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DEMAND ESTIMATION FOR PUBLIC GOODS

Distortionary Taxation and Other Sources of Bias

David E. WILDASIN*

Indiana University, Bloomington, IN 47405, USA

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Sources of error in the estimation of demand for public goods are reviewed and summarized, and a new type of bias is identified and analyzed. This new bias arises when public goods are financed by distortionary taxation, instead of by distortionless taxes as is usually assumed. It is shown that failure to take account of tax distortions leads to a misspecification of the effective price of public goods, which biases the estimates of the price and income elasticities of demand. Sample calculations are presented in order to illustrate the potential magnitude of the errors involved.

1. Introduction

Estimation of the demand for public goods has been a longstanding interest for public finance economists, and for obvious reasons. For practical policy implementation, it is often necessary to predict how public spending by provinces, states, or localities will respond to changing incomes, public service costs, or fiscal incentives offered by higher-level governments. Moreover, estimates of the demand for public goods provide rare insight into one of the fundamental problems of resource allocation through the public sector: the measurement of the benefits of publicly-provided goods and services. Even if such measurements are subject to various imperfections, there are very few alternative sources of information about the benefits of public goods. Accordingly, there have been sustained efforts by many economists to improve and refine estimates of demand for public goods. These efforts have

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involved modifications of the theoretical foundations of demand estimation, exploitation of different sources of data, and experimentation with alternative econometric techniques or the development of entirely different econometric approaches to the problem.

The present paper has two objectives. Its primary objective is to advance this process of gradual refinement and elaboration of the modeling of demand for public goods one more step by identifying, explaining, and tentatively quantifying a source of bias in estimates of demand for public goods that has gone unmentioned in the literature to date. This bias arises when public goods are financed by distortionary taxes. In a nutshell, the problem is that the effective marginal cost of public goods includes not just their direct resource cost, but also the cost of additional tax distortions. Failure to take this fact properly into account in empirical work results in an incorrectly-specified price variable. This being the case, it is not surprising that bias results. Describing the exact nature of this bias and providing some calculations which give an indication as to its possible quantitative importance is the task of sections 3–5 of the paper.

The second objective of the paper is to take stock more generally of the current state of research in this area. There are several reasons to worry about possible bias in the estimation of demand for public goods in addition to the problem of distortionary taxation. Some of these are quite well known, while others have only been discussed more recently. Section 2 presents a brief selective review of some of the main currents in recent research, discussing some of the many problems that investigators in this field have tried to deal with and summarizing what is known about them so far. Readers who are not familiar with the literature on demand estimation for public goods may find this a useful introduction to the general topic, and in any case a sketch of some of the problems confronting empirical researchers will help to put this paper's treatment of distortionary taxation into better perspective.

The paper concludes in section 6 with a brief summary of main conclusions and a discussion of the implications of the analysis for policy and other questions.

2. Demand estimation for public goods: A selective survey of recent developments

The succeeding sections of this paper will present an analysis of a specific problem that can arise in the estimation of demand for public goods when those goods are financed via distortionary taxation. For the sake of analytical simplicity, that discussion will suppress a number of other potential difficulties that have been noted in the literature of this subject since the early work by authors such as Barr and Davis (1966), Borcherding

and Deacon (1972), and Bergstrom and Goodman (1973). In order to provide some perspective on the subject as a whole, it will be useful to discuss at least briefly some of the issues other than distortionary taxation that have been analyzed in recent literature.[1]

To begin with, it might be useful to note that estimation of demand for public goods has in practice amounted to estimation of demand for *local* public goods. A moment's reflection will suggest why this should be the case. An adequate amount of statistical information is an obvious sine qua non for demand estimation. Since public goods are provided through the public sector, one essential variable – the level of public goods provided (or at least expenditure thereon) – can only be observed at the level of governmental units. At the national level, one would have to use international cross-sections or time-series over substantial periods of time in order to obtain samples of adequate size for empirical work. While useful work can no doubt be done with such data, it is obvious that they will present comparability and other problems. At the local level, by contrast, one can use cross-sections to obtain observations on public good provision for an adequately large number of units of government with basically similar institutional structures, existing in a common ambient political and economic environment. This makes local units of government comparatively well-suited as units of observation for empirical research. As will become apparent, however, modeling demand for public goods at the local level is also subject to some intriguing complications that might not be as serious for an analysis of public expenditure by a higher level of government.

A landmark paper in the empirical implementation of median voter models for demand estimation is that by Bergstrom and Goodman (1973), which has provided a standard framework or starting point for much of the empirical analysis of the demand for local public goods. Like the earlier work of Barr and Davis (1966) and Borcherding and Deacon (1972), Bergstrom and Goodman begin with the hypothesis that expenditure decisions conform to the median voter model of the political process. Thus, the observed level of public expenditure in a given locality is assumed to be optimal or utility-maximizing from the viewpoint of the 'median voter'. If this is assumed, then if one could obtain observations of the characteristics and environment of the median voter – age, race, religion, income, 'price', etc. – an estimate of demand or underlying preferences for public goods could in principle be made in exactly the way (or, one should say, in one of the ways)

[1]It is impossible to offer more than a sketch of some of the major issues here. More complete surveys, including references to many important contributions to the literature that are not cited here, are readily available. See, in particular, Inman (1979, 1987), Rubinfeld (1987), and Wildasin (1986, 1987a) for surveys that stress different theoretical and empirical issues in modeling demand for local public goods. Inman (1979) and Bergstrom et al. (1982) provide excellent surveys of the empirical results of most of the literature on demand estimation.

that one does in estimating demand or preferences for private goods. For example, the variation in income across median voters in different jurisdictions could be related to variations in expenditures on public goods to arrive at an estimate of the income elasticity of demand for public goods. The 'price' for public goods facing a given voter is ordinarily assumed to be that voter's share of the relevant tax base in the jurisdiction (e.g., share of property value, if property taxation is used, or share of income, if public expenditure is financed by income taxation) times the marginal cost to the jurisdiction of providing some additional public goods. If this could be measured for each median voter, then the variation across jurisdictions in this tax-price might be used to estimate a price elasticity of demand.

However, the identification of the median voter, and of this voter's personal characteristics and choice environment, is a difficult task. One approach that one might take is simply to assume that the median voter is the household in the community occupying the house of median value, or receiving the median income, among the households residing there. In the absence of some explicit justification, these are just added hypotheses which constrain the model in a more or less ad hoc way. Bergstrom and Goodman (1973) show, however, that given certain assumptions (notably, log-linearity of the underlying demand functions for public goods and a proportional scaling restriction on the distribution of income in different jurisdictions), the level of public expenditure desired by the median voter (whoever that may be) will be a function of median income and of the effective price for the local public good faced by the median-income household. This result makes it unnecessary to ascertain the actual identity of the median voter, which would otherwise have presented a serious problem for empirical work.[2]

Since the early contributions by Bergstrom–Goodman and others, work on demand estimation for public goods has branched out in a number of directions, of which we shall discuss several here. Among many topics that might be discussed, we shall focus on the problem of self-selection through migration (so-called 'Tiebout bias'), the joint supply of inputs by both the private and the public sector in the provision of 'public' services, and, because of its special relevance for the analysis to follow later in this paper, the problem of measuring price variables in public good demand estimation.

'Tiebout Bias' and the demand for local public goods. The original median voter models begin from the assumption that a level of public good provision must be determined by a *given set* of self-interested voters, and proceed to characterize the majority voting equilibrium that such a group of voters would achieve. There is no explicit recognition of the fact that the voting population of a given locality is not fixed for all time, but instead is the

[2]It should be noted nonetheless that one can try to determine whether the median voter is in fact the median income household in a jurisdiction. Inman (1978) finds evidence to support this possibility.

result of a continual process of demographic change including migration. By contrast, the role of migration is well recognized, and indeed of central importance, in other parts of the literature of local public economics, owing in large part to the enormous influence of Tiebout (1956). According to Tiebout, households take local public service provision into account when they make locational decisions, and will prefer to move to those jurisdictions that provide levels of public service in accordance with their 'preferences'. This suggests that the population residing in a given jurisdiction, in equilibrium, will share certain common characteristics with respect to their demands for local public goods. As Goldstein and Pauly (1981) show, this fact needs to be taken into account in demand estimation.

The essence of the Goldstein–Pauly argument is easily enough understood. Suppose initially an economy in which all jurisdictions provide a single public good, in which all households are identical in all respects except their incomes, and in which each household's demand for the local public good is income elastic. Suppose further that households move to jurisdictions that provide levels of public good corresponding to their individually-preferred levels. Under these assumptions, households would migrate in such a way as to become perfectly stratified by income class, with each jurisdiction containing households of a given income level. In such an economy, a cross-section regression of each community's public expenditure on its median income would clearly permit one to infer accurately the income elasticity of demand for the public good.

Now suppose that households differ not only with respect to their incomes, but with respect to their preferences (utility functions) as well. Within any given income class, then, one would find households with relatively high as well as relatively low demands for the public good, although we assume that each household still has a positive income elasticity of demand for the good and that higher-income households have higher demands for the good, on average. Assume again that households migrate to jurisdictions providing the level of the public good that they prefer. Jurisdictions will now not be perfectly stratified by income class, but will instead contain members of several different income classes. A given locality will contain both households with relatively high incomes and weak preferences for the public good and households with relatively low incomes and strong preferences for the local public good. This creates a potential problem for cross-section regression estimation of the relationship between income and demand for the local public good.

The problem can be seen as follows. Suppose that income is non-uniformly distributed in the economy; for instance, suppose that the distribution is normal, log-normal, or some other simple unimodal distribution. Consider the distribution of income in a jurisdiction providing a small amount of the public good. First, the mean income in such a jurisdiction would be low, because of the assumed normality of demand for the public good. Further-

more, however, this jurisdiction will contain disproportionately many high-income households with weak preferences for the public good, and disproportionately few low-income households with strong preferences for the public good, because of the increasing relative frequency of higher-income households at the lower end of the economy's income distribution. This higher relative frequency of higher-income households will tend to raise the median income in the jurisdiction. Conversely, a jurisdiction providing a high level of the public good will have a high mean income; but, being past the mode of the underlying income distribution in the economy as a whole, the local income distribution will be over-represented with lower-income households, tending to lower the median income there. Thus, the unimodality of the basic income distribution in the economy tends to raise the median income in jurisdictions providing smaller amounts of the public good and to raise it in jurisdictions providing larger amounts; as a result, a regression of public good provision on median income in each jurisdiction will fail to detect the true income–expenditure relationship, and will instead tend to *overestimate* the income elasticity of demand for the public good.

As discussed in Rubinfeld et al. (1987), problems with sorting can arise in demand estimation based on micro-level data as well.[3]

Empirical analysis of survey data on individual demands for local public goods has typically relied on maximum-likelihood estimation of models in which unobserved individual characteristics affecting demand are assumed to be uncorrelated with the actual level of public good provision in the jurisdiction in which the individual resides. If, however, unobserved tastes or other variables induce households to migrate, this assumption will be invalidated; because of migration, jurisdictions providing high levels of public goods will tend to contain relatively more households with values of the unobservable variable corresponding to high public good demand as compared with other jurisdictions. As shown in Rubinfeld et al., this means that ordinary maximum-likelihood estimates will be biased (though in an uncertain direction). Correction of the bias leads to substantially lower estimated price and income elasticity estimates. For example, whereas the estimated price elasticity and income elasticities are -0.32 and 0.32, respectively, when estimated without any corrections for Tiebout bias [as in Bergstrom et al. (1982)], Rubinfeld et al. find that the bias-corrected estimates are -0.11 and 0.10 – a substantial reduction in the estimated elasticities.

[3]See also Bergstrom et al. (1982), Gramlich and Rubinfeld (1982a, b), and Rubinfeld and Shapiro (1989) for examples of micro-level research based on a survey of Michigan voters. Schokkaert (1987) describes the results of a survey of voter preferences for public projects in a Belgian municipality. As Rubinfeld (1987) emphasizes, one of the important advantages of using micro-level data is that one can estimate demand parameters without having to invoke the Bergstrom–Goodman interjurisdictional scaling assumption on local income distributions. Nonetheless, Tiebout bias can still arise in estimation based on micro data, as carefully explained in Rubinfeld et al.

Private inputs and public good provision. The relationship between public inputs and the output of public goods in the public good production process is often a difficult one to understand – a problem compounded by the difficulties in measuring public inputs and outputs. Of course, in much empirical work, these problems are swept aside by the assumption that the level of public good being provided is equal to the amount of public expenditure on that function. In other words, output is measured by the value of public inputs. It is widely appreciated, however, that this procedure is subject to various limitations. Among other things, there is evidence that public inputs are not the only important inputs into the local public production process. Most notably, educational performance in elementary and secondary school appears not to depend solely on the level of public expenditure; rather, educational performance depends on various personal 'attributes' of students, such as their socio-economic backgrounds as measured by parental income. One might then think of parental income, or of behavior correlated with parental income, as an input in the production of education.

Hamilton (1983a) makes this observation the basis of an analysis of the relationship that one would expect to find between interjurisdictional income and educational expenditure variations, on the one hand, and inter-jurisdictional variations in the level of fiscal assistance given to local governments by higher-level governments and educational expenditures, on the other hand. Hamilton points out that jurisdictions with higher levels of income will be jurisdictions in which private inputs to education are high, whereas this would not necessarily be true of a jurisdiction that has a high level of support from higher-level governments. Therefore, in contrast to standard theory, having a higher level of grant assistance in a jurisdiction is not fully equivalent to having a higher level of income in the jurisdiction. Depending on the degree of substitutability or complementarity between public and private inputs, resident-voters in a high-income jurisdiction might wish to spend either more or less on the public inputs to the educational process than a jurisdiction that has a high level of grant assistance. In view of the rather low estimated income elasticity of demand for education usually found in the literature, one might think of high substitutability as the more likely case.

Hamilton focuses on the implications of privately-provided education inputs for the equivalence or lack thereof between grant assistance to a locality and income.[4] However, as Rubinfeld and Shapiro (1989) point out, these issues are important for estimation of the income elasticity of demand

[4]The empirically-observed lack of equivalence between the two has come to be known as the 'flypaper effect', because of the finding that grant aid stimulates local public spending more than equal amounts of income – i.e., money tends to 'stick' where it is first received, whether in the public or the private sector.

in any case. They attempt to shed light on this question by comparing estimated income elasticities for macro-based (community-level) demand models with those based on micro-level data. By controlling for individual household characteristics in the micro analysis, it should be possible to separate the effect of those characteristics from the effect of income per se, whereas in the macro-level analysis income must proxy for omitted income-correlated characteristics. They find (as in the results already noted above) that income elasticities estimated from micro data are if anything smaller than those estimated from macro data; hence, there is little support here for the notion that private inputs to education are highly substitutable. Rather, the results seem to indicate that the true income elasticity of demand for actual educational attainment is simply quite small.

Measuring the price of public goods. It will be obvious that measurement of the effective price for the public good is very important for accurate demand estimation. Yet this is not a straightforward task. In the context either of a macro-based median voter model or a model based on a survey of individual household preferences, the proper price variable is one which reflects the real cost to the household of incremental units of public good. This has generally been measured as the household's share in the relevant tax base – ordinarily, property.

However, it has been recognized that a tax-price variable measured in this way is based on the assumption that a $1 increase in public expenditure actually requires a $1 increase in the real local tax burden. In practice, real local tax liabilities may rise by less than $1, for several reasons.

First, as we have already noted, localities often receive grant assistance from higher-level governments. If such assistance is forthcoming at the margin, for example because of matching grants, then the locality need only impose a fraction of the real cost of incremental spending on its residents. The effective tax-price facing each voter should be reduced by the percentage share of the cost of local spending that is paid for by higher-level governments. This is difficult to measure precisely, but can be approximated in various ways depending on the spending category in question. There is no doubt in the empirical literature that grants do stimulate recipient government expenditure. If anything, grants seem to act as if they have relative price effects even when they appear to be lump-sum.[5]

Second, localities, or their residents, receive assistance from the Federal government in the form of income tax deductibility of qualifying state and local taxes. In the case of local governments, the main source of revenue is the local property tax, and property taxes qualify for Federal tax deductibility. This means that for a household who itemized deductions, the real

[5]See, for example, Courant et al. (1979) and Oates (1979). This is the 'flypaper' effect again.

marginal cost of incremental local government spending would be lowered by the household's marginal Federal tax rate.[6]

Third, there is the possibility that local taxes may be exported through ordinary channels of tax shifting. Some portion of local taxes on commercial and industrial property, for example, may be passed on to non-residents, thereby lowering the local cost of public expenditures. Empirical analysis by Ladd (1975) finds that the presence of such property does indeed lower the tax price facing the median voter. As stressed by Mieszkowski and Toder (1983) and elaborated further by Wildasin (1987a, b), however, there is no *necessary* reason why public expenditures should rise when taxes are exported. The key question is whether or not the possibility of exporting occurs at the relevant margin. If a jurisdiction has some flexibility in the choice of its tax structure, it might well optimally be in a position where the gains from exporting had been fully exploited, so that the *incremental* dollar's worth of public expenditure would cost the jurisdiction a full dollar.

To deal with the question of tax exporting adequately, it seems necessary to develop an empirical model in which one could analyze the simultaneous choice of the structure (or mix) of taxation and of the level of local public expenditure. In the case of local governments in the U.S., the 'mix' of taxation is unlikely to involve extensive use of taxes other than the property tax, although large (and sometimes not so large) cities and counties often have sales, income, or other non-property taxes. But many localities use a variety of non-tax revenue sources such as user fees of various kinds. Moreover, and perhaps most subtle and difficult from the viewpoint of empirical work, the fact is that the local property tax need not be a tax that is levied on a uniform basis across different types of property. Instead, through a variety of direct and indirect means, some involving considerable administrative discretion, the effective rate can vary quite a lot from one type of property to another. This is very difficult to monitor statistically, and hence to incorporate into econometric modeling. Thus, there are bound to remain some open empirical questions here for some time.

The foregoing discussion has not covered all of the important recent developments in the analysis of demand for local public goods. Among other topics of interest, one might consider more explicit incorporation of household mobility into the model. In the U.S., migration is often accompanied by the purchase and sale of housing, consideration of which leads one to think about capitalization effects, which have been extensively studied. Also, we have assumed here that there is a simple majority voting mechanism through

[6]Feldstein and Metcalf (1987), Gramlich (1982a, b), Inman (1986), and Zimmerman (1983) emphasize the role of this feature of the Federal income tax.

which decisions are made regarding the level of public expenditure. In fact, the political process might be much more involved than portrayed here. One might wish to model the role of self-interested government bureaucrats in this process, for example. Furthermore, we have abstracted from any intertemporal issues, such as local public investment and/or indebtedness.

At least some of these topics (such as capitalization and alternative political models) have been extensively investigated in the literature. (The concluding section 6 says a few words on the particular question of the modeling of the local political process.) For better or worse, however, the effect of these research developments on demand estimation for local public goods has so far been comparatively slight, and hence they are not quite so directly relevant for our purposes here. Thus, we now conclude our brief survey of research on the demand for local public goods. From the above discussion, readers will understand that this is still very much an evolving area of research. There will remain scope for innovations to be made here, at all levels ranging from the theoretical foundations of demand estimation to econometric technique to the development of new data sources. The recent history of the subject has provided examples of progress in all of these areas.

3. Demand estimation with distortionary taxation

Let us now turn to the potential problem with demand estimation that is the particular focus of this paper; that is, the implications of distortionary tax financing. As has been noted already, the literature on demand estimation has not taken into account the possibility that public goods are financed in ways other than through lump-sum taxation. It is typically assumed in such models (though often without explicit mention) that the median voter (or individual household, in the micro-econometric branch of the literature) holds some fixed share of an exogenously-given and inelastically-supplied tax base that is used to finance public spending. In most applications, the tax base is housing, reflecting the importance of the local property tax as the main revenue source for the local governments that often form the units of analysis for empirical work. In other cases, income derived from labor and capital might be the assumed tax base.

In either case, however, the assumption that the base is totally fixed is inconsistent with the observed non-zero demand and supply elasticities for the taxed commodities. This means that the taxes that are being used in practice are distortionary taxes, but that these distortions are not playing any role in the model of decision-making that underlies empirical demand analyses. From the literature on normative public expenditure theory with non-lump sum or distortionary taxation, however, we know that simple comparisons of the marginal benefit and the marginal cost of public

expenditure are no longer valid guides to determining the welfare effect of public spending.[7] This is true for the measurement of the net benefit of public expenditure for a group and it is also true for the measurement of the net benefit of public expenditure for an individual voter. In particular, tax distortions should be taken into account in modeling the decision-making of voters. As this section will demonstrate, failure to do so will lead to specification error in econometric modeling.

To illustrate the problem, let us suppose, for the sake of concreteness, that we are presented with cross-section macro data on a sample of municipalities.[8] These data include observations on public expenditures, income, and some sort of price variable, such as median house value as a proportion of assessed valuation of all property (possibly modified to reflect an index of the cost of public services for a jurisdiction or a measure of an effective matching grant rate showing the extent to which subsidies from higher level governments lower the marginal cost of public expenditures to the jurisdiction). Imagine that these data are to be used to run cross-section regressions of public expenditures on price and income variables using methods that have by now become standard in the literature. In particular, following Bergstrom and Goodman (1973), let us assume that the demand relationship is assumed to be log-linear.

Thus, if z_i is public spending in locality i, p_i is the price variable facing the median voter, and Y_{im} is the median voter's income, the postulated functional form would be

$$z_i = bp_i^{\delta} Y_{im}^{\gamma} e_i \tag{1}$$

where b is a constant, e_i is an error term, and δ and γ are the price and income elasticities, respectively.[9] Let x_{im} be the median voter's house value, and let X_i be the total value of housing in the locality, so that x_{im}/X_i is the median voter's tax share. Suppose that the proportion g_i of local expenditures is financed by matching grants, and assume, for simplicity, that there are no other sources of intercity price variation. Then the usual procedure would be to define the effective price facing the median voter as

[7]Some basic intuitive insights into this issue can be found in earlier writings, but more rigorous and comprehensive analysis begins to appear in the optimal taxation literature that received such an impulse from the work of Diamond and Mirrlees (1971). See, in particular, Stiglitz and Dasgupta (1971) and Atkinson and Stern (1974). For further developments, see, e.g., Wildasin (1979, 1984a), Stuart (1984), and King (1986).

[8]The problems that will be discussed here will be as relevant for the case of micro-based demand estimation as for the case of estimation done at the level of the individual jurisdiction.

[9]Note that z_i could be either total expenditure, or expenditure per capita. The former would be correct if the local public good is purely public, the latter if it is quasi-private (i.e., total cost is proportional to population). The analysis to follow applies equally in either case.

$$p_i = \frac{x_{im}}{X_i}(1-g_i). \tag{2}$$

It is the measurement of the price variable p_i in (2) that is incorrect if municipal taxes are distortionary. To see why, we must reconsider the foundations of the theory that leads us to a model like (1) and (2) in the first place.

City i contains a number of residents, with a utility function u_{ih} for household h defined over consumption of housing x_{ih}, other private goods y_{ih}, and the local public good z_i (whose units are chosen so that one unit of z_i requires a budgetary outlay of one dollar, i.e., units are measured in expenditure terms). To keep matters as elementary as possible, suppose that all goods have tax-exclusive prices that are exogenously fixed, at least from the perspective of a single city, and that the only taxed commodity (aside from possible lump-sum taxes) is housing. Take the price of all other private goods, and the tax-exclusive price of housing, as fixed at unity.[10] Let τ_i be the ad valorem tax rate on housing. Then household h faces a budget constraint

$$(1+\tau_i)x_{ih} + y_{ih} = Y_{ih}, \tag{3}$$

where Y_{ih} is the household's income.[11]

This household faces two problems, a market problem and a voting problem. The household's market problem is to choose its private good consumption vector (x_{ih}, y_{ih}) to maximize utility u_{ih} subject to (3), taking the level of local public good z_i as given. This maximization yields an indirect utility function $v_{ih}(\tau_i, z_i, Y_{ih})$ and demand functions, particularly the demand function for housing $x_{ih}(\tau_i, z_i, Y_{ih})$, depending on the same arguments.

The household's voting problem is to decide what its most-preferred level of z_i would be, or, more generally, to rank all the levels of z_i on which it may be asked to vote. In determining this, the household is assumed to recognize that the tax rate τ_i on housing, and thus the tax-inclusive price of housing, will have to vary with the level of public spending so as to maintain budget balance. That is, τ_i must solve

$$\tau_i X_i = (1-g_i)z_i, \quad \text{where } X_i = \sum^{n} x_{ih}. \tag{4}$$

[10]This is valid if housing is infinitely elastically supplied to the city. If the property tax is interpreted as a pure tax on 'improvements', i.e., on capital, this is a reasonable long-run assumption. To the extent that the property tax falls on land, however, one would expect capitalization effects that would partially invalidate this assumption. For simplicity, these effects are ignored here.

[11]It is possible to interpret y_i as a vector. This vector might include some negative coordinates, corresponding to variably-supplied factors such as labor.

The household's evaluation of an incremental change in z_i, starting from any arbitrary level, is analyzed by computing the total derivative of v_{ih} with respect to z_i, taking (4) into account. By the implicit function theorem, (4) implies

$$\frac{d\tau_i}{dz_i} = \frac{(1-g_i) - \tau_i \partial X_i/\partial z_i}{X_i + \tau_i \partial X_i/\partial \tau_i}$$
$$= \frac{(1-g_i) - \tau_i \partial X_i/\partial z_i}{X_i(1 + \tau_i \varepsilon_i/[1+\tau_i])}, \tag{5}$$

where ε_i is the own-price elasticity of demand for housing.[12] Thus, using Roy's formula,[13]

$$\frac{dv_{ih}}{dz_i} = MRS_{ih} - \frac{x_{ih}}{X_i}\left[\frac{(1-g_i) - \tau_i \partial X_i/\partial z_i}{1 + \tau_i \varepsilon_i/(1+\tau_i)}\right]. \tag{6}$$

For the median voter, household m, $dv_{im}/dz_i = 0$ in equilibrium.[14] Hence, defining

$$\pi_i = \frac{x_{im}}{X_i}\left[\frac{(1-g_i) - \tau_i \partial X_i/\partial z_i}{1 + \tau_i \varepsilon_i/(1+\tau_i)}\right], \tag{7}$$

the equilibrium choice of z_i can be portrayed as part of the solution $(x_{im}^*, y_{im}^*, z_i^*)$ to the problem

$$\max_{(x_{im}, y_{im}, z_i)} \quad u_{im}(x_{im}, y_{im}, z_i)$$
$$\text{subject to} \quad (1+\tau_i)x_{im} + y_{im} + \pi_i z_i = I_{im} \tag{8}$$

where τ_i and π_i are taken as exogenously fixed and $I_{im} = Y_{im} + \pi_i z_i^*$ is also treated as exogenous lump-sum income.

In the median-voter literature, the fact that the level of housing consumption is an endogenously-chosen variable is generally ignored: x_{ih} is simply treated as exogenously given, for all h. In this special case $\varepsilon_i = \partial X_i/\partial z_i = 0$, and, using the government budget constraint (4), (8) can be reduced to

$$y_{im} + \pi_i z_i = Y_{im} - x_{im}, \tag{9}$$

[12] ε_i is defined as $d \log X_i / d \log(1+\tau_i)$.
[13] For details on such derivations, see, e.g., Wildasin (1979).
[14] Single-peakedness will be assumed for simplicity.

with $\pi_i = p_i$ as given in (2). Then the level of z_i chosen by the median voter subject to (9) will be a function of the price parameter $\pi_i = p_i$ and of the 'net' income parameter $Y_{im} - x_{im}$.[15]

Thus, when housing demand is perfectly inelastic, the standard analyses are correctly specified. However, in the more general case where the demand is not perfectly inelastic, so that tax distortions are present, a specification problem arises because the correct price variable is not p_i but π_i. Comparing (2) and (7), it is clear that the conventional price variable differs from the correct one for two reasons. First, it fails to take into account the effect of local public expenditure on housing demand, i.e., the term $\partial X_i/\partial z_i$. For the sake of simplicity, however, the cross-effect of public good provision on housing demand will be ignored in the remainder of this discussion.[16]

Secondly, using p_i in (2) rather than π_i in (7) as the tax-price variable implicitly treats the own-price elasticity of demand as zero, thus ignoring the term involving ε_i in the denominator of (7). Intuitively, this term reflects the tax distortions in the market for housing. Note that it vanishes if either $\tau_i = 0$ or $\varepsilon_i = 0$. In either case, there is no tax distortion. The first of these cases is obviously one that does not arise in practice, since governments do in fact impose positive taxes. The possibility that $\varepsilon_i = 0$, or that this condition holds approximately, is a more difficult empirical question. As discussed further below, there is some empirical evidence that the demand elasticity for housing is significantly different from zero. In this case, i.e., with $\varepsilon_i < 0 < \tau_i$, it must be the case that π_i exceeds p_i – that is, tax distortions raise the effective price of local public goods to the median voter. Empirical models which use the conventional price variables p_i are thus incorrectly specified, at least if one wishes to impose the maintained hypothesis of correct voter estimation of the true cost of local public goods.

4. An illustration

It is now natural to ask how the estimation of the demand curve might go awry given the misspecification that arises in the presence of tax distortions. This section presents a simple illustration that helps in developing an intuitive feel for this problem. For the purposes of this example, suppose that we have a sample of jurisdictions which differ from one another only in terms of the matching grants they receive from higher-level governments. Thus, in particular, the share of property owned by the median voter,

[15]Note that even in this special case, one could argue that the form (1) is misspecified because it uses income gross of housing expenditure as the income variable. One easy way to rescue the model in this case, however, is to hypothesize that x_{ih} is proportional to Y_{ih}, rather than strictly exogenous.

[16]This is done not because there is any presumption that $\partial X_i/\partial z_i = 0$ [see, e.g., Wildasin (1984a)], but simply because this is a theoretically possible outcome and because there seems to be no evidence on the matter.

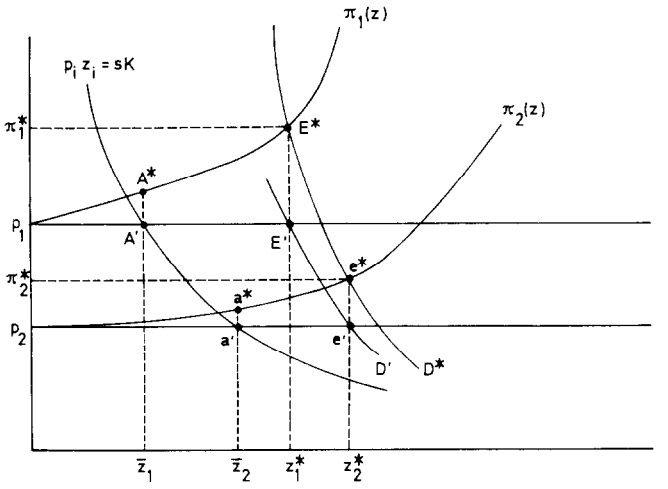

Fig. 1

denoted by s, is the same for all i, as is the income of the median voter. In addition, assume that the housing stock in i, X_i, is a constant elasticity function $X(1+\tau_i)$ of the effective price of housing $1+\tau_i$, with the same elasticity ε for all jurisdictions.

Under these assumptions, the tax-price of the public good for the median voter can be written, using (7) and (2), as

$$\pi_i = p_i\left(1+\frac{\tau_i\varepsilon}{1+\tau_i}\right)^{-1} \tag{7'}$$

and, from the government budget constraint (4), we can solve for τ_i implicitly as a function of $p_i z_i$:

$$\tau_i X(1+\tau_i) = \frac{p_i z_i}{s}. \tag{4'}$$

It is clear from (4') that τ_i is an increasing function of $p_i z_i$, and thus of z_i, and from (7') it is evident that π_i is increasing in τ_i. Thus, in fig. 1, we may plot π_1, the effective marginal price of the public good to the median voter in some locality 1, as an increasing function of z_1. Note that $\pi_1(0) = p_1$, since the tax rate τ_1 drops to zero when the level of spending is zero. If D^* is the median voter's demand curve, z_1^* will be the equilibrium level of public good provided in jurisdiction 1.

Now consider a jurisdiction 2 such that $g_2 > g_1$ and hence $p_2 < p_1$. If we plot π_2 as a function of z, it will obviously lie everywhere below π_1.

However, it will also have a different slope. To relate the two, let the curve $p_i z_i = sK$ be a rectangular hyperbola, so that the points A' and a' identify levels of public good provision $(\bar{z}_1, \bar{z}_2)$ which would entail equal total outlays $p_i z_i = K$ for localities 1 and 2, respectively. Then we know that if locality 1 provided $\bar{z}_1$ and locality 2 provided $\bar{z}_2$, they would have identical tax rates $\bar{\tau}_1 = \bar{\tau}_2$. It follows from (7'), then, that the ratios π_i/p_i would be the same for each locality at these levels of z_i. Thus, if A^* lies 10% above point A', the point a^* on π_2 must lie 10% above point a'. Using this fact, we can construct the curve $\pi_2(z)$ in the proper relationship to π_1, as shown in the figure. The intersection of D^* with π_2 shows the equilibrium level of public good provision in locality 2, z_2^*.

To estimate the demand curve D^*, we should gather observations of price-quantity pairs like (π_1^*, z_1^*) and (π_2^*, z_2^*), corresponding to points E^* and e^*, and then fit the curve. However, the usual procedure in empirical work is to ignore tax distortions and to treat p_1 and p_2 as the prices faced by the median voters. Thus, one will fit a curve to price–quantity pairs like (p_1, z_1^*) and (p_2, z_2^*), which will lead one to infer that the demand curve goes through points like E' and e'. D' might be the estimated demand curve in this case.

What sorts of errors does this method produce? The most obvious point is that the estimated demand curve lies below the true one. Intuitively, this just reflects the fact that the local public good must be worth more at the margin in order to justify incremental tax distortions that it creates.

A more subtle question concerns the elasticity of the demand curve. As drawn in figure 1, it appears that D' is more elastic than D^*. Is this coincidental?

To answer this question, let δ be the elasticity of D^* and $\hat{\delta}$ the elasticity of D'. Then

$$\delta \simeq \frac{z_2^* - z_1^*}{z_1^*} \div \frac{\pi_2^* - \pi_1^*}{\pi_1^*},$$

$$\hat{\delta} \simeq \frac{z_2^* - z_1^*}{z_1^*} \div \frac{p_2 - p_1}{p_1},$$

and hence

$$\frac{\delta}{\hat{\delta}} = \frac{p_2 - p_1}{p_1} \div \frac{\pi_2^* - \pi_1^*}{\pi_1^*} = \left[\left(\frac{p_2}{p_1} - \frac{\pi_2^*}{\pi_1^*}\right) + \left(\frac{\pi_2^* - \pi_1^*}{\pi_1^*}\right)\right] \div \frac{\pi_2^* - \pi_1^*}{\pi_1^*}$$

$$= 1 + \frac{p_2}{\pi_1^*}\left(\frac{\pi_1^*}{p_1} - \frac{\pi_2^*}{p_2}\right) \div \frac{\pi_2^* - \pi_1^*}{\pi_1^*}. \tag{10}$$

Now suppose first that $\hat{\delta} = -1$, so that D' is a rectangular hyperbola. Then, by the same reasoning used to construct the curve π_2, $\pi_1^*/p_1 = \pi_2^*/p_2$. In this case, (10) implies that $\delta/\hat{\delta} = 1$, so that the elasticities of the true and estimated demand curves coincide.

Next, suppose that $\hat{\delta} > -1$, i.e., the estimated curve D' is less than unit elastic. Then it follows that $\pi_1^*/p_1 > \pi_2^*/p_2$.[17] By (10), $\delta/\hat{\delta} < 1$, that is, $\delta > \hat{\delta}$. Thus, the estimated demand curve is *more* elastic than the true one. By contrast, if $\hat{\delta} < -1$, similar reasoning shows that $\delta < \hat{\delta}$, so that the estimated demand curve is *less* elastic than the true one.[18]

In short, ignoring the effect of distortionary taxation in estimating demand curves for local public goods biases the elasticity estimate toward unity, under the assumptions we have made for the purposes of this illustration.

The next section of the paper will discuss the problem of unbiased estimation of the demand curve in more detail. Before proceeding with that discussion, it is worthwhile to explain briefly the potential importance of the bias that we have identified for practical applications. For some purposes, no doubt, the demand curve that would be estimated by the usual methods, such as D' in fig. 1, would be quite suitable for application. From the way that fig. 1 itself has been constructed, it is evident that D' could serve adequately for predicting the response of a local government to a change in the matching grant rate that it faces. Thus, although the estimated and true demand curves might not coincide, the estimated curve might still be very useful.

On the other hand, the demand curve D' is really a sort of reduced-form relationship between unadjusted prices p_1. p_2, etc., and the level of public expenditure. It reflects the simultaneous operation of both demand factors per se and the distortionary effects of local taxes. In any application where a reduced form does not suffice, and one wishes to have estimates of structural parameters, the distinction could be important. To provide just one example, suppose that one is interested in the effect of a substitution of a distortionless (or less distortionary) tax for a distortionary (or more distortionary) one. In the local government context, this might correspond to increased reliance on land taxation, with less reliance on the non-land component of the local property tax. In the standard models of demand for public goods, such a change in the structure of taxation would not be predicted to change the amount of public goods desired, at least as long as all households have shares in the new tax base equal to their shares in the old one. No voter's marginal tax-price for the public good would change as a result of such a tax

[17]To see this, imagine drawing a rectangular hyperbola through E'. This will intersect the horizontal line at p_2 to the right of e' if $\hat{\delta} > -1$. At that point, π_2 exceeds p_2 in the proportion π_1^*/p_1. Since π_2 is increasing in z_2, this proportion must exceed that at e'.

[18]The reader may find it instructive to verify this by drawing the diagram for the case where D^* is infinitely elastic.

substitution, and so there would be no change in the amount of the public good being provided. In fact, however, this tax substitution does lower the effective price of local public goods, and, if one could estimate the true demand curve D^*, it would be possible to predict this increase. Moreover, the increase in the level of public expenditure would result in a welfare gain to at least some of the residents of the locality. To put it more accurately, the change in the real income of any household resulting from the change in the level of public expenditure would be approximately equal to the excess of that household's marginal benefit from the public good over its share of the marginal cost times the change in the level of public expenditure. In the usual models, the median voter would have a zero first-order welfare gain from this source, because its marginal benefit from the public good is equal to its tax price. Here, however, if π_m is the median voter's effective tax-price in the presence of tax distortions and if p_m is that voter's share of the tax base (assumed the same, for simplicity, both before and after the tax substitution), a unit increase in the level of public good provision would generate a real income increase equal to $\pi_i - p_i$. This voter's gain from the tax substitution would thus be $\pi_i - p_i$ times the change Δz_i in the level of public expenditure. Such magnitudes cannot be determined accurately without unbiased estimation of the true demand curve D^*.

With this motivation, let us now turn to the problem of trying to see how important the bias from ignoring the effects of distortionary taxes might be, and how one might correct for it.

5. Quantifying the errors

In the context of a simple example, the preceding section has shown that demand parameters estimated from models which implicitly assume distortionless taxes may be biased. However, the example is limited because of several restrictive assumptions. Also, it provides no insight into the probable empirical magnitude of the errors in the estimates. The objective of this section is to show how the approximate values of the true demand parameters might be obtained from estimated ones.

To make the exercise both tractable and consistent with reasonable empirical specifications, let us assume a particular functional form for the housing demand function, namely that housing demand is proportional to income and is a constant-elasticity function of price, thus:[19]

$$x_{ih} = c(1+\tau_i)^{\varepsilon} Y_{ih}, \tag{11}$$

[19]In applications, some such restrictions will be necessary to make the effective price functions π_i sufficiently well-behaved. A unit income elasticity is not a bad approximation.

where $\varepsilon \leqq 0$ is the demand elasticity.

Under this assumption, the government budget constraint (4) can be written as

$$z_i = \tau_i(1+\tau_i)^{\varepsilon} c Y_i (1-g_i)^{-1}, \tag{12}$$

where Y_i is the total income in locality i, $Y_i = \sum_h Y_{ih}$. If we continue to assume a constant-elasticity demand function for local public goods, as in (1), then

$$z_i = b\pi_i(z_i)^{\delta} Y_{im}^{\gamma} e_i, \tag{13}$$

where

$$\pi_i(z_i) = \frac{x_{im}}{X_i}(1-g_i)\left(1+\frac{\tau_i \varepsilon}{1+\tau_i}\right)^{-1}, \tag{14}$$

as in (7').

The system (12) and (13) is non-linear. However, suppose one linearizes it. First, take logs on both sides of (13) and (14) and differentiate:

$$\begin{aligned} \mathrm{d}\log z_i &= \delta\,\mathrm{d}\log\left(\frac{x_{im}}{X_i}\right) + \delta\,\mathrm{d}\log(1-g_i) - \delta\,\mathrm{d}\log\left(1+\frac{\tau_i}{1+\tau_i}\varepsilon\right) \\ &\quad + \gamma\,\mathrm{d}\log Y_{im} + \mathrm{d}\log e_i \\ &= \delta\,\mathrm{d}\log\left(\frac{Y_{im}}{Y_i}\right) + \delta\,\mathrm{d}\log(1-g_i) - \frac{\delta\varepsilon}{1+\tau_i+\tau_i\varepsilon}\,\mathrm{d}\log(1+\tau_i) \\ &\quad + \gamma\,\mathrm{d}\log Y_{im} + \mathrm{d}\log e_i. \end{aligned} \tag{15}$$

Now differentiate (12) to get

$$\mathrm{d}\log z_i = \frac{1+\tau_i+\tau_i\varepsilon}{\tau_i}\,\mathrm{d}\log(1+\tau_i) + \mathrm{d}\log Y_i - \mathrm{d}\log(1-g_i). \tag{16}$$

Solving (16) for $\mathrm{d}\log(1+\tau_i)$, substituting into (15), and rearranging, one obtains

$$\mathrm{d}\log z_i = \frac{\delta-\rho_i}{1+\rho_i}\,\mathrm{d}\log\left[\left(\frac{x_{im}}{X_i}\right)(1-g_i)\right] + \frac{\gamma+\rho_i}{1+\rho_i}\,\mathrm{d}\log Y_{im} + \frac{\mathrm{d}\log e_i}{1+\rho_i}, \tag{17}$$

where

$$\rho_i = \frac{\tau_i \delta \varepsilon}{(1+\tau_i+\tau_i\varepsilon)^2} \gtreqless 0. \tag{18}$$

Estimation of the linearized version of the model, (17), will yield parameter estimates, $\hat{\delta}$ and $\hat{\gamma}$, say, for the price ($\mathrm{d}\log(x_{im}/X_i)(1-g_i) = \mathrm{d}\log p_i$) and income ($\mathrm{d}\log Y_{im}$) terms. If the demand for housing has a zero own-price elasticity, so that $\varepsilon = 0$, then $\rho_i = 0$. In this case, which is the case implicitly assumed in the literature, $\hat{\delta}$ and $\hat{\gamma}$ are unbiased estimates of δ and γ, respectively. More generally, however, (17) implies that the following relationships hold:

$$\delta = \frac{\hat{\delta}(1+\tau_i+\tau_i\varepsilon)^2}{(1+\tau_i+\tau_i\varepsilon)^2 - \tau_i\varepsilon(1+\hat{\delta})}, \tag{19a}$$

$$\gamma = \hat{\gamma} + (\hat{\gamma}-1)\rho_i. \tag{19b}$$

From (19a), one can see that $|\hat{\delta}|$ will underestimate $|\delta|$ if $|\hat{\delta}| > 1$, whereas $|\delta|$ will be overestimated if $|\hat{\delta}| < 1$. In short, $\hat{\delta}$ biases the estimate of $|\delta|$ *toward* 1. From (19b), the use of $\hat{\gamma}$ as an estimate of γ results in upward bias if $\hat{\gamma} > 1$ and downward bias if $\hat{\gamma} < 1$, i.e., $\hat{\gamma}$ is biased *away from* 1.

This analysis confirms the results obtained in section 4 on the relationship of δ and $\hat{\delta}$. It is, however, more general since it shows that this relationship holds even when jurisdictions differ in terms of parameters other than their matching grant rates. Of course, it also shows that the presence of distortionary taxes leads to biased estimates of the income elasticity of demand for local public goods. But the analysis is perhaps most useful because it provides a quantifiable link[20] between the estimated and true demand parameters. Given estimates of the tax rate τ_i and the elasticity of demand for housing ε, eqs. (19) provide an algorithm for estimating the true demand parameters (δ, γ) from estimates drawn from the usual models, even though they are based on the assumption that local taxation is distortionless. The rest of this section, therefore, exploits eqs. (19) to obtain some notion of the order of magnitude of the errors in parameter estimates that arise in the presence of distortionary taxes.

To do this, let us consider a range of values for the critical parameters. For the property tax rate on housing, τ_i, a somewhat higher than average value would be 0.2, corresponding to a tax of 20% on the imputed annual

[20]Conditional, of course, on the linearization of (12) and (13).

Table 1[a]

Estimated price and income elasticities		Corrected price and income elasticities			
		$\tau=0.2$		$\tau=0.4$	
$\hat{\delta}$	$\hat{\gamma}$	δ	γ	δ	γ
−0.2	0.5	−0.19	0.50	−0.19	0.49
	0.8		0.80		0.79
	1.2		1.20		1.20
−0.5	0.5	−0.49	0.49	−0.48	0.47
	0.8		0.79		0.79
	1.2		1.20		1.21

[a]*Source*: Author's calculations, as explained in text.
All calculations assume price elasticity of demand for housing of $\varepsilon=-0.3$.

rental value of housing, while 0.4 would be a quite high value.[21] (The reader will be able to see easily from table 1 that lower tax rates would lead to negligible errors in parameter estimates, so we needn't present such cases explicitly.) A relatively low estimate of the demand elasticity ε would be -0.3, while -1.0 would be a relatively high value for this parameter. The estimates of the price and income elasticities of demand for local public goods, $\hat{\delta}$ and $\hat{\gamma}$, vary substantially in the literature. For many public services, the interval $(-0.2, -0.5)$ would bracket typical values for the price elasticity of demand. For the income elasticity, estimates for most public services would fall in the 0.5–0.8 range, but values as high as 1.3 might be observed in some cases.[22]

[21]The 1982 *Census of Governments* [U.S. Department of Commerce (1984, table 5)] reports a median effective property tax rate of 1.09% for all categories of property for selected localities. In some major cities, the rate is quite a bit higher – 1.73% in New York City, 1.97% in Baltimore, 4.1% in Detroit. These rates have fallen over time. For example, the median rate was 1.85% in 1967 [U.S. Department of Commerce (1968, p. 15)]. If annual rents are about 10% of property value, property tax rates of 1.09%, 1.85%, and 4.1% would increase the effective price of housing by 10.9%, 18.5%, and 41.0%, respectively. Thus, $\tau=0.2$ is somewhat high relative to current tax rates, but more typical for the rates prevailing some years ago, and $\tau=0.4$ is quite high. Since some of the empirical studies of demand for local public goods use older data, a value for τ of 0.2 may be more appropriate for our purposes than a lower effective tax rate representative of more recent experience.

[22]For the demand elasticity for housing, there is a wide range of values reported in the literature. See, e.g., Mayo (1981) for a survey. $\varepsilon=-0.3$ is probably on the low side, $\varepsilon=-1.0$ is probably a bit high. For estimates of the demand elasticities for local public goods, the results reported in Bergstrom and Goodman (1973) and Inman (1978) are representative. Rubinfeld (1987, p. 608) writes 'Income elasticities vary from about 0.4 to 1.3 but most are substantially less than 1. Price elasticity estimates are generally very low, in the range -0.2 to -0.4'. The values of $\hat{\delta}$ and $\hat{\gamma}$ used in the present calculations, except for the value of 1.2 for the income elasticity, are typical of the values found for most public services. All of the parameter values used in the calculations here could arguably be raised or lowered to make them more appropriate for certain applications, and the results here simply provide a few illustrations. Using eqs. (19), the reader will have no difficulty exploring what happens more generally.

Table 2[a]

Estimated price and income elasticities		Corrected price and Income elasticities			
		$\tau = 0.2$		$\tau = 0.4$	
$\hat{\delta}$	$\hat{\gamma}$	δ	γ	δ	γ
−0.2	0.5	−0.17	0.48	−0.15	0.47
	0.8		0.79		0.79
	1.2		1.21		1.21
−0.5	0.5	−0.45	0.45	−0.42	0.42
	0.8		0.78		0.77
	1.2		1.22		1.23

[a]*Source*: Author's calculations, as explained in text.
All calculations assume price elasticity of demand for housing of $\varepsilon = -1.0$.

Using the above values for the key parameters, we obtain 24 possible cases. Tables 1 and 2 present the results for the cases $\varepsilon = -0.3$ and $\varepsilon = -1.0$, respectively. It is clear from table 1 that with low tax rates and a low demand elasticity for housing, estimates of price and income elasticities for public goods are hardly affected by tax distortions. Even with a fairly high tax rate, the last two columns show errors in the parameter estimates on the order of only 5%, which is not very significant. In table 2, where the demand elasticity for housing is much higher, the errors are more noticeable. With a low tax rate, the price elasticity is underestimated by 10–15%. The income elasticity is still not affected very much – the largest error being 10% when $\hat{\delta}$ is high and $\hat{\gamma}$ is low. When both the demand elasticity for housing and the tax rate are high, the errors of course are at their largest, as shown in the last two columns of table 2. The price elasticity of demand for public goods is underestimated by 16–25%, which is non-trivial. Even here, however, the income elasticities are not biased very much. The largest error is still only 16%.

Thus, we may conclude that the neglect of tax distortions is not likely to cause very large errors in the estimation of income elasticities under a wide range of parameter values. Perhaps this is not surprising, since the error arises from a misspecification of a price variable, which would not be expected a priori to have much effect on an estimated income elasticity. On the other hand, the errors in the estimation of the price elasticity range from negligible to rather large, depending on the magnitude of the tax distortions. These errors might be of some importance in applications, particularly when one is considering high-tax jurisdictions.

6. Conclusion

The analysis in this paper has shown that tax distortions can lead to

errors, sometimes of substantial magnitude, in the estimation of demand functions for public goods. With a demand function specification of the usual log-linear type, the price elasticity of demand for the public good is biased *toward* one, while the income elasticity is biased *away from* one. The error in the income elasticity is, however, not likely to be very large. On the other hand, when the tax base is relatively elastic and when tax rates are relatively high, the error in the estimated demand elasticity can be more substantial. An estimated elasticity of -0.2 might correspond to a true elasticity of as low as -0.15, for example. Depending on the tax and jurisdiction in question, one might find examples where the error in the estimated elasticity is even larger.

Correct estimation of demand for local public goods in general, and accounting properly for the presence of distortionary taxation in particular, is important for several reasons. At the most basic level, many policy analysts wish to predict accurately how lower-level governments will respond to changes in the environment in which they operate. Many of these governments obtain a large share of their revenue in the form of transfers from higher level governments and it is always of interest to know how the recipients will respond to different sorts of higher-level government policy.

To illustrate, let us consider a problem that has been analyzed extensively in the literature, namely determining the impact on spending and welfare of a lump-sum transfer to a lower-level government. In a world of distortionless taxes, such a transfer is just like income and ought to affect demand and welfare accordingly. In a world of distortionary taxes such as we have been discussing here, however, matters are different. As observed by Hamilton (1986), a lump-sum transfer will ease the recipient government's reliance on distortionary taxation, and that will have a relative price effect on the demand for public goods. As Hamilton notes, this can provide a partial explanation for the celebrated 'flypaper' anomaly, that is, the empirical finding that lump-sum grants stimulate public expenditures by recipient governments more than equal increases in income. Here is a case where failure to take local tax distortions into account can lead to significant error.[23]

Allowing for distortionary taxation is also important for the normative analysis of grant policy, as discussed in detail in Wildasin (1984b). The transfer of resources to a jurisdiction in which local tax distortions are severe at the margin can be of substantially greater value than would be the case if there were no distortions. Indeed, this is one way that lump-sum intergovernmental transfers can achieve net welfare gains in addition to their pure

[23]The same point is made in Wildasin (1987c) with respect to the effect of tax exporting on demand for local public goods. The ability to export taxes, even if this results only in a lump-sum revenue transfer to a locality from non-residents, will still lower reliance on distortionary local taxes and produce a relative price effect favoring higher local public spending.

redistributive effects. Part of the net benefit of such a resource transfer is that the part of it which is spent on providing additional public services will yield a high welfare return because the tax distortions raise the marginal benefit of local public expenditure above $1. This benefit cannot be properly understood if one confines oneself to a model in which tax distortions are ignored.

Of course, the extent to which tax distortions are empirically important for any particular level of government is open to discussion. They would be unimportant if the demands or supplies of taxed commodities were fixed. In the specific context of property taxation, there is currently some debate over this matter. In particular, Hamilton (1975, 1983) has argued that zoning policy imposes severe quantity constraints on housing that, among other things, would obviate the distortions that are the focus of the present analysis. This view is contested by other writers, however, e.g., Zodrow and Mieszkowski (1983). Obviously, the resolution of this issue is important in determining the potential applicability of the results of the present analysis to local governments in the U.S.[24] The debate about zoning and property taxation itself underlines the need to allow explicitly for the potential distorting effects of taxes and for the impact of these distortions on the demand for local public goods.

Indeed, whether or not zoning in current practice effectively eliminates property tax distortions, it is interesting to compare the hypothetical extreme cases where zoning is irrelevant and where it is fully effective. Imagine a world in which zoning initially either is non-existent or ineffectual, and suppose that one wishes to consider the implications of the introduction or improvement of zoning procedures. If one could ignore distortionary taxation, a move from an unzoned to a zoned equilibrium would not necessarily affect any voter's tax share and hence this shift would not change the demand for local public goods. If instead one acknowledges the presence of the initial tax distortions, a move to zoning, by eliminating the marginal excess burden from local taxation, would lower the marginal tax price for voters throughout the jurisdiction, which ought to increase the demand for local public goods.

Let us close by recalling that the discussion in this paper has been presented within the framework of a median voter model of the standard type. As noted earlier, the analysis and conclusions carry over directly to the micro-data environment which has been used in so much recent work. In broad terms at least, if not in detail, they are also applicable to other models of local government decision-making that have been investigated. To take one well-known example, Romer and Rosenthal (1978, 1979) depart from the median voter model by assuming that self-interested budget-maximizing

[24]Note that in certain applications, such as in the analysis of public expenditure demands by states (which use income or sales rather than property taxes), the zoning issue does not arise at all or is substantially less important.

bureaucrats control the political agenda. Their model, like the usual median voter models, abstracts from tax distortions. However, such distortions would not be irrelevant to the voters in a Romer–Rosenthal world. Tax distortions, much like an increase in the unit cost of public goods, tend to depress not only the ideal points of all voters, but their entire preference schedules, thus presumably constraining a Romer–Rosenthal budget maximizer more effectively. This echoes the ideas found in Brennan and Buchanan (1980), among others, that distortionary taxation may serve as a brake on excessive government spending. It is quite clear that tax distortions are crucial ingredients in such arguments.

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