

Slack Cost and the Demand Function for Local Public Goods*

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1. Introduction

Since Borcharding and Deacon (1972) and Bergstrom and Goodman (1973) estimated the demand function for local public goods in conjunction with testing the median voter hypothesis, a number of analyses and applications have appeared. These analyses not only have generally supported the plausibility of the median voter model, but also have shown interesting estimation results about the parameters concerning a demand function¹⁾.

While these analyses have some common estimation results to a certain extent, the problems and limits of these analytical methods have also been pointed out and the arguments concerning the interpretation of the parameters estimated have been taken place²⁾. For instance following arguments have been presented. The first is about the correspondence between actual decision making processes and the median voter model, the second is about the consistency between the median voter model and an econometric specification, and the third is about the

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- 1) We can already see some papers intending a survey for those early literature in 1970's. See for example Gramlich (1977), Inman (1979), and Romer & Rosenthal (1979).
- 2) About the empirical results in this area, Oates (1986) pointed out the following four main findings and examined how reliable those results are. (1) The demands for local public goods are highly price inelastic. (2) The typical estimates for income elasticities of demand are low and below unity. (3) The estimation of a congestion parameter is near or almost at unity, which indicates local public goods as "quasi private goods." (4) Residents dwelling in rental units demand higher levels of public goods than do owner-occupants. He concluded that the findings (1) and (4) are relatively reliable.

correspondence between an econometric specification and the actual data used for estimation, which are generally given with the form of aggregation. About a part of these points, some modifications have been attempted.

In addition, the estimation results about a congestion parameter have attracted much attention concerning its plausibility and interpretation, since almost all analyses have shown that the extent of congestion of local public goods is similar to that of private goods and thus have given the negative impression to 'publicness' of publicly provided goods. There are several explanations for this negative impression.

On the other hand, the analysis of supply agents of public goods since Niskanen's public bureau model has also raised another question about the median voter model. It is because that the model of a median voter type focuses only on the demand side for provision of public goods, whereas the mechanism of a supply side is neglected. In those supply side analyses, however, it has been hypothesized that firstly a public bureau pursues its own objective (for instance budget maximization or discretionary budget maximization), secondly the restrictions to property rights owned by a public sector can affect the productive efficiency of that sector, and thirdly the competitive environment surrounding local governments can also affect the productive efficiency of that sector. In part, empirical analyses of these hypotheses have been attempted. In recent years, some attempts to combine such supply side hypotheses with the demand analysis of a median voter type also have appeared.

The purpose of this paper is also to examine how the interpretation of the previous estimation results in these literature is modified by an additional viewpoint about the supply side of public goods. We could say that usual analyses implicitly assume that supply agents of public goods perform cost minimization (or productive efficiency) and all public expenditure is appropriated for supplying public goods. Here we are concerned with how the parameters estimated in the demand function for local public goods are biased in the case where supply agents have productive inefficiency or in the case where wasteful public expenditure is included within a budget.

2. Slack Cost and the Effect on An Empirical Estimation of Public Goods Demand

Since Niskanen's public bureau model, the analyses of the supply side of public goods have argued that supply agents don't necessarily minimize their production cost. The hypotheses that a public sector not only engages in providing public goods as a faithful agent, but also seeks his or her own purposes, have been asserted. Once Williamson (1964) and Leibenstein (1966) indicated that public agents or bureaucratic organizations contain organizational slack or X-inefficiency within their productive activities. Migue and Belanger (1974) pointed out that a public bureau seeks to extend its discretionary budget in conjunction with providing public goods. These arguments have suggested that the restriction to property rights of public sectors, the competitive environment between private and public sectors, and the competitive environment among local jurisdictions could influence the organizational performance and thus the productive efficiency of public sectors.

Thus, these arguments imply that the productive activity of a public sector could involve productive inefficiency³⁾ and the total of public expenditure might not always be appropriated for provision of public goods. Put another way, actual data of public expenditure might include wasteful cost from the viewpoint of efficient provision of public goods. We shall call such cost as the slack cost here. In case where slack cost is contained within public expenditure, we shall examine the problems involved in the empirical analysis of demand for local public goods.

The most typical model in this area is the median voter model. This model needs a lot of assumptions to apply to an empirical estimation. We shall explain the standard form for estimating the demand function for local public goods using the median voter model according to Borchering and Deacon (1972), Bergstrom and Goodman (1973), and Oates (1986). We shall introduce the assumptions

3) It is said that there are two aspects about the productive efficiency of public sectors. One is the problem concerning about whether the effort by an organization or an individual for productive activity is maximized. This aspect is related to the concept of X-inefficiency. The other is the problem concerning about whether the optimal combination of production factors is selected. On this point, we can see both hypotheses that a public sector prefers either capital intensive or labor intensive mix.

necessary for an empirical estimation by turns⁴⁾. In this process, we shall consider our concerns, namely the productive inefficiency of public agents.

Before explaining the empirical model, let us note our notations as follows.

- x : private goods (or post-tax income) consumed by median voter
- g : the level of public goods actually consumed by median voter
- G : the level of public goods output to a community as a whole
- P : the minimized cost for a unit of public goods output (G)
- P^* : the actual cost for a unit of public goods output (G)
- y : median voter's income level
- t : median voter's tax share
- E : the level of public expenditure for provision of public goods
- N : population size of a community
- Z : a vector variable expressing regional characteristics
- s : the slack indicator of a supply agent

In the literature above mentioned, the following relationship is usually added to specify the congestion parameter of local public goods.

$$g = G N^{-\delta} \quad (1)$$

where the level of consumption (g) enjoyed by an individual (median voter) and the level of public goods output (G) to a community are distinguished, and thus the congestion parameter (δ), which is sometimes called the 'publicness' parameter, combines both variables; g and G . Depending on the value of δ ($0 < \delta < 1$), this publicly provided goods corresponds to a point on the continuum between pure public goods ($\delta=0$) and pure private goods ($\delta=1$).

Furthermore, according to our concerns, we shall distinguish two unit costs (P and P^*) for public goods output (G). That is to say, P means the unit cost or the constant marginal cost for public goods output, based on cost minimization by supply agents, and P^* means the unit cost actually spent for provision of public

4) In applying the median voter model to an empirical analysis, for convenience a number of assumptions are needed. Crucial assumptions are as follows. First, the constancy of the marginal cost for provision of public goods is supposed. Second, a tax share for each individual is given. This assumption is important to assure the single-peaked preference for each individual and thus the median voter equilibrium. Third, it is supposed that a median voter has median income of each region. This assumption is crucial to pick a median voter up from aggregation data for each region. Fourth, the form of a demand function is generally supposed to be a log-linear. Notice that we properly need more assumptions other than these.

goods, which consists of the minimized unit cost (P) plus the slack cost owing to the productive inefficiency of a supply agent.

By introducing the slack indicator (s), which corresponds to the slack cost for a unit of public goods output, we assume that both unit costs are related as follows ;

$$P^* = sP \quad (s \geq 1) \quad (2)$$

As the slack indicator becomes larger, the productive inefficiency of supply agents becomes larger. When s equals one, then supply agents behave to minimize their production cost. From these notations, actual public expenditure (E) is expressed as

$$E = P^*G = sPG \quad (3)$$

and then slack cost is expressed as

$$\text{slack cost} = E - PG = (s-1)PG = (1-1/s)E. \quad (4)$$

In the standard model of public goods demand, a median voter as a representative individual is supposed to maximize his or her utility subject to his or her individual budget constraint. Then usually the supply side of public goods is assumed to behave in an efficient manner, even if productive inefficiency might actually exist. In other words, it might mean that individuals don't notice the slack cost of a public sector. Thus we could say that the standard model assumes that individuals recognize the unit cost of public goods output as P and are confronted with the minimized production cost for public goods.

Let us describe such situation for a median individual. Using the notations above and equation (1), the budget constraint can be written as follows ;

$$y = x + tPG = x + tPN^{\delta}g \quad (5)$$

Namely, we can see that a median voter recognizes his or her tax price for a unit of G as tP and that for a unit of g as tPN^{δ} . Therefore the private demand (g) for consumption of public goods by a median voter is expressed as follows, provided that a log-linear form is assumed as usual.

$$g = a(tPN^{\delta})^{\alpha}y^{\beta}Z^{\gamma} \quad (6)$$

where a is a constant term and α is the price and β is the income elasticities.

However, since the privately consumed level (g) of public goods can not ac-

tually be observed, some arrangement is needed to develop this demand function (6) to a regression equation for estimation using actual data. Substituting equation (1) for g on the left hand side of equation (6), and multiplying both sides by an actual unit price (P^*), we get P^*G , namely public expenditure (E) which can be observed from actual data, on the left hand side.

$$E = P^*G = at^a P^a N^{\delta(1+\alpha)} y^\beta Z^\gamma = at^a s P^{1+\alpha} N^{\delta(1+\alpha)} y^\beta Z^\gamma \quad (7)$$

Rewriting equation (7) in the form of estimation, we obtain the following one, provided that a random disturbance term is shown by u ;

$$\ln E = \ln a + \alpha \ln t + (1+\alpha) \ln P + \delta(1+\alpha) \ln N + \beta \ln y + \gamma \ln Z + \ln s + u \quad (8)$$

$$\ln E = \ln a + \alpha \ln t + (1+\alpha) \ln P^* + \delta(1+\alpha) \ln N + \beta \ln y + \gamma \ln Z - \alpha \ln s + u \quad (9)$$

Equations (8) and (9) are the standard forms used for estimation, except that they include the slack indicator term ($\ln s$) as one of explanatory variables. In case of the median voter model, a median income (y) and a tax price (t) corresponding to a median voter are applied. Notice here that as the unit price of public goods (P or P^*) is usually difficult to observe, some assumption for simplicity must be added. The easiest way is to suppose that P or P^* is constant across regions and to combine this variable with a constant term. Otherwise, in a model which includes the production function for public goods, a factor price affecting the unit cost for public goods is used for P . For instance the wage rate of a public sector could be used as a proxy of P^5). Anyway we get the demand related and congestion parameters from the reduced form parameters estimated from these regression equations.

However, our regression equations (8) and (9) are different from the standard specification at one point. Equations (8) and (9) include the slack indicator term ($\ln s$) as an explanatory variable. Put another way, in our model setting, if that term ($\ln s$) is excluded from the right hand side, then we need to revise the dependent variable ($\ln E$) to $\ln(E/s)$ or $\ln(s^\alpha E)$, where α is the price elasticity as a negative value. That is to say, we must either subtract slack cost from total public expenditure or include the slack indicator variable among explanatory variables. Otherwise we could not obtain the true parameters concerning a demand function and congestion relation. When public expenditure as a dependent variable contains slack cost and the slack indicator term is not included among ex-

5) See for example Borcharding and Deacon (1972).

planatory variables, we can't help seeing that every reduced form parameter estimated is biased upward.

Referring to the general results about empirical analyses noted by Oates (1986) (see footnote 2), we could indicate the following points from our model; if public expenditure contains slack cost inside, then (1) income elasticity might actually be smaller, (2) price elasticity might actually be larger in absolute value, and (3) a congestion parameter has either upward or downward bias, depending on which value is more biased upward—the reduced form parameter of population or the price elasticity parameter.

As a way of removing these biases implied above, we could design the following modification. The easiest way is to take some proxy variable representing the slack indicator into consideration in equations (8) or (9). In fact we point out several empirical analyses attempting this way of modification. Deacon (1979) estimated the demand function of a median voter type adding the dummy variable, which is applied the value of zero to the cities where public services are directly provided by a local government and the value of one to the cities where public services are provided by a private agent⁶⁾. We can understand that this additional variable intends to identify the hypothesis that the productive efficiency of public provision of public goods is different from that of private provision and the former produces more slack cost than the latter. We could also say that this analysis belongs to the 'comparative efficiency approach', about which a number of literature intending to analyze the productivity of public sectors are recognized⁷⁾.

Megdal (1983) also employed a similar approach using a dummy variable. In the framework of public goods demand, he tested the hypothesis that the levels of public expenditure are different between the cities with referendum system and the cities without this system. That is to say, he believed that referendum system could work as a check to the productive inefficient behavior in a public sector. Thus, in the case where the comparative efficiency viewpoint can be applied, as the simplest method, we could make use of some dummy variable as a proxy for

6) Adjusting to our model setting here, we may attach the value of one to this dummy variable in case of public provision of public goods. Further it is interesting to note that Deacon (1979) showed much smaller congestion parameters than other similar analyses.

7) About the analyses of comparative efficiency between public provision and private provision, see for example the survey by Borchering, Pommerehne, and Schneider (1982).

the slack indicator, which could reduce the biases exerted to other parameters estimated.

Similarly, we could design the way of transposing a proxy in behalf of the slack indicator to the left hand side and revising public expenditure data itself as a dependent variable. However in this case, it is necessary to find a different value to each jurisdiction and a continuous variable (not a dummy variable), and so this approach seems more difficult. For example, if regular and positive correlation might come into existence between a share of personnel expenditure to total public expenditure and the slack indicator, it might be possible to use these shares as a modification value. Nevertheless it is basically same to take the slack indicator into consideration in the left hand side and in the right hand side.

3. The Monopolistic Power of Local Public Agents Correlated with City Size

In recent literature focusing on the supply side of public goods, one characteristic is to regard the public sector as a monopolistic supply agent. Borchering, Bush and Spann (1977) advanced that the monopolistic power of a public bureau is positively correlated with a city (or jurisdiction) size. This means that when a government size tends to extend with a city size, as the scale of a local government becomes larger and larger, then the monopolistic power of that government is also growing larger and larger. As a result, such governments can pursue their behavioral purposes more easily in larger cities⁸⁾.

Here in our model setting, supposing that the slack indicator (s) has correlation with the population size (N) of a city, we shall proceed to examine how the estimation result of a demand function for public goods is affected by this modification. That is to say, we consider that as the scale of a public sector becomes larger, either supply agents could get their discretionary budget more easily or X -

8) Recently the correlation between a jurisdiction size and a budget size through the monopolistic power of a public bureau has attracted much interest in empirical analyses. Among them, Nellor (1984) explained this hypothesis as follows; As a group size for decision making grows larger, the effect of one individual's behavior on a total decision would decrease, and as a result people selecting 'rational ignorance' increase. Or as a city size grows larger, the moving cost to another city rises up. As a result, local governments would not have to worry about residents escaping from their cities. Thus the monopolistic power owned by a local government or a public bureau enlarges with a jurisdiction size.

inefficiency of a public organization would spread, and thus the share of wasteful expenditure to total public expenditure would enlarge.

Now let us assume the slack indicator function; $s=s(N)$. To simply deduce the effect of this function on the demand function according to our model setting, we shall specify the relationship between the slack indicator (s) and a city population size (N) as follows;

$$s=s_0N^\sigma \quad (\sigma>0) \quad (10)$$

The slack indicator increases with an increase of a population size and s_0 is the constant slack indicator across all jurisdictions. Introducing equation (10) into equations (8) or (9), and arranging to lead a regression equation, the following equations are obtained.

$$\ln E = \ln(as_0) + (1+\alpha)\ln P + \alpha \ln t + (\delta(1+\alpha) + \sigma)\ln N + \beta \ln y + \gamma \ln Z + u \quad (11)$$

$$\ln E = \ln(a/s_0^\sigma) + (1+\alpha)\ln P^* + \alpha \ln t + (\delta(1+\alpha) - \alpha\sigma)\ln N + \beta \ln y + \gamma \ln Z + u \quad (12)$$

As we can see from these equations, the parameter σ is added to the reduced form parameter about the population variable ($\ln N$). This implies that the positive correlation between population (N) and the slack indicator (s), namely a positive value of σ , has the effect of raising the reduced form parameter of population upward (notice that α has a negative value). Therefore, when the correlation between the slack indicator and a city size exists, neglecting this relation and calculating the congestion parameter (δ) using only the price elasticity (α) and the reduced form parameter of population (N) comes to include an upward bias within it⁹⁾.

Thus the hypothesis that a share of slack cost to public expenditure of a local government has correlation with a jurisdiction size could explain the high congestion parameters estimated in the previous demand analyses for local public goods. To obtain the true congestion parameter in this case, it is requisite to identify the parameter σ within the reduced form parameter of population in equations (11) or (12), though it is impossible to do that here. We must specify and estimate the

9) Wyckoff (1988) showed that the congestion parameter has a downward bias under the following assumptions; (1) Bureaus behave to maximize their discretionary budget (or the slack in our model setting). (2) Bureaucratic power has positive correlation with a city population size. (3) Individuals have an elastic demand function for public goods. It is noteworthy that his result suggests the opposite direction of a bias with our result.

separate equation expressing the supply side such as equation (10). Though we can not here present such a concrete equation for estimation, as the direction for a future analysis, it is at least implied that the demand side and the supply side concerning provision of public goods should be estimated at the same time.

4. Slack Cost of Local Public Agents and Fiscal Illusion

The arguments stated above have shown that if the supply side of public goods entails productive inefficiency and further individuals reveal their demand preferences without realizing that, adapting actual public expenditure reflecting inefficient cost to the demand function based on such individuals' behavior includes the specification bias in estimation. In this sense, this argument means that individuals have fiscal illusion with respect to the behavior of local public agents and their productive inefficiency.

In this final section, let us discuss one application and its implication from our arguments about the slack cost of public agents. When an individual notices or doesn't notice the actual unit price of public goods including slack cost, what differences will appear on the individual equilibrium of demand for public goods? Further, does such differences involve any normative implication?

If individuals notice the productive inefficiency of a supply side accurately, namely if they recognize the slack indicator (s) or the actual unit cost (P^*) of equation (2), what happens in this case? When individuals recognize P^* and reveal their demand preferences accordingly, the problems of estimation we have mentioned will not occur. Usually the empirical analyses in this area are based on the assumption that individuals don't have fiscal illusion about the information surrounding them and behave rationally. It is because that once we admit the existence of fiscal illusion in any way, the results estimated will lose any confidence and interpretation.

However, we cannot accept this premise, since it is actually uncertain whether individuals have no fiscal illusion or whether individuals grasp the information about a public sector accurately. In particular, we could say that it is very difficult for individuals to judge how faithful local public agents are in supplying local public goods.

As an argument, when there exists productive inefficiency (or slack cost) in a public sector, we shall examine how individuals change their demand behaviors, depending on noticing or not noticing this inefficiency. In figure 1, we measure

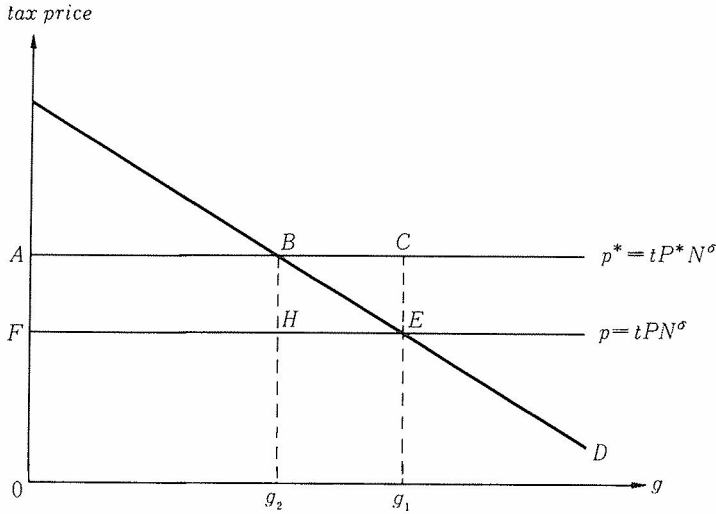


Figure 1

the amount of public goods (g) individually enjoyed on the horizontal axis and its tax price on the vertical axis. The curve D expresses the demand function for this good by an individual. The two horizontal curves (p and p^*) show the tax price or the constant marginal cost for this individual, where p reflecting the minimum unit cost (P) and p^* reflecting the actual unit cost (P^*) including slack cost.

When an individual is not aware of productive inefficiency in a public sector and takes the tax price p into consideration, he or she arrives at the individual equilibrium at point E which reveals the amount (g_1) of public goods as his or her optimal demand. However, if productive inefficiency is accurately noticed, how is his or her demand changed? Then a tax price should be p^* and an individual equilibrium is obtained at point B , and thus a demand level is revealed at g_2 . Owing to recognition of productive inefficiency, deservedly he or she will decrease the demand level for public goods from g_1 to g_2 ¹⁰.

10) Though it is certain that he or she decreases his or her demand for public goods, then we can not generally guess whether he or she decreases the demand level for budget (expenditure) necessary for providing that level of public goods as well. Explaining in figure 1, the demand for a budget changes from rectangle $OFeg_1$ to $OABg_2$. What determines an increase or decrease of a budget is the elasticity of a demand function (D). More generally speaking, that depends on the elasticity of substitution between this public goods and other goods. When the elasticity of substitution exceeds one, the demand level for budget also decreases. For instance, see the analysis using CES utility function by Lovell (1975).

What could we indicate from this argument? First of all, if admitting the existence of slack cost and supposing point B should be demanded primarily, demanding at point E means to bring about triangle BCE as deadweight loss. Expanding the amount of public goods from g_2 to g_1 produces only the benefit of g_2BEg_1 less than the cost of g_2BCg_1 . Comparing with the equilibrium as point B , this cost is an additional burden in which $BCEH$ is the slack cost.

Secondly, if not admitting the existence of slack cost and supposing point E should be demanded, the original burden comes to be rectangular $OFeg_1$ and thus the slack cost of $FACE$ means an additional and unnecessary burden (deadweight loss). This burden might be characteristically described as a transfer or gift from individuals to public agents or as exploitation of public agents by making use of fiscal illusion.

Thirdly, using total public expenditure data as a dependent variable to estimate the demand function (D) means to assume point C not point E as an individual equilibrium. Therefore, in an empirical analysis, supposing a representative individual revealing his or her demand at point E on one hand and using total public expenditure data on the other hand contain the inconsistency in estimation. As a result, as we have already mentioned, the specification error will occur and thus the parameters estimated will contain biases.

Finally, as an implication, this story might present one explanation for the recent movement to smaller governments and tax limitations. That is to say, until recently, people have trusted the efficient activity of public sectors and then have shown their preferences. However, as the information with respect to inefficient public sectors have become clearer, and as the existence of productive inefficiency or slack cost have been recognized, people may have begun to modify their preferences and to shift the demand level for public goods from g_1 to g_2 . Furthermore in this case, if people require suppression of not only the amount of public goods but also the budget needed, we might infer that such public goods have large substitutability with the goods provided in the market mechanism (see footnote 10).

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