MULTIPART PRICING OF PUBLIC GOODS

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The free market has long been regarded as inferior to other institutional devices for making resource allocational decisions involving public goods. Market failure comes about because direct bargaining regarding an output which is indivisible among users must result in explicit and unanimous agreement among these users. Such agreements, which involve multilateral bargains, may require prohibitive transactions costs. In addition, the cost of policing devices to exclude those not paying may be high. If policing and exchange costs associated with a market arrangement are too high, substitute non - market devices may be preferred even though information regarding consumer valuations, generated by a market, may be sacrificed.[1]

Other pricing devices, such as marginal benefit taxation, which do not result in prohibitive police or exchange costs, give rise to the classic "free rider" or revealed preference problem whereby individuals are induced to hide or understate their true preferences in order to improve their individual welfare while foregoing jointly available potential gains.[2]

A device is proposed herein to resolve these revealed preference and exchange - policing cost problems. The proposed system requires an assignment by society of cost responsibilities, which differs in important respects from a usual specification of cost shares, and relies on a multipart pricing procedure to elicit reliable demand information.

The assigned cost responsibilities, called *assigned* marginal prices, are specified prior to the determination of output such that the vertical sum of the individual assigned prices per unit of output is equal to the marginal cost of supply. Individuals are then given the opportunity to reveal demand schedules from which a set of *derived* marginal supply price schedules are determined, for each individual, by subtracting the total revealed demand of *all other* participants from the marginal cost of supply. Actual output is determined where the revealed demand price of each individual is equal to his derived marginal supply price. A characteristic of the proposed system is that each participant, choosing separately his desired output given his derived marginal supply price schedule, will agree on the same output.

[1]For a discussion of police and exchange costs in relation to the public goods problem, see Harold Demsetz, "The Exchange and Enforcement of Property Rights", Journ. Law and Econ. 7 (Oct. 1964), 11 - 26.

[2]This is the well - known Samuelson dilemma. See Paul Samuelson, "The Pure Theory of Public Expenditure", RE Stat 36 (November, 1954).

Each individual's contribution consists of a *fixed* charge and a *variable* charge. His fixed charge is determined on the basis of his assigned price and an *assigned* output determined where his assigned price schedule and his derived marginal supply price schedule intersect. It is also the output where the vertical sum of his assigned price schedule and the revealed demand price schedules of all others is equal to the marginal cost of supply. The fixed charge is the area under the individual's assigned price schedule up to the assigned output. Under constant cost conditions, the fixed charge is equal to his assigned price times his assigned output.

Each individual's variable charge is determined on the basis of his derived marginal supply price schedule. This charge is positive, negative, or zero depending on whether actual output, which is common to all participants, is greater than, less than or equal to the individual's assigned output. The variable charge is the sum of the incremental payments indicated by the individual's derived marginal supply price schedule between his *assigned* output and the *actual* output. If, for example, actual output is greater than an individual's assigned output, he pays a variable charge equal to the area *under* his derived marginal supply price schedule between actual and his assigned output.

The proposed system induces each participant to reveal his true demand schedule in order that his true demand price is equated with his derived marginal supply price at the actual output. In this way he maximizes benefit less his variable charge independent of the derived marginal supply price schedule he confronts. An individual cannot influence his own fixed charge by changing his demand revelation nor can he influence the demand revelations of others and thereby favorably alter his own opportunity set by revealing his demand incorrectly. Thus the proposed system eliminates the usual incentive to strategic behavior which characterizes the "free rider" problem.

The plan of the remainder of this paper is as follows: Section I considers aspects of the revealed preference problem that must be overcome in devising an optimum pricing system. In Section II the proposed pricing system is specified in detail. Section III is an analysis of a two - person public goods interaction under the proposed system. The analysis first shows how individuals behave in accordance with socially desired results under independent behavior assumptions, i.e., they treat the behavior of others as a state of nature and do not attempt to behave strategically. Then the analysis shows how the usual incentives to behave strategically are eliminated under the proposed system. Section IV considers the costs of the proposed system, including transactions and information costs.

I. THE REVEALED PREFERENCE PROBLEM

The public goods problem arises because of the incentive to individuals to understate their demand for public goods relative to other goods. In the public

goods literature there are broadly two general approaches for attempting to cope with the problem through market exchange devices. Each has important flaws. Either prohibitive transactions costs are required to arrive at an output determination that will be mutually satisfactory to all participants and/or "free rider" behavior arises that leads to suboptimal output solutions.

The "free rider" problem, as well as its resolution under the proposed system, is usefully considered with reference to alternative assumptions about individual behavior under a conventional marginal benefit taxation scheme, where government, lacking information about individual preferences, confronts each individual with a tax - price proportional to the intensity of his revealed demand at the margin.[3] Consider, first, a rather naive response of individuals to such a pricing system where each behaves independently. He treats the behavior of others as a state of nature.

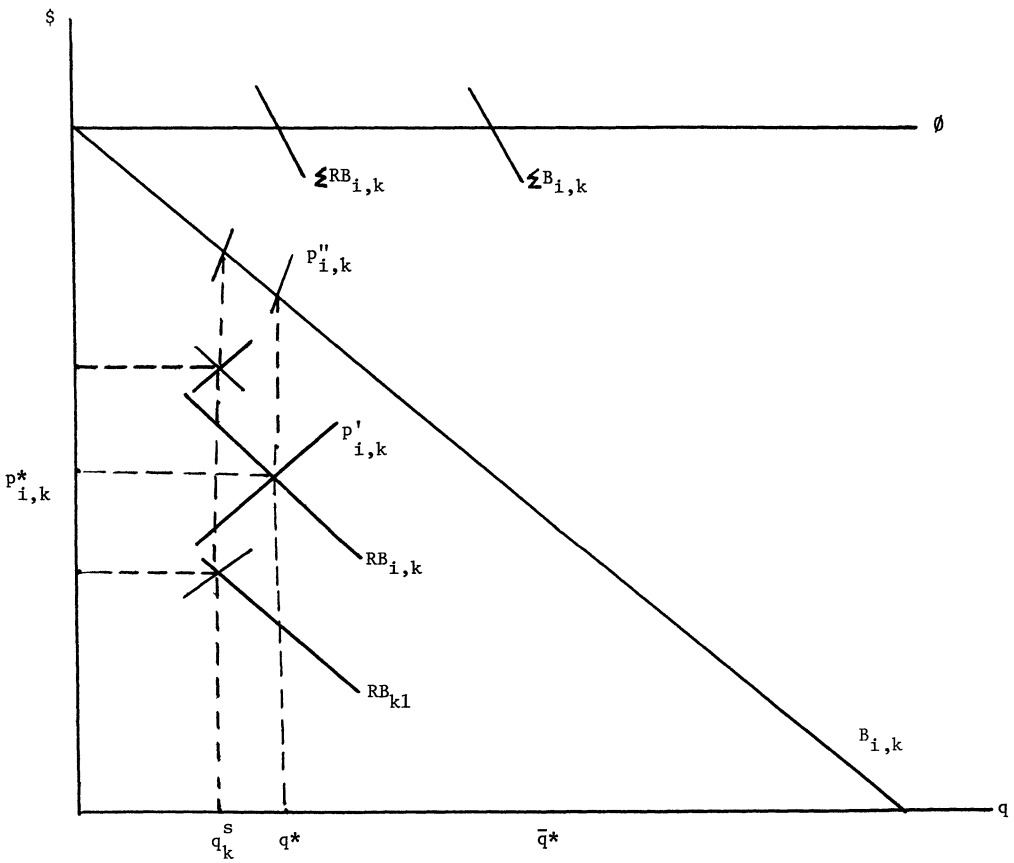
Independent Behavior

The result of independent behavior is illustrated in Figure 1. Output, q*, of a pure public good will be determined where the vertical sum of the revealed demand prices of two individuals, i and k, is equal to the marginal cost of supply, ϕ. Although these individuals have true demand price schedules B_i, B_k as shown, each seeks to reveal a demand, RB, such that his true demand price will be equal, at q*, to his marginal contribution.

Where the marginal (average) tax - price, $\bar{p}^*$, of each is proportional to his revealed demand price at the margin, each individual will regard $\bar{p}'$, a *derived* supply price schedule determined by subtracting the revealed demand of the other from the marginal cost of supply, as his own *average* price schedule. Each will, in turn, regard a schedule $p'' = d(p')/d(q)$ marginal to his *average* price schedule as his own marginal price schedule and will maximize utility at an output where his true demand price is equal to his marginal supply price ($B = p''$) and his revealed demand price is equal to his average supply price ($RB = p'$).

Even though each participant may initially be "wrong" in regarding his derived supply price schedule, p', as a given, a trial and error adjustment process will lead to a stable but suboptimal equilibrium output, q*, where each participant is "right" in regarding this derived supply price schedule as a given. The marginal benefit, B, to each will equal to his marginal contribution $p'' = d(p^*q^*)/d(q)$ where p* becomes his average tax - price per unit of actual output q*. Each participant also equates his revealed demand price with his average supply price and the vertical sum of the revealed demand prices are equal to the marginal cost of supply at this suboptimal output. Although the participants are foregoing jointly available potential gains, each finds himself in individual equilibrium.

[3]The marginal benefit taxation approach is described concisely in R. A. Musgrave, The Theory of Public Finance. New York: McGraw Hill, 1959.



KEY

Ø marginal cost of supply	$\bar{q}$* social optimum output
RB revealed demand schedule	q* actual output
B true demand schedule	q^s_k individual k's strategic optimum
p* individual tax-price	
p' derived supply price schedule, e.g., $p'_i = Ø - RB_k$	
p" = d(p')/d(q)	

FIGURE 1

The problem here is to find a pricing system which will motivate individuals to properly regard their derived supply price schedules as *marginal*, rather than *average*, price schedules so that each will equate his true demand price, B, with his derived supply price, p', at the optimum output, $\bar{q}$ *, where the vertical sum of the true demand prices is equal to the marginal cost of supply. The solution must, however, remove the incentive to strategic behavior where an individual is motivated to misreveal his demand in order to improve his own opportunity set by altering the demand revelation of his rival.

Strategic Behavior

A marginal benefit taxation system can motivate individuals to behave strategically so as to disturb a suboptimal independent adjustment equilibrium. If individual k, for example, believes that individual i will continue to behave independently, i.e., that i will treat k's behavior as a state of nature, then k can reveal a lower demand (RB_{kl} in Figure 1) than he would reveal at the independent adjustment equilibrium output and be made better off. In turn, individual k can reduce his contribution by an amount greater than the reduction in his utility deriving from a lower output. Individual i, on the other hand, pays a larger share of the cost and is made worse off. When k behaves strategically and i behaves independently, the participants will arrive at some equilibrium output such as q_k^s in Figure 1, where an even larger amount of jointly available potential gains are sacrified than under the independent adjustment equilibrium. If both individuals attempt to behave strategically, *both* may be made worse off relative to their welfare positions at the independent adjustment equilibrium. The output result, however, is indeterminate.

Revealed Preferences and Direct Bargaining

Some of the incentive to "free rider" behavior can be removed by resort to alternative market approaches. For example, government can assign supply prices to each of the participants in a public goods interaction. Given these assigned prices, each would select a quantity that equates own marginal benefit with own marginal price. But different persons may not agree on the same quantity, given any arbitrary set of prices. If they do not, then the way is opened for negotiation of modified sets of supply prices. It has been shown, in small number cases, that this negotiation process does coverge toward optimality, as instanced by agreement on the same quantity.[4]

[4]The manner in which the participants might, in the absence of strategic behavior, arrive at a Pareto optimal solution has been described in J. M. Buchanan, Demand and Supply of Public Goods. Chicago: Rand McNally, 1968.

The convergence toward optimality is hindered, of course, by strategic behavior, especially in small number cases. Each participant attempts to bluff his rivals in order to make his own supply price lower with the result that "free-rider" phenomena reemerge.

With large numbers, other difficulties arise. Unanimity, in a direct and explicit sense, of all the participants is required. In reaching the multilateral agreement, each party will have to consider his contribution in relation to each of the other parties and to all combined. In these circumstances, trades become difficult to organize and transactions costs become overwhelming, resulting in a "unanimity transactions cost trap".

II. THE PROPOSED SYSTEM

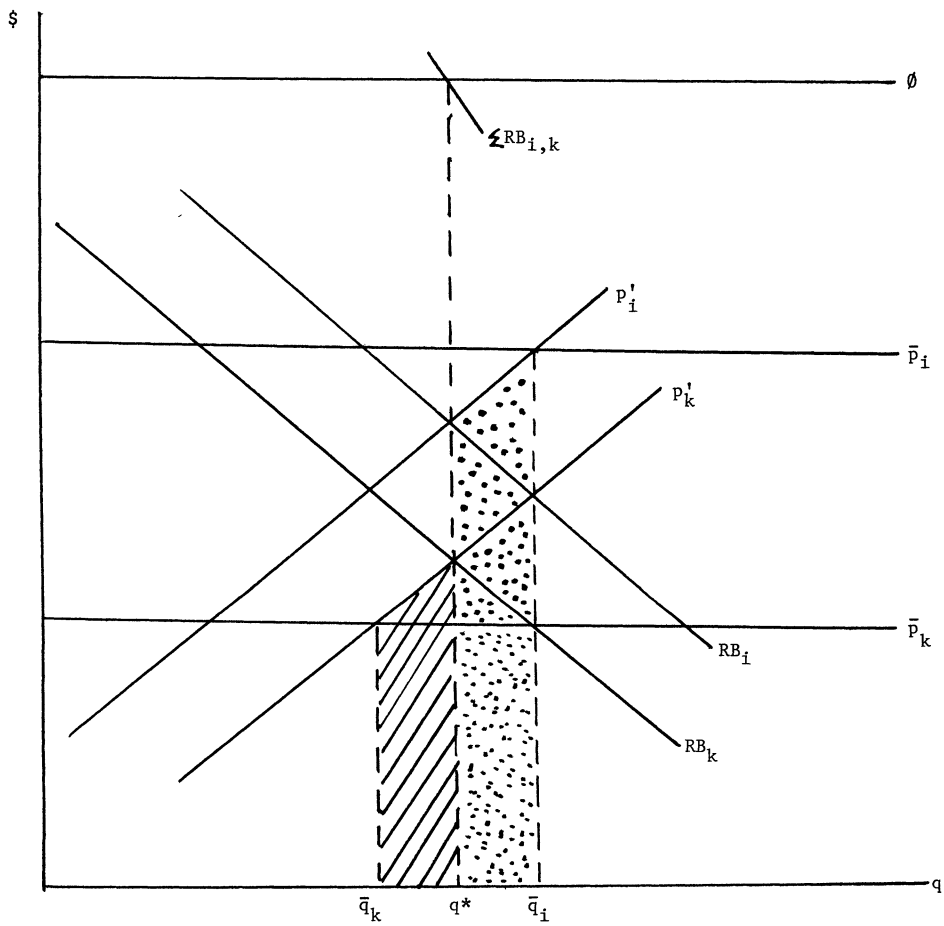
A multipart pricing system introduced below avoids the revealed preference problem and removes incentives to strategic behavior. The proposed system also avoids the problem of prohibitive transactions and information costs.

Assigned Prices

The proposed device is a two-part tariff, a prerequisite for which is an assignment by society of a set of cost responsibilities. The cost responsibilities, which might be specified for potential users by a court, are a set of *assigned* marginal price schedules. These schedules are chosen such that the (vertical) sum of the assigned marginal prices adds up to the marginal cost of supply. The price assignments may be arbitrary, subject to the adding up constraint described above, but should be specified independent of individual demand revelations.

Algebraically, $\sum_{i}^{n} p_i = \phi$ where p_i represents the assigned price schedule for the i^{th} participant, ϕ is the marginal cost of supply, and $i = 1, \ldots, n$ represents the ith participant. Figure 2 illustrates an assignment for two individuals where the verticalsum of $\bar{p}i$ (individual i's price assignment) and $\bar{p}k$ (individual k's price assignment) is equal to the marginal cost of supply per unit of output.

It is important that the assigned marginal price schedules, which do not influence the determination of output, be carefully distinguished from *derived* marginal supply prices to be described below. The *assigned* prices serve only to determine, in conjunction with the derived supply prices, each individual's *fixed* charge, also described below.



KEY

Ø	marginal cost of supply	q*	actual output
RB	revealed demand schedules	$\bar{q}$	assigned outputs
$\bar{p}$	assigned price schedules		
p'	derived marginal supply price schedules		

FIGURE 2

Derived Marginal Supply Prices

The *derived* marginal supply price schedule for each individual is a function of both the marginal cost of supply and the revealed demand of *all other* participants. The i^{th} participant's derived marginal supply price schedule is determined by subtracting the revealed demand prices of all others (the vertical sum of the revealed demand prices of all except the i^{th} participant) from the marginal cost of supply. In Figure 2 where individuals i and k are assumed to reveal demand schedules RB_i and RB_k respectively, individual i's derived marginal supply price schedule is defined as $p_i' = \phi - RB_k$. Individual k's derived marginal supply price schedule is defined as $p_k' = \phi - RB_i$.

Each individual may choose to reveal only a portion of a schedule or no revealed demand schedule. In any range of output where he does not reveal a demand schedule, his revealed marginal benefit is taken to be the same as his assigned price schedule $\bar{p}$.

Determination of Output

That output will be produced which equates the (vertical) sum of the revealed demand prices of the participants with the marginal cost of supply. In Figure 2 an actual output, q^*, is produced at that point where the vertical sum of RB_i and RB_k is equal to the marginal cost of supply, ϕ.

Given the rules for determining each individual's derived marginal supply price schedule and the output to be produced, it must be the case that the revealed demand price of each is equal to his derived marginal supply price at the actual output. A characteristic of the proposed system is that each individual, choosing separately his desired output, will agree on a common output. In Figure 2, for example, individual i's revealed demand, RB_i, must be equal to his derived supply price $p_i' = \phi - RB_k$ at the actual output, q^*. Also k's revealed demand, RB_k must be equal to $p_k' = \phi - RB_i$ at q^*. Thus any individual may, given his derived marginal supply price schedule, select the actual output, q^*, to be produced. This output will be indicated where his revealed demand price is equal to his derived marginal supply price.

Determination of Contributions

Given the assigned marginal prices and the demand revelation of the participants, their respective contributions can be determined. Each participant pays a two - part tariff, composed of a fixed charge and a variable charge.

The *fixed charge* is, under constant cost conditions, equal to an individual's assigned price, $\bar{p}$ times his assigned output, $\bar{q}$. Each individual's assigned output, which may be different from the actual output, is determined at that point at

which his assignment price, p, is equal to his derived marginal supply price, p'. It represents the output which would be produced if the individual did not reveal a demand schedule in which case his assigned price schedule and the revealed demand of all others would be vertically summed and equated with marginal cost to determine output.

Consider the determination of assigned outputs in the Figure 2 illustration. Individual i's assigned output, $\bar{q}_i$, is determined at that point where his assigned price schedule, $\bar{p}_i$ intersects his derived marginal supply price schedule, p_i'. Since $p_i' = \phi - RB_k$, $\bar{q}_i$ is also the output at which $\bar{p}_i + RB_k = \phi$. Individual k's assigned output, $\bar{q}_k$, in Figure 2 is determined where his assigned price schedule, $\bar{p}_k$, intersects his derived marginal supply price schedule p_k'. Also $\bar{p}_k + RB_i = \phi$ at $\bar{q}_k$.

The fixed charges are then equal to an individual's assigned price times his assigned output. Individual i's fixed charge equals $\bar{p}_i\bar{q}_i$ and individual k's fixed charge equals $\bar{p}_k\bar{q}_k$. This element of the contribution of each participant is fixed (to him) in that he can't alter it by changing his revealed demand. His fixed charge varies as a function of the revealed demand of others since his assigned output $\bar{q}$ is determined, in part, by the demand revelation of others.

The *variable charge* for each individual, which may be negative or positive, is equal to the sum of the incremental supply prices indicated by his derived marginal supply price schedule between his assigned output and the actual output. Each individual's variable charge is the area under his derived marginal supply price schedule between his assigned output and the actual output and can be expressed as

$$\int_{\bar{q}}^{q^*} p' \, dq$$

Assuming the normal case where each participant's derived marginal supply price schedule is positive in the range of output defined by his assigned output and the actual output, his variable charge will be positive when actual output q^* is *greater* than his assigned output $\bar{q}$ and will be negative when actual output is *less* than his assigned output. The variable charges to individuals i and k are shown in Figure 2 where individual i's negative variable charge (a rebate) is represented by the dotted area and individual k's positive variable charge is represented by the diagonally shaded area.

The *contribution* of each participant is equal to his fixed plus his variable charge, $\left(C = \overline{pq} + \int_{\bar{q}}^{q^*} p' \, dq\right)$. A characteristic of the proposed system is that

total contributions must always be equal to or in *excess* of the total supply cost. Only if assigned marginal prices $\bar{p}$ for each of the participants are equal to their respective derived supply prices p' at the actual output q^* will total contributions be equal to total supply cost; in other cases total contributions will be in excess of total supply cost. An excess of total contributions over total supply cost may give rise to an incentive for the participants to make side arrangements. Possible side arrangements will be ignored in the analysis to follow but will be introduced in Section IV.

III. ATTAINING THE SOCIAL OPTIMUM

In order to demonstrate the process by which individuals arrive at an optimal output solution, strategic behavior considerations will be initially set aside. It will be shown that the proposed system induces each individual to reveal his correct demand schedule independent of both his derived marginal supply price schedule and his assigned marginal price schedule. In the absence of incentives to strategic behavior, each individual is induced to equate his marginal benefit with his derived marginal supply price in determining a common, and socially desired, output.

For purposes of the following illustration, it is assumed that the cost of policing (excluding possible users) a pure public good, which is indivisible both with respect to users *and* over time, is prohibitively high. These constraints, when combined with a large number of participants sharing the public good, usually characterize the most difficult circumstances for efficient resource allocation involving public goods choice.

Due to the partial equilibrium nature of the analysis, assumptions are introduced which set aside income effects and problems involving internalization of pecuniary externalities.[5] These include (1) constant costs of producing the collective good relative to any other good and additive utility for the collective good and as a function of all other goods, (2) zero income elasticity of demand for the collective good, (3) a truly lump sum arrangement for distributing any expected excess of contributions over cost of supply.

Initially it is assumed that the participants accept the price assignments made by the government and do not attempt to modify these assignments through negotiations. All other side arrangements are also assumed to be effectively prohibited.

[5]Earl Thompson has pointed out the problems associated with the partial equilibrium nature of the analysis herein and the nature of the required assumptions. (The lump sum arrangement for distributing the excess of contributions over cost would have the government rebate, ex ante of the revelation of demands, the expected value of this excess. Thus the expected benefit to the participants would be equal to expected social benefit. Any difference, ex post, between the actual excess and the lump sum rebate would constitute a nonforecasted rent.)

Following the demonstration that the proposed system leads to socially desired results, the possibility of strategic behavior is introduced via a leader - follower analysis, where the leader is in a position to misinform his rival in an attempt to improve his own opportunity set. It will be shown that the proposed system eliminates any such incentive to strategic behavior.

Independent Behavior

In order to maximize under the proposed system, each individual must reveal a demand schedule which will equate his revealed and true demand prices at the marginal unit of provision. This is easily demonstrated when individuals behave independently and lack knowledge of the demand to be revealed by others.

Each individual seeks to choose an output, q^*, such that his benefit, $\int_0^{q^*} B\,dq$, less his contribution, $C = \bar{p}\bar{q} + \int_{\bar{q}}^{q^*} p'\,dq$, is maximized. By assumption, he cannot alter his derived supply price schedule. Therefore, he cannot influence his assigned output $\bar{q}$ which is determined, in part, by this derived schedule. Since his assigned price, $\bar{p}$, is also independent of his own demand behavior, he will ignore his fixed charge, $\bar{p}\bar{q}$, in determining what demand to reveal.

Thus it is the variable charge, $\int_{\bar{q}}^{q^*} p'\,dq$ which influences his demand revelation. This charge, which may be positive or negative, is equal to the sum of the incremental derived supply prices between his assigned and the actual output. Without knowledge of the demand revealed by others, however, each individual has a possibly infinite feasible set of derived supply price schedules. To maximize, he must choose a locus of points on the feasible set of derived supply schedules such that, at each point on the locus, his true demand price is equal to a marginal derived supply price. Since his true demand schedule defines such a locus, he will maximize by revealing this schedule. In so doing he chooses an output which maximizes his benefit less his variable charge.

It is clear that he would also not, if given the opportunity, choose to alter his true demand revelation once his rival has revealed a demand and his own derived supply price schedule is known. If he chose to understate his demand by moving down this derived supply price schedule to some suboptimal output, he would forego utility greater than reductions in his variable charge or increased rebates received. Alternatively, by overstating his demand and moving up his derived supply price schedule, he would pay an increased variable charge or incur a rebate reduction greater than the additional benefit received from increased output.

The result under the proposed system contrasts with the suboptimal output result when independent behavior is assumed under a marginal benefit taxation

system. As shown in Section II, the latter motivates participants to regard derived supply schedules as *average* price schedules rather than *marginal* price schedules with the result that each understates his true demand. Under the proposed system, each participant regards his derived price schedule as a marginal price schedule and reveals a demand price equal to his true demand price at the marginal unit of provision.

The proposed system also removes the incentives to strategic behavior inherent in a system of marginal benefit taxation. Under the proposed system, any change in an individual's demand revelation will result in changes in the derived marginal supply price schedule confronting his rival such that the rival's equilibrium position remains undisturbed. That is, the rival will maintain equality of revealed and derived supply prices at the new output and will have no incentive to alter his revealed demand in response to a change in his derived supply price schedule. As a result, the incentives to strategic behavior are lacking.

Strategic Behavior

Characterized by an attempt to influence the demand revelations of rivals by manipulating the market prices confronting these rivals, strategic behavior would be viable only if one could alter the derived supply prices confronting rivals and in turn motivate them to change their demand revelations so as to favorably alter one's own opportunity set. The lack of incentive to strategic behavior under the proposed system can be demonstrated first by showing what motivates an individual to reveal his true demand schedule *independent* of the demand revelation of his rival.

Consider a leader - follower situation where the leader knows that the follower's behavior will be governed by *two* optimality conditions. First, the follower must reveal a *point* on his true demand schedule at that output where his true marginal benefit is equal to his marginal supply price. The optimum point varies with the supply price schedule he confronts but all optimum points lie on a locus defined by his own true demand schedule. Second, he must reveal a demand *schedule* independent of the leader's demand revelation. Any dependence of demand revelations, if perceived by his rival, may induce the latter to reveal in a manner to make the rival (the leader) better off and the follower worse off. Independence of demand revelations is thus *necessary* to fulfill the follower's second optimality condition. He can always fulfill this optimality condition, however, by revealing his true demand schedule which is *sufficient*, but not necessary in order to attain an individually preferred welfare position.[6]

[6]That which motivates the follower to reveal a schedule independent of the leader's demand revelation rather than only a point on his true demand schedule can be illustrated as follows. The revelation by the follower of a point demand at some rate of output implies that

Thus the follower will always reveal a demand *schedule* independent of the demand revelation of the leader. Since the follower's demand revelation is invariant with respect to the derived supply price schedule he confronts, the leader cannot favorably alter his own opportunity set by misrevealing his demand and altering the derived supply price of the follower. Thus the incentive to strategic behavior is lacking.

The precise reason why the proposed system eliminates the incentive to strategic behavior can also be illustrated by comparing the proposed system with a marginal benefit taxation system. Section II described how such behavior arises under the latter system, giving rise to a departure from an independent adjustment equilibrium. That is, if an individual anticipates that his rival is behaving independently, he will reveal a lower demand relative to that revealed at the independent adjustment equilibrium, shifting his rival's derived supply price schedule upward. The rival, who regards his derived supply price schedule as an *average* price schedule, will maximize by regarding a schedule $p^{**} = d(p')/d(q)$ marginal to his supply schedule as his own marginal price schedule. Under such conditions, an individual can improve his own welfare at the expense of his rival.

In contrast, the proposed system motivates each participant to reveal, at the margin, a demand price equal to his supply price p'; he no longer equates demand price with a price p'' marginal to p'. If one's rival is thus motivated to reveal a demand which remains invariant with respect to the derived supply price schedule he confronts, one cannot improve his own opportunity set by altering that of one's rival.[7]

the leader will have an equality of derived supply and assigned price at other rates of output. If the leader correctly anticipates a point demand revelation policy by the follower, the former will reveal a perfectly inelastic demand schedule at that output where his true demand price is equal to his assigned price. An inefficient rate of output will probably result and the leader will incur welfare gains to the detriment of the follower. This illustrates a case of extreme interdependence with respect to demand revelations by the follower but the same analysis holds where this interdependence is less extreme. When the follower reveals a schedule which satisfies the first optimality condition (equality of true demand and derived supply price at the actual output) but fails to satisfy the second condition (demand revelation independence), then the leader can, by correctly anticipating the policy of the follower, favorably alter his own opportunity set.

[7]A necessary condition which gives rise to strategic behavior is that rivals interpret their supply schedules as something other than marginal cost schedules. Rivals do not regard their supply schedules as their marginal cost schedules if they regard scarcity rents as costs over which they have control. Under a marginal benefit taxation system a participant does have control over his scarcity rent, where scarcity rent is measured by the difference between his actual price p^* and derived supply price p' per unit of actual output. Under the proposed scheme, however, he has no control over scarcity rent. Given a rival's revealed demand, his own rent (which is reflected in his fixed charge) is equal to $\int_0^{\bar{q}} (\bar{p} - p'\, dq)$ and he has no control over $\bar{p}$ or $\bar{q}$. As a result he is induced to regard his supply schedule p' as a marginal price schedule. In turn, his rival has no incentive to behave strategically because his own response will be invariant with respect to his rival's demand revelation.

IV. SOME ASPECTS OF THE PROPOSED SYSTEM

Side Arrangements and Transactions Costs

Section III set aside consideration of that incentive, arising from a possible excess of total contributions over supply cost, for participants to enter side arrangements designed to reduce or eliminate the excess. Introducing such arrangements, it will be shown that these imply no departure from a socially optimum rate of output and though they may give rise to transactions costs, the costs may be insignificant in any realistic setting.

One way in which the level of possible transactions costs can be appraised is in terms of the level of benefits to be received from side arrangements. If it can be shown that the potential benefits are insignificant, then people will not incur significant costs to obtain them.

The potential benefits from side arrangements represent the reduction in the excess of total contributions over supply cost as the difference, at the marginal unit of provision, between each individual's assigned price, $\bar{p}$, and derived supply price, p', is reduced. This excess becomes increasingly small as individual derived supply price schedules become increasingly inelastic and as the difference, at the margin, between individual derived supply and assigned prices becomes increasingly small.

Given a simplifying assumption of unitary individual demand elasticities and equal relative differences between assigned and derived supply prices ($D = 1.0 - p'/\bar{p}$) for all individuals at the marginal unit of provision, then the ratio (E) of the excess contribution to total supply cost can be expressed as a function of the number of participants (n) and the relative assigned/derived supply price differences.

$$(1) \qquad E = (D^2/2) / (n-1)$$

One concludes that the potential benefit from side arrangements becomes insignificant in even moderately small group interactions. When, for example, there are more than ten participants and there is an average ten percent differential, at the marginal unit of provision, between individual assigned and derived supply prices, the total excess of contributions over cost is .0005 or less of total supply cost. In very large number interactions, the potential benefit becomes so infinitesimally small as to preclude side arrangements.

In indicating the insignificance and even absence of side arrangements in moderate to large number interactions, the above analysis suggests little regarding the level of transactions costs in small number interactions other than a maximum limit on these costs. Yet there is little to suggest that transactions costs would be significant even in small number interactions.

Consider the nature of the side arrangements by which participants might attempt to reduce or eliminate their excess contributions. These arrangements include either (1) *collusion* whereby the participants reveal mutually advantageous demand schedules, shifting each others' derived supply schedules in a manner such that differences, at the margin, between assigned and derived supply prices are reduced or (2) *negotiating modified price assignments* in which case such differences are reduced or eliminated directly.[8]

In either case, the exchange process by which the participants reduce assigned and derived supply price differences avoids the conventional public - goods difficulty in which the attempt to obtain unanimous agreement regarding an indivisible output of a public good gives rise to prohibitive contracting costs – the so - called "unanimity transactions cost trap." In contrast, these side arrangements involve the exchange of perfectly *divisible* goods and are characteristic of a private goods exchange process. The difference in the nature of the exchange process involved implies important differences in the relative costs of reaching agreement in that the side arrangements which arise reflect *implicit* unanimity among participants rather than unanimity in a direct and *explicit* sense, as is the case with the conventional public goods dilemma.

Costs of the Proposed System

Choice among alternative institutional arrangements should be based on that which minimizes all relevant costs – external, information, transactions and administrative costs. Although the comparative costs of alternative institutional arrangements are usually an empirical matter, a rather important aspect of the proposed system is revealed when it is assumed that each of a large number of participants in a public goods interaction has perfect knowledge of and can costlessly communicate his demand for a public good. Essentially, this assumes zero *individual* information costs.

Other important costs have been considered earlier. *External* costs, which represent the welfare loss to society deriving from a non - optimum output of public goods, would be zero. *Transactions* costs, at least in large number settings,

[8]Given certainty regarding each others' true demands and zero contracting costs, participants could make equal, at the margin, their own derived supply and assigned prices by negotiating changes in the latter subject to the constraint that the vertical sum of their assigned prices be equal to the marginal cost of supply. However, given uncertainty regarding each other's demands, they will arrive at a set of modified price assignments which maximize expected utility. In this case excess contributions or further potential benefits from exchange will remain which reflect a cost, to the participants, of uncertainty regarding each others' true preference orderings. The exchange process, by which the participants arrive at a set of modified price assignments which maximize their expected utility, has one very crucial characteristic. This is the independence of the process by which modified prices are determined and the process of output determination. In other words, behavior designed to alter the wealth distribution through the negotiation of modified price assignments is independent of resource allocation, implying that strategic behavior which arises in the price negotiations process will not lead to a divergence from Pareto optimality.

would be negligible or zero. As in any system where it is worthwhile to organize collectively to supply public goods, the proposed system has *administrative* costs but it would not appear that these would differ substantially from those required under alternative arrangements.

Thus if individual information costs are zero (and administrative costs are zero in an opportunity sense), the proposed system becomes, in effect, a zero cost arrangement for public goods choice. This contrasts with what are usually considered to be rather high external and decision - making costs under collective choice arrangements, which arise as a result of the usual problems which prevent obtaining reliable information about individual preferences.

The Information Problem

In any realistic setting, however, the proposed system would face the same problem that any collective choice procedure faces. In general, there would be little or no reason why any individual should devote resources to properly specify his preference function, that, in fact, information about the benefits of a public good is itself a public good. However, this overlooks the fact that individuals might economize on individual information costs under the proposed system as efficiently as under any alternative system. There is no *a priori* reason to believe that the form or organization which individuals use to economize on information costs under the proposed system would mean that potentially valuable information about individual tastes must be foregone.

It is relatively easy, given positive individual information costs, to speculate regarding the kind of organizational forms which would arise in order to generate a socially desired level of information. Assume that in a large number interaction each individual's demand for a pure public good is a function of both observable (say, income) and nonobservable (taste) variables. Assume initially that individual tastes are homogeneous. In such circumstances it is likely that individuals will allow one agency (the government) to collect information about observable (income) variables and estimate demand for the collectivity. The government would obtain the desired level of information gathering activity. An individual would simply not participate and would accept his "benefit tax" (assigned price times assigned output) without specifying a demand. This is analogous to a situation where individuals do not participate in a democratic process (they do not vote) and are rational in doing so.

Suppose, however, that among the collectivity there are some individuals who have highly differentiated tastes. Such individuals might choose to form group(s) to represent them in the choice process. The degree to which they efficiently communicate information about their tastes may involve no more than the act of joining a group. Or it might involve generating more detailed information about the degree of their individual taste variation.

Group demand estimates would be based on whatever division of information gathering functions between the government, group agents, and individuals that would be most efficient, and would reflect the usual marginal considerations regarding the cost and returns of information gathering.

The proposed system would then elicit demand revelations from groups of appropriate sizes and characteristics. Unlike conventional collective choice processes, the proposed system motivates the groups to reveal "best" estimates of group demands. In addition, it directs resources to information gathering in an efficient manner, i.e. the group demand estimates minimize information costs, including the external costs of incomplete information.