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**TAX-PRICE SPECIFICATION AND THE DEMAND FOR LOCAL
PUBLIC GOODS**

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Tax-Price Specification and the Demand for Local Public Goods*

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Abstract

Nearly all public expenditure demand studies define the marginal price for publicly provided goods as the household's share of the local property tax burden, or what is often called the tax-price. Such a definition is at odds with two familiar facts: taxes are ordinarily distortionary, and property values are often influenced by the value of local services. This note constructs a theoretically consistent marginal tax-price measure incorporating these considerations. The new measure demonstrates that previous estimates of the price and income elasticities of demand for public services are biased except under very restrictive circumstances. Moreover, the direction of this bias will depend upon the actual incidence of public spending and the tenure status of residents.

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I Introduction

In most empirical public expenditure demand studies, and many theoretical studies as well, the marginal price paid for public services is specified as a household's share of the local property tax burden, or "tax-price." This specification appears to be at odds with two well-known results about the behavioral effects of fiscal policy: that taxes are ordinarily distortionary, and that property values often reflect the value of local services.¹ While these results imply that the marginal cost of public services to a resident will be a nonlinear function of the spending level, few researchers have included this implication in their work.

Zodrow and Mieszkowski (1983, 1986) and Mieszkowski and Zodrow (1989) have studied certain aspects of the relationship between tax distortions, the value of land and the form of public expenditure rules in their analyses of the "new view" of property taxation (i.e., in models with mobile capital), yet an integrated discussion of the implications of these basic relationships for demand modelling is nonexistent. The potential influence of capital gains income on household perceptions of costs and benefits has also been ignored. In a public expenditure framework, Wildasin (1987) has discussed the proper way to account for the tax distortion effect, but only for the case of renters facing fixed prices. On the other hand, Crane (1988) has analyzed the appropriate use of capitalization (or incidence) measures in the presence of distortionary taxes, though not in the context of demand modelling. This paper consolidates and extends the analysis of distortionary finance and the capitalization process in a public expenditure framework in order to construct the true effective price of local spending, and to illustrate its relevance to empirical application.

Our approach is to pose the basic positive question of whether an individual consumer prefers more, less or the same amount of the public good now provided in the community of residence. We assume this involves a rational comparison of the direct benefit of a increase in local public spending with its associated cost, where a proposed change in public expenditure is expected to induce, on the cost side, equilibrium responses in local tax burdens, property values and possibly

¹The importance of tax distortions to public spending rules has long been an integral part of the optimal tax and spending literature, as in Atkinson and Stern (1974). For recent reviews of the empirical capitalization literature see Martinez-Vazquez and Ihlanfeldt (1984) and Yinger, et al. (1988). The theoretical conditions under which capitalization may take place are discussed in Yinger (1982) and Starrett (1988).

incomes, via simultaneous changes in individual and aggregate housing demand and supply behavior. The purpose of this paper is to sort out these responses in a manner that reveals the various circumstances under which the traditional tax-price specification of household cost is or is not valid.²

The next section introduces a standard model of local finance. Section III explains the role of second-order behavioral effects, and derives the correct marginal price in terms of the usual tax-price measure. Section IV presents an illustrative example, and the final section summarizes a number of the implications of this study.

II The Framework

We employ a Tiebout-like (1956) model of local public finance in which households are identical³ and consume only three commodities: housing h , a composite good x , and a local public good g . An excise tax on housing finances the public good. Migration is possible, though not necessarily costless, and there are a finite number of jurisdictions in the economy.

A two-stage process characterizes the household problem of choosing private and public consumption. The behavior within a given community and the choice of community are each distinct decisions made conditional on the outcome of the other. This approach is fully general and offers the advantage of emphasizing the importance of migration as an element of local public goods demand.

²This approach does not require us to specify in any detail either the nature of interjurisdictional residential equilibrium or the mechanisms that characterize household and capital migration, as we do not solve explicitly for migratory behavior. The analysis therefore runs somewhat orthogonal to studies concerned with the existence and efficiency of Tiebout equilibrium, such as those examining the applicability of the so-called Henry George Theorem (i.e., that aggregate rents equal the cost of public services at efficient service levels: see, e.g., Arnott and Stiglitz (1979) and Hartwick (1980)) or related studies of the character of equilibrium community formation (e.g., Stiglitz (1977, 1983) and Scotchmer and Wooders (1987)). It should be mentioned, however, that most theoretical examinations of the relationship between land prices and public policies implicitly or explicitly assume lump-sum finance, and thus ignore the economic costs of the local tax structure. See also footnote 12.

³The assumption of homogeneous households is made for convenience only. All the expressions in this paper may be generalized in a straightforward manner to the case of heterogeneous consumers by adopting the appropriate notation. The assumption may be justified under some circumstances, however, by reference to the results of Scotchmer and Wooders (1987) who argue in a club setting that the population of the community core is homogeneous in equilibrium.

Conditional on the choice of location, and the public policies found there, the representative household chooses housing and the composite good to

$$\begin{aligned} \max \quad & U(x, h, g) \\ \text{s.t.} \quad & y = ph(1+t) + x \end{aligned} \quad (1)$$

where $U(\cdot)$ is the differentiable, strictly quasi-concave household utility function, p is the (annualized) unit price of housing, t is the *ad valorem* tax on housing, y is (disposable) income, and the price of x is normalized to unity. Optimization yields the conditional indirect utility function $V(p(1+t), y, g)$ and conditional housing demand function $h(p(1+t), y, g)$, which depend on prices and income as well as public policies (t, g) via the choice of jurisdiction.⁴

Most empirical demand studies ignore the discrete self-selection component of residential equilibrium to focus on the value of g implied by the conditional function $V(p(1+t), y, g)$.⁵ A typical implementation is to specify a demand function of the form

$$\log g = \beta_0 + \beta_1 \log T + \beta_2 \log y + \beta_3 Z + u \quad (2)$$

where T is the household's after-tax share of the local property tax base, or tax-price, Z is a vector of other factors thought to influence demand, and u is the error term.^{6,7} The estimated coefficient on T is often interpreted as the price elasticity of demand.

⁴The solution to the unconditional utility maximization problem is the location j satisfying $U^* = \max\{V_j : j \in J\}$, where U^* is maximum utility, $V_j = V(p_j(1+t_j), y)$ is the utility available in jurisdiction j and J is the choice set of communities. The solution U^* gives the jurisdiction chosen for residence and the public good demand function. When there are random terms in the model, the solution also provides the probability that each jurisdiction is chosen. This equals the probability that the choice yields the highest utility among all other locations, and can be interpreted as the demand function in a discrete choice model.

⁵Rather, efforts to control for selectivity bias in public goods demand have been almost exclusively concerned with "Tiebout" bias, first identified by Goldstein and Pauly (1981). This refers to the observation that residents self-select into heterogeneous jurisdictions, within which public services are distributed uniformly. See Rubinfeld and Shapiro (1989), Rubinfeld, et al. (1987) and Ladd and Christopherson (1983) for instrumental variables strategies.

⁶See, e.g., Bergstrom and Goodman (1973), Bergstrom, et al. (1982), Gramlich and Rubinfeld (1982), Oates (1986), Rubinfeld (1987), Reid (forthcoming) and footnote 5. For a somewhat different approach to the same question, using aggregate data, see Groves and Todo-Rovira (1986).

To assess the short-comings of this approach, consider an individual who is asked if he or she prefers a different level of local public spending relative to that now offered.⁸ That person's response depends on their evaluation of expected change within the community. We represent this evaluation by totally differentiating the conditional indirect utility function, giving

$$\frac{dV/dg}{\partial V/\partial y} = MRS_{gx} \cdot \left[(1+t) \frac{dp}{dg} + p \frac{dt}{dg} \right] + \frac{dy}{dg} \quad (3)$$

from Roy's identity, where

$$MRS_{gx} = \frac{\partial V / \partial g}{\partial V / \partial y}$$

is the marginal value of a change in spending. The term on the right-hand-side of (3) is the perceived marginal, or effective, "price" of the public good, which we denote by

$$M = h \left[\frac{dp}{dg} (1+t) + p \frac{dt}{dg} \right] + \frac{dy}{dg} \quad (4)$$

As individuals consider various levels of local public spending, they compare the marginal benefits MRS_{gx} with the effective price M , where M is in turn nonlinear in g . If the policy change makes the community more attractive, there will be entry and local prices may be bid up. At the same time, tax rates may have to increase to finance the change, and this will influence the local price at the margin. To the extent that (3) describes the household's decision calculus, the benefit of the policy change

⁷In practice, the calculation of T would also need to account for the deductibility of property taxes under the federal personal income tax, as well as for the structure of state and local intergovernmental aid in the form of property tax credits.

⁸This is the basic form of the question asked in several public expenditure opinion surveys, including those described in Courant, et al. (1980) and Ladd and Wilson (1982).

must be just offset by the change in housing and tax expenditures and income, M , at the most preferred public service level.

Whether or not the price specification (4) is consistent with the demand equation (2) turns on two issues. The first concerns the extent to which a household considers general equilibrium effects when it calculates the costs of fiscal reform. In particular, does a household allow for the possibility that tax rates and housing prices might change? If not the perceived marginal cost of new public spending is zero, which seems unlikely. If so, the second issue is the relationship of those tax rate and price changes to the tax-price measure T . We will argue below that the empirical literature has implicitly assumed both that households incompletely calculate the tax rate changes necessary to finance additional spending, and that households ignore the possibility that house prices will change at all. These assumptions imply perfectly price-inelastic housing demand and infinitely price-elastic housing supply. When either assumption is invalid, the price and income elasticities of public expenditure demand estimated from (2) are biased.⁹ When housing is not a substitute for or complement to public spending *and* there is no migration, the assumption of inelastic housing demand alone generates unbiased parameter estimates.

In the next section we use the local fiscal budget identity to derive these results, by examining the relationship between changes in the value of the tax base and the tax rate necessary to finance a change in public spending. This also provides the opportunity to analyze the differences that exist between the marginal price M and the proportional tax-price T , for $T = h/\sum_i h_i$.

III The Marginal Price of Municipal Services

The effective price, M , has three parts: the change in gross-of-tax housing costs due to the price change, the change in tax payments due to the tax rate change, and the change in household income. The first and third components are due to the familiar property value capitalization effect,

⁹Conversely, we assume below that household expectations over tax changes, migration, and price changes are fully rational. Were this assumption to be relaxed, as it likely should be in practice, the degree of household foresight would then determine equilibrium, which therefore may not exist.

which has rarely played an explicit role in expenditure studies.¹⁰ The second term, the change in tax payments, is proportional to the share of the tax base held by the household, and appears to provide the basis for using T as a tax-cost variable.

The first step in constructing a reduced form expression for M is to find the change in tax rates associated with the public service change. This can be determined by reference to the local fiscal budget identity:

$$C(g,N) = tpNh + A \quad (5)$$

where $C(\cdot)$ is the cost of providing the service level g , N is community population, and A is the (fixed) level of intergovernmental aid.¹¹ Our immediate interest is to use (5) to solve for the reduced form of (4) in terms of the variables we assume the household takes as exogenous at this point; namely, dp/dg , dy/dg , dN/dg and the behavioral parameters.

Differentiating (5), where $h(\cdot)$ is taken as endogenous, to find

$$\frac{dt}{dg} = \frac{\frac{dC}{dg} - th\frac{dp}{dg} [N + (1+t)\epsilon_{hr}] - tp \left[h\frac{dN}{dg} + N \left(\frac{\partial h}{\partial g} + \frac{\partial h}{\partial y} \frac{dy}{dg} \right) \right]}{phN \left(1 + \frac{t\epsilon_{hr}}{1+t} \right)} \quad (6)$$

and substituting into (4) allows us to rewrite the marginal price as

$$M = T \left[\frac{\frac{dC}{dg} + Nh\frac{dp}{dg} - tp \left(h\frac{dN}{dg} + N\frac{\partial h}{\partial g} \right)}{1 + \frac{t\epsilon_{hr}}{1+t}} - \frac{dy}{dg} \left(1 + ptN\frac{\partial h}{\partial y} \right) \right] \quad (7)$$

¹⁰Brueckner (1982) uses property values to test for the efficiency of municipal spending policies, but he does not account for tax distortions. Yinger (1982) discusses the influence of capitalization distortions on expenditure rules, but also assumes a fixed size tax base. Tax-distorted measures of capitalization are also discussed in Crane (1988).

¹¹The public good may therefore be subject to congestion. In the context of the present model, the presence of congestion effects is not necessary, but it does serve to strengthen the argument that expected migration is relevant to marginal costs.

where ϵ_{ij} is the elasticity of i with respect to j , and $r = p(1+t)$ is the gross-of-tax unit price of housing. The numerator of the first term in (7) represents the direct marginal costs associated with a change in local public spending along the public budget line. These include new production costs, the change in net-of-tax expenditures on current housing consumption, and the change in tax revenues at the going tax rate. The net cost of increased spending is lower: the lower production costs, the less house prices rise, and the more tax revenue is raised due to induced changes in housing consumption by residents via substitution effects, and by immigrants' purchases of additional housing.

The effect of an increase in income is to lower the marginal public goods price in two ways. The nominal benefit is the increase itself, which is why the income term enters (7) with a negative sign. Moreover, from (6), an increase in y increases housing consumption (where housing is a normal good), and thus decreases the amount by which the tax rate must rise to finance the project. Each dollar increase in nominal income therefore reduces costs by more the more income-elastic is housing demand.

The denominator of the first term in (7) includes the indirect effect on costs of the tax distortion through its effect on housing demand and hence the size of the tax base. Each item in the numerator must be inflated to reflect its true cost to account for the cost of raising funds in a distortionary manner. This effect is naturally stronger the more price-elastic demand and the higher the tax rate.¹²

The important case of homeowners who at least partly expect to receive capital gains benefits from improvements in local public spending has been more or less ignored in the expenditure literature. To examine the possible implications of such expectations, we now explicitly endogenize capital gains income by defining $y = ph$. Differentiating and solving for dy/dg in (7) gives the following form for the marginal price:

¹²Note that if $dN/dg = \partial h/\partial g = \epsilon_{hr} = dy/dg = 0$ then by (3) $dV/dg = 0$ iff the induced change in property values exactly equals the difference between project benefits and production costs. This situation has been interpreted as one where residential equilibrium implies exact property value capitalization (i.e., land rents equal net project benefits), and it requires the absence of both tax revenue effects and tax distortions. See Crane (1988) and Starrett (1988) for discussions.

$$M = \frac{T}{1 + \frac{t\epsilon_{hr}}{1+t}} \left\{ \frac{dC}{dg} \left(1 + \Delta \frac{\epsilon_{hr}}{1+t} \right) + Nh \frac{dp}{dg} [1 - \Delta(1 + \epsilon_{hr})] - tp \left[N \frac{\partial h}{\partial g} \left(1 + \frac{\Delta}{t} \right) + h \frac{dN}{dg} \left(1 - \Delta \frac{N\epsilon_{hr}}{1+t} \right) \right] \right\} \quad (8)$$

where

$$\Delta = \frac{1 + \frac{t\epsilon_{hr}}{1+t} - t\eta}{1 + \frac{t\epsilon_{hr}}{1+t} - \eta}$$

is less than one if positive and greater than negative one if negative, and η is the (positive) income elasticity of housing demand. The second term in the bracketed coefficient on each remaining variable in (8), i.e., the terms weighted by Δ , reflects the influence of capital gains income on that variable's role in M .¹³ In general, the sign of each effect is indeterminate, depending as it does on the magnitudes of the housing demand elasticities. However, in those cases where $\epsilon_{hr} > -1$ and housing demand is sufficiently income-inelastic such that Δ is positive, then endogenizing income unambiguously decreases the housing cost component of the marginal cost of public services. It is also possible that $\epsilon_{hr} < -1$ yet $\Delta > 0$, if demand is not too price-elastic, so that a rise in house prices increases the resident cost of public goods even though such price gains amount to an increase in wealth. In this situation the nominal income effect of rising prices does not induce a sufficient increase in housing consumption to generate enough new tax revenue at the going rate to offset the consumption effect of the price change.

If, on the other hand, $\epsilon_{hr} = \eta = 0$, then (8) becomes simply:

$$M = T \left\{ \frac{dC}{dg} - p \left[N \frac{\partial h}{\partial g} (1 + t) + th \frac{dN}{dg} \right] \right\}$$

¹³In empirical application, one may want to weight Δ by a parameter, say α , measuring the degree of foresight of the household. One could then test the hypothesis that $\alpha = 0$; i.e., that a homeowner does not rationally account for capital gains when evaluating local public policy.

and the price change term disappears altogether. M nonetheless differs from T in this instance to the extent $\partial h/\partial g$ and dN/dg differ from zero (i.e., there exist tax revenue effects), and/or a dollar increase in public goods spending costs something other than a dollar.

The practical importance of these factors in the general case can be seen more plainly by solving for the incidence of the policy change. The local market equilibrium condition that supply must equal demand is

$$S(p) = Nh(p(1+t), y, g)$$

where $S(\cdot)$ is local aggregate housing supply. Differentiating and substituting for dt/dg from (6) gives the price change that maintains fiscal and market equilibrium:

$$\frac{dp}{dg} = \frac{\frac{1}{h} \frac{\partial h}{\partial r} \frac{dC}{dg} - \frac{t \epsilon_{hr}}{1+t} \frac{h dN}{dg} + N \left(\frac{\partial h}{\partial g} + \frac{\partial h}{\partial y} \frac{dy}{dg} \right)}{N \left[S' \left(1 + \frac{t \epsilon_{hr}}{1+t} \right) \cdot \frac{\partial h}{\partial r} \right]} \quad (9)$$

If supply is sufficiently elastic such that the denominator in (9) is positive, then the higher is income or the more income-elastic is housing demand, the more will the unit price of housing rise. However, if there is no capital gains income, dN/dg and $\partial h/\partial g$ are zero, and housing supply is perfectly inelastic then

$$Nh \frac{dp}{dg} = - \frac{dC}{dg} < 0$$

In effect, landlords finance the public good via decreases in unit rents; i.e., with inelastic supply and no migration, the cost of local spending is shifted entirely to nonresident homeowners. Note also that if $\partial h/\partial g = 0$ then $dp/dg = 0$ if either $\epsilon_{hr} = 0$ or $\epsilon_{sp} = \infty$, for any value of η . This can be seen by solving for capital gains income in (9) to get

$$\frac{dp}{dg} = \frac{\left[N \frac{\partial h}{\partial g} + \frac{\epsilon_{hr}}{r} \left(\frac{dC}{dg} - t_{ph} \frac{dN}{dg} \right) \right] \left(1 + \frac{t\epsilon_{hr}}{1+t} \right)}{N \left\{ S' \left[1 + \frac{t\epsilon_{hr}}{1+t} \left(2 + \frac{t\epsilon_{hr}}{1+t} - \eta \right) - \eta \right] - \frac{\partial h^c}{\partial r} - \frac{t\epsilon_{hr}}{1+t} \right\}} \quad (10)$$

where the superscript *c* denotes a compensated derivative.

Substituting from (10) into (8) gives the reduced form expression of interest for the marginal price of the local public good. For the case of owner-occupiers the resulting forms are quite difficult to interpret in the general case, so the remainder of this paper will focus on the case where the household treats its income as fixed. Solving for dp/dg in (8), with $dy/dg = 0$, provides the following expression for the marginal price of local public goods:

$$M = T \left(\frac{\frac{dC}{dg} - pt \left[\left(1 - \frac{1}{t\epsilon_{sp}} \right) N \frac{\partial h}{\partial g} + h \frac{dN}{dg} \right]}{1 + \frac{t\epsilon_{hr}}{1+t} \left(1 - \frac{1}{t\epsilon_{sp}} \right)} \right) \quad (11)$$

As in (8), the marginal price depends on production costs and tax revenue effects, as well as demand and now supply derivatives. The more (less) elastic is supply, the less (more) responsive is the net price to fiscal variation, and hence the less (more) important are price changes as a component of *M*.

In the numerator, changes in demand due to migration and substitution have somewhat offsetting effects. The tax revenue effect and the effect of demand on consumption prices lower and raise the effective price, respectively. The net effect is an empirical matter, depending on the behavioral parameters. Through the denominator, increases in the price act to decrease the indirect effect of policy on the size of the tax base, which acts to decrease costs. The denominator of (11) is also larger than that of (8), so long as $\epsilon_{hr} \neq 0$. This suggests that if the tax revenue effect is

negligible, ignoring capitalization effects overstates the project's marginal economic cost to the household.

Wildasin (1987) has argued that disregarding the tax distortion effect alone may cause estimates of the price elasticity of demand to be biased downward as much as 25%. However, he explicitly assumes a zero tax revenue effect and implicitly assumes an infinitely price-elastic housing supply. From (11), we see that the less elastic is supply, the smaller will be the downward bias. In fact, the denominator of (11) is greater than one if supply is sufficiently inelastic relative to demand. In that case, estimates of ϵ_{hr} based on T will be biased *upward*, rather than downward. From (7), sufficient conditions for the equivalence of M and T are that: (i) g be measured in dollar expenditures, so that $dC/dg = 1$, (ii) the tax revenue effect be zero, and (iii) $\epsilon_{hr} = 0$. These conditions also imply there is no capitalization. However, if conditions (i) and (iii) hold, but the tax revenue effect is nonzero, capitalization is perfect net of new tax revenues. And if (i) and (ii) hold, but $\epsilon_{hr} \neq 0$ while $\epsilon_{sp} = \infty$, the capitalization effect vanishes and only the pure tax distortion effect must be taken into account. These relationships represent a new set of implications not available in previous research.

V An Example

A simple example illustrates the effect of misspecifying the effective price.¹⁴ Imagine that the demand for public goods by household i takes the form

$$g_i = b M_i^{\delta} y_i^{\gamma} u_i \quad (12)$$

where the public good is expressed as expenditure, the household takes its income as fixed, and the tax revenue effect is negligible, so that the marginal public goods price may be expressed as

¹⁴For purposes of comparison, this example follows the format of an example in Wildasin (1987).

$$M_i = \frac{T_i}{1 + \frac{t\varepsilon_{hr}}{1+t} \left(1 - \frac{1}{t\varepsilon_{sp}}\right)} \quad (13)$$

Substituting from (13) into (12), taking logs and differentiating both sides of (12) gives:

$$d \log g_i = \delta d \log \left[1 + \frac{t\varepsilon_{hr}}{1+t} \left(1 - \frac{1}{t\varepsilon_{sp}}\right) \right] + \gamma d \log y_i + d \log u_i$$

Let the fiscal budget be $g = t\rho \sum_i h_i$, and assume that housing demand takes the form $h_i = ky_i [p(1+t)]^{\varepsilon_{hr}}$, so that the budget may be written as

$$g = t\rho k Y [p(1+t)]^{\varepsilon_{hr}}$$

where $Y = \sum_i y_i$. Taking logs and differentiating, the fiscal budget constraint becomes

$$\begin{aligned} d \log g_i &= d \log t(1+t)^{\varepsilon_{hr}} + (1 + \varepsilon_{hr}) d \log p + d \log Y \\ &= \frac{1+t+t\varepsilon_{hr}}{t} d \log (1+t) + (1 + \varepsilon_{hr}) d \log p + d \log Y \end{aligned} \quad (15)$$

Solving for $d \log (1+t)$ from (15), and substituting into (14) gives

$$d \log g_i = \frac{\delta - \xi}{1 + \xi} d \log T + \frac{\gamma + \xi}{1 + \xi} d \log y_i + \frac{\xi(1 + \varepsilon_{hr})}{1 + \xi} d \log p + \frac{d \log u_i}{1 + \xi} \quad (16)$$

where

$$\xi \equiv \frac{\delta t \varepsilon_{hr} (1 + 1/\varepsilon_{sp})}{\left(1 + t + t \varepsilon_{hr} - \frac{\varepsilon_{hr}}{\varepsilon_{sp}}\right) (1 + t + t \varepsilon_{hr})}$$

As stated earlier, the standard approach in the literature is to estimate a demand equation having the form of (2), and to interpret the resulting parameter estimates $\hat{\beta}_1$ and $\hat{\beta}_2$ as the price and income elasticities of public goods demand, respectively. Looking at (16), we see that $\hat{\beta}_1$ and $\hat{\beta}_2$ are actually biased estimates of the elasticities, δ and γ , where

$$\delta = \frac{\hat{\beta}_1}{1 - (1 + \hat{\beta}_1) \frac{\xi}{\delta}} \quad (17)$$

and

$$\gamma = \hat{\beta}_2 + \xi(1 - \hat{\beta}_2) \quad (18)$$

Note that $\xi = 0$ if housing demand is price-inelastic, so that $\delta = \hat{\beta}_1$ and $\gamma = \hat{\beta}_2$. More generally, $\xi > 0$ if housing demand is not too price-elastic, indicating that the estimate of δ is biased toward negative one, and that the estimate of γ is biased away from positive one.¹⁵

These results are limited in their generality since they depend on the assumption that tax revenue effects, due in part to the tax revenues lost or gained due to household migration, and capital gains income are zero. Still, they suggest that the actual price elasticity of public education demand is *less* elastic than recent studies indicate, and that the actual income elasticity of demand is *more* elastic.¹⁶ The results from (16) also demonstrate the omitted variable bias in (2) from not including the housing price as an explanatory variable. The unit price p is not directly observable, and its correct specification is left to another paper. Note however that this source of specification error disappears only if housing demand is perfectly price-inelastic.

¹⁵If housing demand is not too price-elastic, the direction of the bias is identical to that discovered by Wildasin (1987) under the assumption of no capitalization. However, the formulae for the reconstruction of the true elasticities δ and γ using (15) and (16) are different from his, and the resulting magnitudes of those elasticities are more different the less price-elastic is housing supply.

¹⁶Comparing survey data for Massachusetts and Michigan, for example, Rubinfeld and Shapiro (1989) report estimated tax-price elasticities between -0.43 and -0.72 and income elasticities between 0.2 and 0.93, depending on the data set and specification of household characteristics. These ranges are consistent with the findings of Reid (forthcoming) and Bergstrom, et al. (1982), among others.

V Conclusion

This paper derives a theoretically consistent marginal price for local public services financed by a tax on real property. The price can be quite complex, and varies systematically from the proportional tax-price variable commonly employed. The extent of that variation depends on the tax distortions at work, second-order tax revenue and income effects, and the influence of services on local prices. The derivation makes clear that the empirical significance of these biases depends on the behavior of housing suppliers, on how households perceive demand and income effects, and the price incidence of policy changes.

In particular, the standard approach provides unbiased parameter estimates only when, broadly speaking, housing demand is price-inelastic and behavioral responses to changes in public services do not affect tax revenues. When these conditions do not hold, property value capitalization effects must also be taken into account when interpreting the parameter estimates, and when specifying the variables to be included in the demand equation. Moreover, holding prices constant will not neutralize the effect of tax distortions unless one assumes price-inelastic housing demand. An example using a standard demand specification confirmed that published estimates of the price and income elasticities of public goods demand are biased downward. However, the example ignored the potential role played by income effects due to capital gains income, and by tax revenue effects due to migration and the substitutability and complementarity between private and public goods by residents.

As mentioned early in section II, the framework of public expenditure research is incomplete because, among other things, it fails to properly incorporate the migration margin in the household decision calculus. A fruitful research project might build on the progress made in this paper by explicitly modelling the migration decision.¹⁷ This could eliminate selection bias, as well as provide more information on the tax revenue effects that influence the true economic cost of a change in local spending. The resulting model will have to be quite detailed, however, which suggests that something along the lines of a computable general equilibrium model might be appropriate for many applied policy evaluation purposes.

¹⁷See the approach suggested in footnote 4.

References

- Arnott, Richard and Joseph Stiglitz. (1979) "Aggregate land rents, expenditure on public goods, and optimal city size," *Quarterly Journal of Economics* 93, 471-500.
- Atkinson, Anthony B. and Nicholas H. Stern. (1974) "Pigou, taxation and public goods," *Review of Economic Studies* 41, 119-128.
- Bergstrom, Theodore and Richard Goodman. (1973) "Private demands for public goods," *American Economic Review* 63, 280-296.
- Bergstrom, Theodore, Daniel Rubinfeld and Perry Shapiro. (1982) "Micro-based estimates of demand functions for local school expenditures," *Econometrica* 50, 1183-1205.
- Brueckner, Jan (1982) "A test for allocative efficiency in the local public sector," *Journal of Public Economics* 19, 311-331.
- Courant, Paul, Edwin Gramlich and Daniel Rubinfeld. (1980) "Why people support tax limitation amendments: The Michigan case," *National Tax Journal* 33, 1-20.
- Crane, Randall (1988) "Second-best property value capitalization," *Economics Letters* 27, 175-178.
- Goldstein, Gerald and Mark Pauly. (1981) "Tiebout bias on the demand for local public goods," *Journal of Public Economics* 16, 131-144.
- Gramlich, Edwin and Daniel Rubinfeld. (1982) "Micro estimates of public spending demand functions and tests of the Tiebout and median voter hypotheses," *Journal of Political Economy* 90, 536-560.
- Groves, Theodore and A. Todo-Rovira. (1986) "The theory and estimation of demand for local public goods: An alternative to the median voter model," October, University of California, San Diego, unpublished.
- Hartwick, J. (1980) "The Henry George rule, optimal population, and interregional equity," *Canadian Journal of Economics* 13, 695-700.
- Ladd, Helen and Julie Wilson. (1982) "Why voters support tax limitations: Evidence from Massachusetts' Proposition 2 1/2," *National Tax Journal* 35, 121-148.
- Ladd, Helen and Claire Christopherson. (1983) "Demand for local public services: Evidence from survey data," February, Harvard University, unpublished.
- Martinez-Vazquez, Jorge and K. Ihlanfeldt. (1984) "Why property tax capitalization rates differ: a critical analysis," Working Paper No. 84-13, Georgia State University.
- Mieszkowski, Peter and George Zodrow. (1989) "Taxation and the Tiebout model: The differential effects of head Taxes, taxes on land rents and property values," unpublished, Rice University.
- Oates, Wallace (1986) "The estimation of demand functions for local public goods: Issues in specification and interpretation," University of Maryland, October, unpublished.
- Reid, Gary (forthcoming) "The many faces of Tiebout bias in local education demand parameter estimates," *Journal of Urban Economics*.

- Rubinfeld, Daniel (1987) "The economics of the local public sector," in A. Auerbach and M. Feldstein, eds., *Handbook of Public Economics*, V. II, Amsterdam: Elsevier Science, 571-645.
- Rubinfeld, Daniel and Perry Shapiro. (1989) "Micro-estimation of the demand for schooling: Evidence from Michigan and Massachusetts," January, University of California, Berkeley and Santa Barbara, unpublished.
- Rubinfeld, Daniel, Perry Shapiro and Judith Roberts. (1987) "Tiebout bias and the demand for local public schooling," *Review of Economics and Statistics* 69, 426-437.
- Scotchmer, Suzanne and Myrna Holtz Wooders, (1987) "Competitive equilibrium and the core in club economies with anonymous crowding," *Journal of Public Economics* 34, 159-173.
- Starrett, David A., (1988) *Foundations of Public Economics*. Cambridge: Cambridge University Press.
- Stiglitz, Joseph (1977) "The theory of local public goods," in M. Feldstein and R. Inman, eds., *The Economics of Public Services*. London: Macmillan.
- Stiglitz, Joseph (1983) "The theory of local public goods twenty-five years after Tiebout: A perspective." in G. Zodrow, ed., *Local Provision of Public Services: The Tiebout Model after Twenty-five Years*. New York: Academic Press, 17-54.
- Tiebout, Charles (1956) "A pure theory of local expenditures," *Journal of Political Economy* 84, 416-424.
- Wildasin, David (1987) "Distortionary taxes and demand estimation for public goods," CORE Discussion Paper No. 8721.
- Yinger, John (1982) "Property value capitalization and the theory of local public finance," *Journal of Political Economy* 90, 917-943.
- Yinger, John, Howard Bloom, Axel Borsch-Supan, and Helen Ladd. (1988) *Property Taxes and House Values: The Theory and Estimation of Intrajurisdictional Property Tax Capitalization*, New York: Academic Press.
- Zodrow, George and Mieszkowski, Peter (1983), "The incidence of the property tax: The benefit view versus the new view." in G. Zodrow, ed., *Local Provision of Public Services: The Tiebout Model after Twenty-five Years*. New York: Academic Press, 109-130.
- Zodrow, George and Mieszkowski, Peter (1986), "Pigou, Tiebout, property taxation, and the under-provision of local public goods." *Journal of Urban Economics* 19, 356-370.