, unlike the standard model, the distribution of the burden of local taxes affects the optimal amounts of local public goods.

The alternative model is discussed in section III. Section II reviews the standard model and establishes some notation and results that are used later. Section IV discusses incentives with respect to facility segregation and homogeneous jurisdictions and introduces a diagrammatic analysis that can be used to understand the segregation issue within the standard as well as the alternative model.

II The Standard Model

1. Some Notation Local jurisdictions exist within the territory of some higher level of government. This higher level of government is solely responsible for redistribution while the local governments are responsible for the provision of local public goods, which are public goods the impact of which is geographically limited to the local jurisdiction. These local public goods may be excludable or nonexcludable and they may or may not be subject to congestion.

At a point in time, a given set of individuals indexed by the superscript "*h*" constitutes the population of a local jurisdiction. Individual utility measures u^h are functions of 1) a private good z^h which is the numeraire with a unitary price, 2) the consumption of local public services indexed by the subscript "*i*" where x_i^h is the amount of use of the i^{th} service by individual *h*, 3) the total use by the community of the services x_i, where $x_i = \sum_h x_i^h$ and 4) the amount of infrastructure g_i that is devoted to each local good. With upper case bold variables denoting vector quantities, the utility functions are $u^h = u^h(z^h, \boldsymbol{X}_i^h, \boldsymbol{X}_i, \boldsymbol{G}_i)$ for all *h*, where $\frac{\partial u^h}{\partial z^h} \geq 0$, $\frac{\partial u^h}{\partial \boldsymbol{X}_i^h} \geq 0$, $\frac{\partial u^h}{\partial \boldsymbol{X}_i} \leq 0$, $\frac{\partial u^h}{\partial \boldsymbol{G}_i} \geq 0$. The nonpositive partial derivatives for the $\boldsymbol{X}_i$ reflect possible congestion of local public services on the assumption that users are anonymous. The nonnegative partials for $\boldsymbol{G}_i$ reflect possible benefits of facility expansion including congestion-easing.

To keep notation as simple as possible, the amount of infrastructure devoted to each local good, g_i, is measured by the numeraire-cost of inputs. Also for simplicity, operating costs and joint costs are assumed away, so the local government's use of resources given by $\sum_i g_i$. This plus the community's consumption of z, $\sum_h z^h$, must not exceed a total resource constraint R. In addition, local-government revenue equals local public-good costs. Suppose that the contribution to government revenue of any individual *h* is given by r^h, where $\sum_h r^h = \sum_i g_i$. r^h is a function of the public-goods vector $\boldsymbol{G}_i$ that depends on the particular structure of taxes or user charges implemented by the locality, with $\sum_h \frac{\partial r^h}{\partial g_i} = 1$. This balanced budget requirement may be incorporated into the resource constraint to yield the condition that $R \geq \sum_h z^h + \sum_h r^h$.

A social welfare function over the local population, $W = W(u^1, u^2, \ldots u^h, \ldots)$, is defined by the higher-level government and maximized by the joint policy actions of the higher-level government, which redistributes the numeraire good, and the local government, which provides local public goods, taxes members of the local jurisdiction and sets user charges for locally provided services. In this model, the higher level of government establishes the condition that the marginal social value of the numeraire is the same to everyone; the local government takes this condition as a given. So, from the outset, we have

$$\frac{\partial W}{\partial u^h}\frac{\partial u^h}{\partial z^h} = \lambda \ , \forall h \qquad (1)$$

where λ is the shadow price of the numeraire, the Lagrangian multiplier on the resource constraint facing the local government.

2. Local Efficiency Conditions With a shadow price of λ on the constraint, the local jurisdiction's role is provide infrastructure and to set user fees so as to maximize the following expression with respect to the x_i^h for all *h* and all i, and the infrastructure variables g_i: $L = W\left(u^1, u^2, \ldots u^h, \ldots\right) + \lambda\left[R - \sum_h z^h - \sum_h r^h\right]$.

Assuming an interior solution and noting that $\frac{\partial x_i}{\partial x_i^h} = 1$, the first order conditions for a welfare maximum are

$$\frac{\partial L}{\partial x_i^h} = \frac{\partial W}{\partial u^h}\frac{\partial u^h}{\partial x_i^h} + \sum_h \frac{\partial W}{\partial u^h}\frac{\partial u^h}{\partial x_i} = 0\,,\ \forall h\,,\ \forall i \tag{2}$$

$$\frac{\partial L}{\partial g_i} = \sum_h \frac{\partial W}{\partial u^h}\frac{\partial u^h}{\partial g_i} - \lambda \sum_h \frac{\partial r^h}{\partial g_i} = 0\,,\ \forall i \tag{3}$$

These two equations describe optimal conditions for the provision of local public goods, given (1), provided the global conditions for a maximum and the local second-order sufficiency conditions are satisfied. With v^h used to denote individual utilities in numeraire units, so that $\frac{\partial v^h}{\partial x_i^h} \equiv \frac{\partial u^h}{\partial x_i^h} \div \frac{\partial u^h}{\partial z^h}$, equation (2) may be rewritten as

$$\frac{\partial v^h}{\partial x_i^h} = -\sum_h \frac{\partial v^h}{\partial x_i}\ ,\ \ \forall h\,,\ \forall i \tag{4}$$

Using equation (1), equation (3) may be cleared of λ and rewritten as

$$\sum_h \frac{\partial v^h}{\partial g_i} = \sum_h \frac{\partial r^h}{\partial g_i} = 1\,,\ \forall i \tag{5}$$

Equations (4) and (5) are the necessary efficiency conditions that local jurisdictions must achieve if welfare is to be maximized according to this standard normative model. (4) sets the marginal value of services equal to their respective marginal costs; (5) is a Samuelson public-goods condition that equates marginal benefits to the marginal costs of infrastructural spending. These of course represent maximal social-welfare outcomes only if equation (1) is assumed to hold.

3. Revenue Structure and Local Politics. As a theory of local public finance, this standard model is not very informative, principally because its results are completely independent of the structure of taxation or other revenue, even though local budgets are in balance. Equation (5), for example, would look the same whether 100 per cent of the local revenue burden was assigned to one member of the community or whether the burden was spread equally among all. This, of course, is a consequence of the way the standard model separates local government actions from their distributional impacts.

To determine whether individuals in a local jurisdiction would support an efficient allocation of resources, the structure of local revenue must be specified. Suppose that there are two sorts of public good, one giving rise to excludable services and one for which service use is nonexcludable. Uniform prices, p_i, may be established for excludable services x_i to yield revenue of $\sum_h p_i x_i^h$. The remaining local revenue needs are met by imposing lump-sum taxes of t^h on each individual in the jurisdiction.

Optimal uniform prices for the excludable services may be derived from equation (4). The left-hand side of this equation is the marginal utility in numeraire terms to individual *h* of the use of service *i*; the right-hand side is the marginal congestion cost (recall that operating or other direct costs have been suppressed). With utility-maximizing individuals adjusting their marginal utilities to the prices p_i set by local government,[1] optimal prices become

$$p_i = -\sum_h \frac{\partial v^h}{\partial x_i} \ , \forall \ excludable \ i \qquad (6)$$

[1]In equation (4), the term on the right-hand side is the sum of congestion effects across all consumers, including person *h*. If person *h* takes into account some sort of self-imposed congestion represented by the h^{th} component of this sum, then in general there cannot be a uniform optimal price. Optimal prices would have to be individualized. Strotz (1964) noted this in an early contribution to the literature on optimal urban transportation pricing, and resolved the difficulty by assuming that for each person congestion was a parameter the size of which was not affected by the individual's travel decisions. If all members of the community are identical, then uniform prices will be optimal and the problem does not arise. But with a heterogeneous community the Strotz assumption in one form or another must be introduced. Some writers simply assume that the self-congestion effect is so small that the costs of incremental use are more or less the same for everyone. Recent literature, especially in club theory, frequently makes use of a measure-theoretic formulation that assumes a dense continuum of consumers with a congestion integral that remains constant no matter how many individuals are removed from under the integration sign.

With uniform prices in place for the excludable services, each individual *h* contributes a revenue share of $\frac{x_i^h}{x_i}$ to the financing of service *i*, with $\sum_h \frac{x_i^h}{x_i} \equiv 1$. Using this, and assuming that incremental facility expansion for any excludable services is paid for from service revenues, (5) may be partitioned into excludable and nonexcludable services parts and rewritten as

$$\sum_h \left(\frac{\partial v^h}{\partial g_i} - \frac{x_i^h}{x_i} \right) = 0 \text{ , } \forall \textit{ excludable } i \tag{7}$$

and

$$\sum_h \left(\frac{\partial v^h}{\partial g_i} - \frac{\partial t^h}{\partial g_i} \right) = 0 \text{ , } \forall \textit{ nonexcludable } i \tag{8}$$

If infrastructure is optimal for excludable service *i*, the configuration would be supported and proposals to expand or to contract the facility unanimously rejected by the local population only if every term under the summation sign in (7) was equal to 0. Such support would require every individual's share in the benefit of an incremental expansion in infrastructure to be the same as their share of incremental cost. In a population of individuals with heterogeneous tastes and incomes, this condition is unlikely to be met unless the optimal public-goods configuration is one with segregated excludable services for each homogeneous subgroup within the population.

Equation (8) can be satisfied with an indefinitely large variety of marginal tax burdens, but the only distribution of taxation that will result in political consensus for the optimal allocation of resources to a nonexcludable good is one in which each of the terms under the summation sign similarly becomes zero at the optimum. This is benefit taxation at the margin, and it has to do not with the standard efficiency conditions for local government but with the desirability of consensus. For consensus to prevail with respect to all nonexcludable goods, there would in general have to be a different distribution of marginal tax burden for each good.

4. Social Welfare Weights A distributional role for local governments may be introduced into the standard model through the use of differentiated social welfare weights, b^h, for individuals. These weights provide a measure of the relative marginal social value of the numeraire among members of the local jurisdiction. In this case, equation (1) must be replaced by an alternative that reflects the welfare weights:[2]

$$\frac{\partial W}{\partial u^h}\frac{\partial u^h}{\partial z^h}\frac{1}{b^h} = l \text{ , } \forall h \tag{9}$$

This leads to the two local-government prescriptive conditions that are equivalent to equations (4) and (5):

$$b^h \frac{\partial v^h}{\partial x_i^h} = -\sum_h b^h \frac{\partial v^h}{\partial x_i} \text{ , } \forall h \tag{10}$$

$$\sum_h b^h \frac{\partial v^h}{\partial g_i} = \sum_h \frac{\partial r^h}{\partial g_i} = 1 \text{ , } \forall i \tag{11}$$

It is evident from (10) that, in general,[3] personalized and not uniform prices for excludable goods would now be required in order to decentralize optimal responses:

$$p_i^h = -\frac{1}{b^h}\sum_h b^h \frac{\partial v^h}{\partial x_i} \text{ , } \forall \; excludable \; i \, . \tag{12}$$

Equation (11) can be recast as was done in (7) and (8) to help illuminate the politics of infrastructural development (excludable and nonexcludable goods have not been differentiated):

$$\sum_h \left(b^h \frac{\partial v^h}{\partial g_i} - \frac{\partial r^h}{\partial g_i} \right) = 0 \text{ , } \forall i \tag{13}$$

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[2]The welfare weights would usually be normalized by setting one of them, perhaps the median weight, to the value 1. This normalization ensures that the policy prescription for some local jurisdiction with identical individuals will be to use resources in a Pareto efficient manner. If a common b^h in such a homogeneous community were to be different from 1, then equation (12) below would require the local government to be inefficient.

[3]If a local jurisdiction had a heterogeneous population but if all users of some particular service had the same b -weight, *and* if only the users were affected by congestion, then uniform prices for the service would be optimal.

From (13), we can see that, because the benefit term is multiplied by a b-weight, benefit taxation (at the margin) or benefit-related user fees, in the case of excludable services, is now not sufficient to ensure that the equation is satisfied. If individuals with higher marginal valuations for good i happened to be those with b-weights less than 1, then marginal benefit taxation would result in a consensus to overproduce the good, and *vice versa*.

III An Alternative Approach using a Time-constrained Model

1. National and local roles "It can be argued," Juster and Stafford (1991) suggest at the beginning of their review article on the allocation of time, "that the fundamental scarce resource in the economy is time ... ." This is a particularly apt perspective from which to view local economies. Suppose that time may be converted into numeraire, z-goods at individually different after-tax wage rates and that time is needed in order to use at least some local public goods. For such goods, the time cost of use is the same for everyone but dependent on congestion. Congestion is a function of the total amount of use and the amount of infrastructure devoted to the service. Local public-good congestion is taken literally to mean delay times in using congested facilities, which is the way in which much of the urban transportation literature handles its special type of local public good.

The higher level of government exercises its redistributive responsibilities in two ways: it redistributes income, as in the standard model, and it affects, through its tax structure, the rate at which individuals can convert time into goods. The marginal value of this rate will be called the after-tax or net wage rate, and it will in general be different for every individual. In the basic version of this alternative model, the role of local government is to allocate resources efficiently on the presumption that the higher level of government, through its redistribution and tax structure, has adjusted the marginal social value of time so that it is equal for everyone, and equal therefore to the shadow price of time in the local economy. This equality of the marginal social value of time replaces the assumption in the standard model of an equal marginal social numeraire value.

2. Further notation   The structure of the time-constrained local public finance model is very similar to the structure of the standard model except that congestion costs associated with at least some local public goods are now not differentiated by person (because they involve the same time costs for every user) and can be taken out of the utility functions and put into the local economy's resource (time) constraint. After the local efficiency conditions are derived, I will focus on this type of local public good. Initially, however, I will keep the analysis general by assuming that the aggregate service use, x_i, and infrastructure size, g_i, appear both as arguments in the utility functions and in the time constraint.

For everyone, then, there is a uniform time cost associated with each use of some service *i*, a time cost that could be 0. This unit cost is a function of total use and infrastructure size: $\gamma_i = \gamma_i(x_i, g_i)$. From this, the total time cost of using local public services is $\sum_i \sum_h x_i^h \gamma_i\left(x_i, g_i\right)$. Individual utility functions are, as before,

$u^h = u^h(z^h, \boldsymbol{X}_i^h, \boldsymbol{X}_i, \boldsymbol{G}_i)$ for all *h*, where $\frac{\partial u^h}{\partial z^h} \geq 0$, $\frac{\partial u^h}{\partial \boldsymbol{X}_i^h} \geq 0$, $\frac{\partial u^h}{\partial \boldsymbol{X}_i} \leq 0$, $\frac{\partial u^h}{\partial \boldsymbol{G}_i} \geq 0$. Now, however, the $\mathbf{X}_i$ and the $\mathbf{G}_i$ in the utility functions reflect aspects of service use and infrastructure spending other than time delays.

The numeraire cost to government of supplying local public goods is $\sum_i g_i$ (assuming as before simple linear, homogeneous local-good cost functions). With a balanced budget, the numeraire-denominated local revenue necessary to pay for these goods is again $\sum_h r^h = \sum_i g_i$. r^h is a function of the public goods vector $\mathbf{G}_i$ and depends on the particular structure of taxes or user charges implemented by the locality, with

$$\sum_h \frac{\partial r^h}{\partial g_i} = 1.$$

Individuals are heterogeneous and have different wage rates at which they can translate their limited time into numeraire goods. The higher-level government, with its responsibility for redistribution, establishes through its tax structure the net, after-tax rate at which this exchange can occur for each person. At the margin, the inverse of this after-tax wage rate is the marginal after-tax price of the numeraire in units of time, t^h. Using this marginal time price of the numeraire, the local revenue contribution by each individual, r^h, may be translated into the time-equivalent individual payments, $t^h r^h$ The total time-equivalent revenue of the local government becomes $\sum_h t^h r^h$.

Given the higher-level government's redistribution activities and its tax structure, each individual will optimize the balance between leisure and work so that the marginal utility of leisure in numeraire terms equals the net, after-tax wage rate. With that understanding, leisure can be suppressed in the model and the amount of nonleisure time for each individual set at y^h. This may be used to cover access times for the use of local public goods or it may be converted into numeraire goods. The numeraire goods are used for consumption or to pay local-facility user charges or local-government taxes. Although it seems reasonable to assume that the time costs of local user charges and local taxes reflects the marginal time cost of numeraire goods, t^h, the conversion of time into z goods should acknowledge the difference between average and marginal conversion rates. A simple way to do this is to assume that the marginal conversion rate is a function of the amount of z consumed. Letting m^h stand for this marginal time cost, each person's time allocation to z may be written as $\int_0^{z^h} m^h(x)dx$, with $m^h(z^h) = \tau^h$. Each individual's time constraint then becomes

$$y^h = \int_0^{z^h} m^h(x)dx + \tau^h r^h + \sum_i x_i^h \gamma_i(x_i, g_i).$$

As before, a social welfare function, $W = W(u^1, u^2, ..., u^h, ...)$, is established by the higher-level government. In contrast with the standard model, the assumption on which the local government is now to act is that the higher level has adjusted its redistribution efforts and tax structure so that the marginal social value of time is the same for everyone and equal to the shadow price (in W units) of time:

$$\frac{\partial W}{\partial u^h}\frac{\partial u^h}{\partial z^h}\frac{1}{\tau^h} = \lambda \tag{14}$$

Given that the marginal social value of time is the same for everyone, we can aggregate the individual time constraints into an aggregate local time constraint, $\sum_h y^h = \sum_h \int_0^{z^h} m^h(x)dx + \sum_h \tau^h r^h + \sum_i \sum_h x_i^h \gamma_i(x_i, g_i)$, and form a Lagrangian expression to be maximized

$$L = W\left(u^1, u^2, \ldots, u^h, \ldots\right) + \lambda\left[\sum_h y^h - \sum_h \int_0^{z^h} m^h(x)dx - \sum_h \tau^h r^h - \sum_i \sum_h x_i^h \gamma_i(x_i, g_i)\right].$$

Given (14), the local government's role is again to provide infrastructure and to set user fees so that social welfare is maximized with respect to all g_i and all x_i^h.

3. Efficiency conditions Using (14) and again letting v^h stand for utility in terms of the numeraire *z*, the first-order conditions of relevance to the local government become:

$$\tau^h \frac{\partial v^h}{\partial x_i^h} - \gamma_i = \sum_h x_i^h \frac{\partial \gamma_i}{\partial x_i} - \sum_h \tau^h \frac{\partial v^h}{\partial x_i} = x_i \frac{\partial \gamma_i}{\partial x_i} - \sum_h \tau^h \frac{\partial v^h}{\partial x_i}, \forall h, \forall i \tag{15}$$

$$\sum_h \left\{ t^h \frac{\partial v^h}{\partial g_i} - x_i^h \frac{\partial g_i}{\partial g_i} - t^h \frac{\partial r^h}{\partial g_i} \right\} = 0 \, , \forall i \tag{16}$$

These two equations are the equivalent in the time-constrained, alternative model of equations (4) and (5) in the standard model, or (10) and (11) in the variant with social welfare weights. Notice that without access times, g_i, entering into the constraint, and with $t^h = 1$ for all h, (15) and (16) collapse to (4) and (5).

4. Type I Local Public Goods I want to focus attention on a particular type of local public good, those for which the whole of the congestion effect is captured in the time constraint, type I goods for short. For type I goods, $\frac{\partial v^h}{\partial x_i} = \frac{\partial v^h}{\partial g_i} = 0$ for all h, so the efficiency conditions, (15) and (16) become

$$t^h \frac{\partial v^h}{\partial x_i^h} - g_i = \sum_h x_i^h \frac{\partial g_i}{\partial x_i} = x_i \frac{\partial g_i}{\partial x_i} \, , \forall h, \forall i \tag{17}$$

$$\sum_h \left\{ -x_i^h \frac{\partial g_i}{\partial g_i} - t^h \frac{\partial r^h}{\partial g_i} \right\} = 0 \, , \forall i \tag{18}$$

For all *h*, the right-hand side of (17) is constant. This is the anonymous congestion cost in hours for the incremental use of service *i*. The g_i term on the left-hand side is the common access time required to use a unit of service while $t^h \frac{\partial v^h}{\partial x_i^h}$ is the time-denominated marginal value to person *h* of a unit of service. For public goods that can be priced—excludable public goods—, equation (17) could be achieved by uniform time-equivalent user charges equal to the congestion cost. In numeraire terms, optimal prices would not in general be uniform. Using p_i^h to stand for the optimal numeraire price of excludable services to individual *h*, then

$$t^h p_i^h = x_i \frac{\partial \gamma_i}{\partial x_i}, \forall \; excludable \; i \tag{19}$$

In contrast to the optimal price given in equation (6) for the standard model, optimal prices in numeraire terms are personalized and vary directly with after-tax, net wage rates (i.e., inversely with t^h). For nonexcludable goods, the congestion costs cannot be charged back to the users so any given level of infrastructure will be overused if congestion exists, as with the standard model.

Equation (18) shows the conditions that must be met for the optimal allocation of resources to type I local public goods: the value of benefits in time units, $-\sum_h x_i^h \frac{\partial \gamma_i}{\partial g_i}$, must equal the community cost in time units, $\sum_h t^h \frac{\partial r^h}{\partial g_i}$. The numeraire cost of an extra unit of g_i will be 1, by definition, but the time cost will depend on the structure of payments by different members of the locality. The politics of support for the optimal outcome depends on the values in the bracketed term in equation (18). If this term is equal to 0 for everyone at the optimum, then support for the optimum will be unanimous.

5. Political Consensus with Type I Excludable Goods Optimally priced excludable goods will in fact exhibit this unanimity. If the cost of facility expansion (or contraction) is paid for (or saved) from changes in user fees, then facility users among the local population will unanimously favour or unanimously oppose the facility change. At optimal prices, total time-denominated revenue generated by excludable service *i* is $\sum_h \left(x_i^h \sum_h x_i^h \frac{\partial \gamma_i}{\partial x_i} \right)$, of which person *h*'s share is x_i^h / x_i. Benefits of incremental changes in g_i are similarly x_i^h / x_i . Benefit and cost shares are thus identical when prices are optimal.[4]

In this alternative model, wages-based prices for excludable services lead to political consensus on the question whether or not to expand or contract public spending. By contrast, the standard model would prescribe a uniform numeraire or z-good price on these services which would result in a benefit share of $\frac{x_i^h}{t^h} \Big/ \sum_h \frac{x_i^h}{t^h}$ for person *h*, with a payment contribution of x_i^h / x_i. For those with high after-tax wage rates (i.e., a low t^h), marginal benefits would exceed marginal payments while for those with low after-tax wage rates the share of payments for incremental changes in infrastructure would be more than their share of benefits. Such an outcome may well help explain opposition that is frequently encountered to the more widespread introduction of uniform numeraire-denominated user charges.

For excludable goods, the public-finance prescription flowing from this alternative model is politically more satisfying than the results of the standard model. If optimal congestion pricing can be achieved, the alternative model provides a very simple and direct way of deciding whether to allocate incremental resources to any particular service: ask the users.

6. Other Types of Local Public Goods The infrastructure, g_i, associated with some public good *i* and its aggregate use, x_i, appears only in the constraint for type I goods. For all other goods, infrastructure and aggregate use can appear as well (or only) in the utility functions of at least some members of the community. For these other types of good, the relevant efficiency conditions are represented by (15) and (16). With either

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[4]In numeraire terms, the common ratio of user-charge payments and of expansion benefits for person *h* is $\frac{x_i^h}{t^h} \Big/ \sum_h \frac{x_i^h}{t^h}$. Notice that this argument does not require that total user-charge revenue equals total infrastructure cost. Such full-cost recovery entails either a local or a global constant-returns-to-scale assumption, as shown in footnote 6.

or both of $\frac{\partial v^h}{\partial x_i} \neq 0$ or $\frac{\partial v^h}{\partial g_i} \neq 0$, optimal user charges for excludable goods would still be uniform in time-denominated units (and so proportional to after-tax wage rates) but they would have to take into account the utility effect of crowding and they would no longer necessarily equate the marginal benefits of facility expansion to marginal costs. How important for this is for the politics of infrastructural spending depends not only on how relatively large the utility terms are but also on how the utility and the access-time benefits are distributed among the users. If heavy users are also those with relatively high marginal utility benefits from infrastructure expansion, then the discrepancy between marginal benefits and marginal costs with optimal user charges may be small.

7. Nonexcludable goods For non excludable goods, decentralized pricing solutions to equation (15) or (17) cannot be found, but equation (16) or (18) provides the necessary efficiency condition for the allocation of resources to infrastructure: the aggregate time-denominated benefits of facility expansion at the margin must equal the time-denominated resource cost of the expansion. If the benefits of facility expansion measured in time were the same for all—i.e., if $-x_i^h \frac{\partial g_i}{\partial g_i}$ from (18) or $t^h \frac{\partial v^h}{\partial g_i} - x_i^h \frac{\partial g_i}{\partial g_i}$ from (16) is the same for all *h*—then using a uniform tax in proportion to after-tax wage rates to pay for the facility change would result in political consensus.

To the extent that marginal benefits from nonexcludable service facilities vary widely among people, even when measured in time-equivalent units, equations (18) or (16) in this alternative model provide no more help to local-government policy makers than the corresponding optimality condition in the standard model, equation (8). But if pure utility effects are small and if time savings or losses from infrastructure expansion or contraction is not widely disparate among the members of the community, then the model would provide an interesting argument for a proportional local tax based on net wage rates, just as the standard model would provide an argument for a uniform poll tax if the utility effects were more-or-less the same for all. For some nonexcludable services, such as general administrative functions, police and fire services and perhaps local health services, the primary effect of infrastructural changes may well be on access times, in which case a tax proportional to net wage rates may be a useful way of achieving some measure of political consensus on the related spending issues.

For local goods that are used with different frequencies by different people (i.e., different x_i^h values for different people), or for which infrastructural change affects quality more than access time, the argument for a proportional net-wages tax breaks down and we are left, as in the standard model, with no conceptual way to determine the tax structure that would best produce political consensus by functioning as a marginal benefit tax. It bears emphasis that in both the alternative and the standard model, the first-order efficiency condition is compatible with an infinite variety of marginal tax burdens and benefit distributions; benefit taxation at the margin is not part of the efficiency condition but rather a political desideratum.

8. Further Comment From the perspective of the alternative model, optimal prices for excludable goods are personalized, in numeraire terms. Redistribution takes place from high marginal net wage earners to low, as the local government plays its role in helping to implement the social welfare objectives of the higher-level government. In this way, the model is similar to the b-weight version of the standard model, but the political consensus with respect to facility size at these optimal prices is missing in the b-weight model. With respect to taxes to pay for nonexcludable goods, the alternative model has features of both the standard model and its b-weight variant. If the distribution of taxes is given, then, as may be seen from equation (18), the distribution of benefits is irrelevant. Only the aggregate marginal benefit is relevant, as in the standard model, equation (8), but unlike the b-variant, equation (13).

However, like the b model but unlike the standard model, different tax structures lead to different optimal amounts of infrastructural spending, with a tax structure weighted more heavily towards high-t^h people calling for lower levels of infrastructure, and vice versa. This would mean, for example, that optimal amounts of nonexcludable infrastructure paid for through uniform poll taxes (in numeraire terms) would be less than the optimal amounts of such infrastructure if progressive taxes based on marginal net wage rates were used.

A b-weight version of the alternative model could, of course, also be constructed. Differential b-weights in such a variant would imply that the higher level of government had not succeeded in bringing about equality among the marginal social utilities of time. However, as I said in the introduction, it is hard to see the basis upon which any particular set of b-weights would be chosen, and so their use would be essentially arbitrary.

IV Facility Segregation and Jurisdictional Homogeneity

1. Standard and Alternative Models Compared Normative theory in the case of the standard model tells us to price excludable local public services at uniform numeraire-denominated prices even in jurisdictions in which the optimal public goods provision involves services with heterogeneous users. The alternative, time-constrained model says we ought to price excludable services at uniform time-denominated prices, i.e., at numeraire prices that are proportionate to individual after-tax wage rates. For type I goods, the optimal allocation of resources will be supported and sustained politically under the assumptions of the alternative model even for heterogeneous jurisdictions. Under the assumptions of the standard model, however, optimal pricing guarantees political consensus only in homogeneous jurisdictions or with respect to a service that was used only by a homogeneous group of people within a mixed jurisdiction.

Local governments acting on the prescriptions of the standard model create incentives for facility segregation and, if the population is sufficiently mobile, the development of homogeneous jurisdictions. If, for example, each local public good exhibited constant returns to scale in its production and consumption,[5] then, given the standard model's pricing structure, the utility levels of all homogeneous subgroups within a heterogeneous jurisdiction would benefit by having each local public good designed to its own optimal specifications (Berglas and Pines 1981 and 1984; a proof of this Berglas and Pines result can easily be shown diagramatically using a construction similar to Figures 1 and 2 below). For excludable goods, this could be achieved through facility segregation within a given heterogeneous jurisdiction; in fact, the lack of consensus over optimal infrastructure size would help drive the process of facility segregation.

In the alternative model, optimal pricing by the local jurisdiction involves redistribution; some users pay more than others (in numeraire units) for the same service. A consequence of this is that facility segregation will not in general benefit all homogeneous subgroups within a mixed population, even if local public goods exhibit constant returns to scale. Although the best mixed-use facility size is agreed upon by all members of the jurisdiction, some would prefer their own segregated facility and some would not.

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[5]This requires utility functions for all individuals that are homogeneous of degree zero in x_i and g_i for each service, given that the magnitude of the local public good g_i is measured simply by its cost in numeraire goods. (In the alternative model, the equivalent assumption is that the g_i function exhibit constant returns to scale.) If utility functions are of this sort for all levels of x_i and g_i, then these two arguments may be replaced in the utility function simply by the ratio x_i/g_i. However, if homogeneity of degree zero is a local condition only, sufficient and necessary (given the way g_i is defined) to define jointly optimal infrastructure and population sizes, then the improved utility with segregated facilities of all homogeneous subgroups may require that a jointly optimal facility be replicatable an integer number of times. As a sufficient condition for segregation to be better for homogeneous subgroups, this replicatability condition must apply both to the optimally sized integrated facility and to the segregated facilities. In essence, the constant-returns assumption is a way around the integer problem.

2. Incentive to Segregate with Excludable Goods These different group incentives with respect to facility segregation is shown in Figure 1 for a type I excludable service. Two types of users are assumed, Type A with a low time cost of numeraire goods (a low t) and Type B with a high time cost (a high t). The proportion of each type of user is unimportant. The first panel of the figure illustrates the mixed use of a constant-returns-to-scale facility with the efficiency conditions (17) and (18) satisfied. Efficient pricing with efficient facility size result in revenues that just cover facility cost.[6] Users of both types face a common access cost of g_i per unit of service and uniform, optimal time-equivalent user charges. The access cost and its associated marginal cost are functions of service use only and not of type of user—the anonymity assumption—so their relative positions in the three panels is constant.

In Panels 2 and 3, users are assumed to be homogeneously Type-A or Type-B respectively facing a facility the same size as the optimally sized facility of Panel 1. (Because users are homogeneous in Panels 2 and 3, the average total cost is well defined at all levels of use, whereas in Panel 1 it is well defined only when the optimality conditions are met.) If the amount of optimum service use shown in Panel 1 were consumed by Type-A users only, reading down the dashed line X-X, the facility size would be inefficiently small and congestion inefficiently high. These

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[6]This may be established by showing that equations (19)—which is derived from (17)—and (18) along with constant-returns-to-scale (CRS) entail revenues equal to total facility cost. Two conditions make up the CRS assumption: $\sum_h \frac{\partial r^h}{\partial g_i} = 1$ and $x_i \frac{\partial g_i}{\partial x_i} + g_i \frac{\partial g_i}{\partial g_i} = 0$. From (18), (19) and CRS, and the fact that $\frac{\partial r^h}{\partial g_i} = \frac{x_i^h p_i^h}{\sum_h x_i^h p_i^h}$, we get

$$x_i \frac{\partial g_i}{\partial g_i} = -\sum_h t^h \frac{\partial r^h}{\partial g_i} = -\sum_h t^h \frac{x_i^h p_i^h}{\sum_h x_i^h p_i^h} = -t^h p_i^h \frac{x_i}{\sum_h x_i^h p_i^h} = -x_i \frac{\partial g_i}{\partial x_i} \frac{x_i}{\sum_h x_i^h p_i^h} = g_i \frac{\partial g_i}{\partial g_i} \frac{x_i}{\sum_h x_i^h p_i^h} ,$$

which yields $\sum_h x_i^h p_i^h = g_i$. This is the result we want, showing that the total numeraire-valued revenue equals the numeraire valued facility cost.

users would be better off with a larger facility that, while costing more per unit of service use, would reduce access costs.

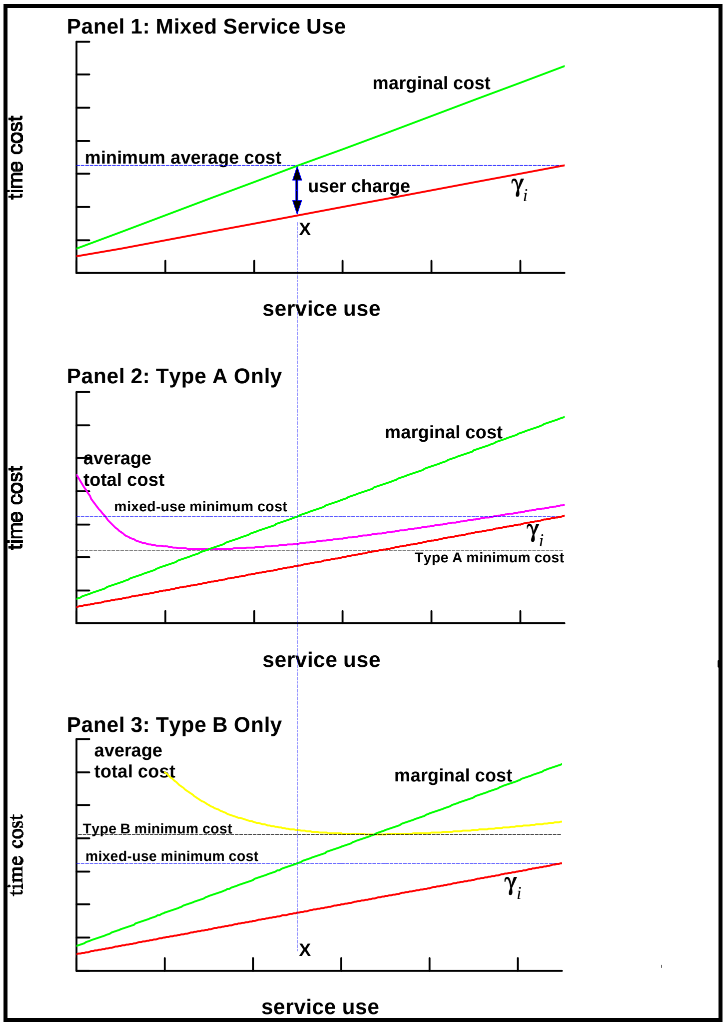

FIGURE 1: Conflict over Facility Segregation for Excludable Goods in the Alternative Model

The optimally sized facility for Type-A users would provide service at an average total cost indicated by the dashed line labelled "Type A minimum cost" in Panel 2. Because of the constant-returns-to-scale assumption, this would be the minimum average cost independently of the number of Type-A users. Type-B users, on the other hand, with high time costs of numeraire goods, would find the Panel-1 facility size inefficiently large for a service use represented by line X-X. An optimally sized facility in a homogeneous Type-B community would entail more congestion and lower per unit facility costs, all of which could be provided at a minimum average total cost indicated by the dashed line "Type B minimum cost" in Panel 3. From the diagram, it is evident that Type-A users would prefer a segregated facility because their service cost per unit would be lower than it is with a mixed-use facility. For Type-B users, the reverse is true: optimally priced and optimally provided mixed-use facilities cost them less per unit of service use than would a segregated facility.[7] If the low-t, Type-A users are the richer and the Type-B the poorer members of a mixed community, then the rich would prefer their own segregated facilities, but not the poor. This is the same sort of conflict that can lead to fiscal rezoning (Hamilton 1975) and can arise whenever pricing or taxing policies at the local level have a redistributive effect, in this case an effect that is optimal with respect to the higher-level government's social welfare objectives. Facility segregation is preferred by all homogeneous subgroups in the standard model, under the constant-returns-to-scale assumption, only because redistribution is ignored, in the sense that the social value of a numeraire unit is assumed to be uniform across the local population.

3. Nonexcludable Goods With respect to non excludable local public goods, neither the standard nor the alternative model has any rule for generating revenue to pay for their cost aside from the prescription that at the optimum the aggregate marginal benefits from infrastructural expansion in any given service should equal its aggregate marginal costs. In the standard model, the distribution of marginal costs among tax payers is irrelevant. In the alternative model, the optimum infrastructure size described by equation (18) is in general affected by the distribution of marginal tax payments, but there is no rule governing this distribution. In what follows, I assume that payments for non excludable goods are in the form of poll taxes—equal taxes per person. In the case of the alternative model, these are time-denominated poll taxes or personal taxes in proportion to marginal net wage rates.

The use of poll taxes rather than user charges introduces additional complexity to the analysis of facility segregation because the different amounts of use of non excludable

[7] This diagrammatic demonstration of subgroup preferences for mixed or segregated facilities could be extended to include any number of subgroups—those with lower-than-average time costs per unit of numeraire will prefer separate facilities while those with higher-than-average costs will prefer the mixed facility.

facilities by different people is now unaccompanied by different contributions to revenue—heavy and light service users pay the same poll tax. In both the standard and the alternative models, there will be a tendency for those members of a mixed population who use the non excludable facility relatively heavily to prefer a mixed rather than a homogeneous jurisdiction and for those who use the facility relatively lightly to prefer segregated facilities. Within the framework of the standard model, this means that separate facilities for different homogeneous user groups may not be preferred by all subgroups even for local public goods exhibiting constant returns to scale. If, however, the relatively heavy users happen also to be those who have a stronger utility or "quality" preference for the non excludable good, then, still within the framework of the standard model, a consensus in favour of segregated facilities for homogeneous subgroups may exist. If such facility segregation is optimal, it cannot take place within a heterogeneous jurisdiction since the use of non excludable services or facilities by the local population cannot, by definition, be monitored, so the Tiebout solution is required, the formation of separate jurisdictions of homogeneous populations (Tiebout 1956).

The tendency towards conflict over facility segregation if poll taxes are set according to the alternative model may be illustrated with another diagram, Figure 2. In this figure, Panel 1 shows the average facility cost plotted against population in a mixed jurisdiction. Facility size is assumed to be adjusted optimally according to equation (18). For a given mixed population, with the optimum facility size, there will be some average "congestion" or access cost, but this will be a well-defined function of population size only in the homogeneous jurisdictions of Panels 2 and 3 where it is shown as the "access cost" function.

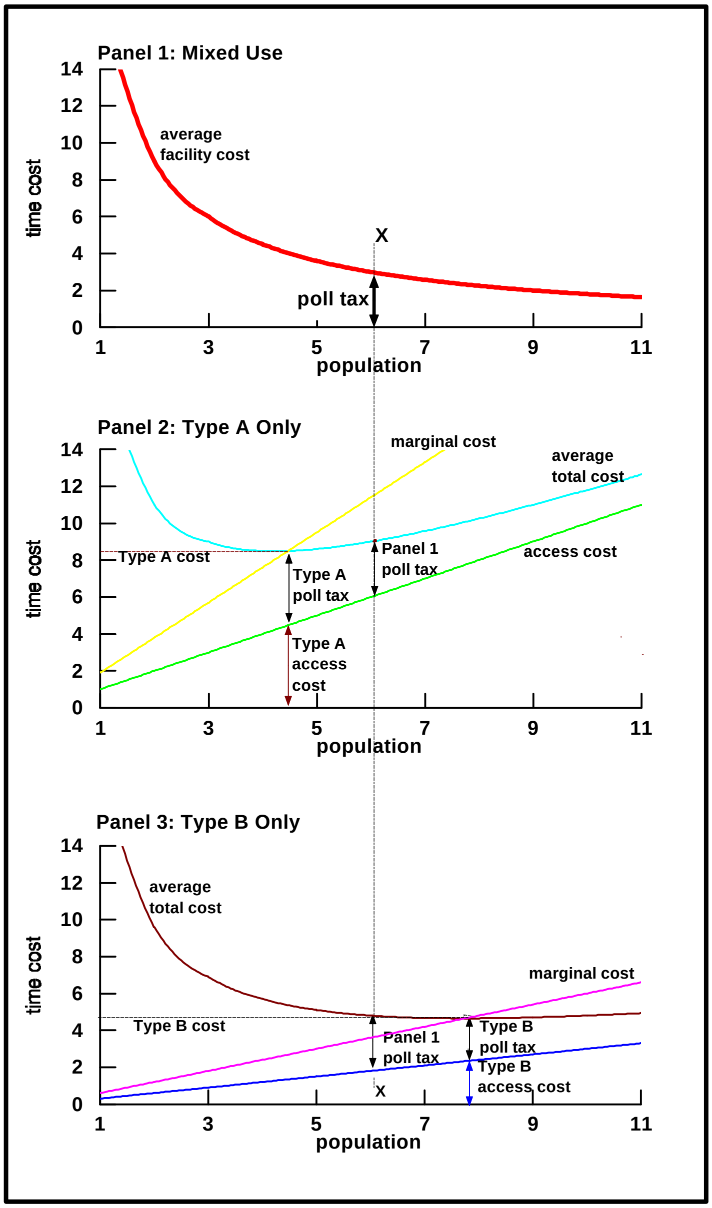

FIGURE 2: Conflict over Facility Segregation for Non Excludable Goods in the Alternative Model with Uniform t^h

All individuals in the mixed population of Panel 1 are assumed initially to have the same t^h but to differ with respect to the amount of use each makes of the non excludable facility. As in Figure 1, the average total cost curve in Panels 2 and 3 shows the cost to the subgroup populations of the particular facility that was optimum in Panel 1. Since both Type A and Type B people have the same t^h, the average time-denominated cost of this facility is the same for each type, but Type A people use the facility more than Type B people, which gives rise to a higher and steeper access cost curve (per unit of population) in Panel 2 compared to Panel 3. For each homogeneous subgroup, the optimum service use will occur where the total service use is the same as the total use in the mixed population (since congestion costs are a function of facility size and total use undifferentiated by individual). Associated with this optimum service usage will be a population of Type A or Type B individuals constructed as if the service use per person is the same for each type as it was in Panel 1. These associated population sizes must be less than the original mixed population—shown by the line X-X through the three panels—for the Type A subgroup and more than the original for Type B.

At the subgroup populations associated in this way with the optimal service usage, the access costs per unit of population for Types A and B—shown as "Type A access cost" and "Type B access cost" on Panels 2 and 3 respectively—will be the same as they were for each respective subgroup in the original mixed population. On top of this access cost, each subgroup member must now pay a new poll tax, shown on Panel 2 as "Type A poll tax" and on Panel 3 as "Type B poll tax." This tax in the homogeneous subgroups is clearly higher than the original, Panel 1 uniform poll tax for Type A and lower for Type B, which means that the total cost of the facility is higher than it was in the mixed jurisdiction for each Type A person and lower for each Type B person. Since this is true for constant levels of usage for each type of person, it must be the case that Type A people would be worse off with a separate facility and Type B people would be better off. Since constant returns to scale prevail, this argument is independent of the proportions or size of each subgroup type that exist in the mixed jurisdiction, and the diagram could clearly be extended to embrace any number of different subgroup types.

Now suppose that that the subgroups differ not only with respect to facility use but also with respect to t . If the Type A subgroup has a lower t than the Type B, then the time-equivalent cost per capita of the given facility for Type A will be less than the average facility cost shown in Panel 1. In Panel 2, the "access cost" curve will remain unchanged, but the "average total cost" curve will be lower (and the optimal service use would diminish). At some sufficiently low t , the facility cost for a homogeneous Type A subgroup will become less than the cost to the subgroup in the mixed jurisdiction, so facility segregation will be favoured. The opposite will occur for Type B people, however. Their relatively higher t will push up the average total cost curve in Panel 3, increase optimal service usage and, at some point, lead Type B people to prefer the mixed-use facility. There could exist a combination of higher use and lower t values for Type A people such that Type A and Type B individuals both paid the same numeraire amount per unit of use. In such a case, segregated facilities would be preferred by both subgroups, as the outcome of the standard model with uniform use pricing of excludable goods showed. If Type A people have higher t values and Type B people lower, then the conflict over facility segregation illustrated in Figure 2 will be reinforced.

V Conclusions

The alternative model is a welfare maximizing model in which the higher-level government maintains its traditional responsibility for redistribution while the local government acts in part as an agent of redistribution, responding to the framework set by the higher-level. By assuming that the higher-level government establishes its transfer and tax policies so as to equate the marginal social utlitites of time, the redistributive role played by time-constrained, optimal local prices derives not from some competing or independent social welfare function, but from the fact that different people are able to translate their limited time into basic goods only at different rates. The higher-level government has sole responsibility for deciding what those different rates should be.

In a sense, one fiction, that the senior government equalizes marginal social utilities of income, is replaced with another, that marginal social utilities of time are equalized. The advantage of this is that it provides a framework within which the redistributive role of local government can be analyzed. The local jurisdiction is involved as an agent of redistribution, in consequence of which some groups will be left worse off if facility and jurisdictional segregation occurs. In spite of this redistribution, optimal pricing for some goods will lead to political consensus with respect to facility size. In addition, the model leads to the intuitively reasonable result that the distribution of the burden of local taxes will affect the amount of spending that should take place.

The idea of a fee or tax schedule that is positively related to income levels is certainly not strange or unusual. In this paper, it is the distribution of marginal net wage rates (the inverse of the t^h used in this paper) that is relevant. This distribution depends on both the pre-tax wage and the marginal tax rate. Pre-tax earned income reduced by the marginal tax rate could provide a good proxy distribution; after-tax earned income might be an easier proxy to use. In both cases, the distribution of the proxy for after-tax wage rates would be tighter–i.e., less dispersed–than the distribution of pre-tax wages (or earned income), as long as the tax structure was progressive.

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