A Mechanism for Allocating the Expenses of Public Goods: Analyses of a Swedish Government Project

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Abstract: *Bohm (1982) reported a Swedish census project, which used a cost-sharing mechanism giving participants incentives to misrepresent their willingness to pay (WTP), yet still ended up providing a public good. In this paper we offer a theoretical analysis of the mechanism and propose two revisions. In the first revision, the incentives to overstate or understate are randomized, weakening participants' tendency to misrepresent WTP. Whereas in the second revision, reporting true WTP is participants' weakly dominant strategy. Our revisions delineate a simple approach to induce true WTP, while the Swedish mechanism can be treated as a special case.*

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I. Introduction

The provision of public goods has long been an important focus for economists. Two main issues are how to induce users' true WTP and how users can share the costs of the public good commensurate with their true WTP. Since the market mechanism is not reliable in providing public goods because of the often insurmountable free rider problem, many researchers have devised alternative mechanisms trying to reveal participants' true WTP and thus achieve efficiency. Most of the theoretical frameworks for providing public goods are able to induce true WTP; nevertheless, they may be too complicated to be applied in the public sector (as discussed in Bohm, 1979 and 1982).

Bohm (1982) reported a Swedish census project using a cost-sharing mechanism which required participants to state their WTP for the census data. According to Bohm's report, participants in the project were divided into two groups to share the cost. Based on their responses, group 1 (hereafter G1) had to pay a percentage of their reported WTP and group 2 (hereafter G2) a fixed fee. Participants knew to which group they were assigned before reporting. G1 members, consequently, had incentives to understate their WTP because the higher WTP they reported, the more they would have to pay. As for G2 members, as long as their true WTP is above the fixed fee, they tended to overstate because they would pay a fixed fee no matter how much they reported. The mechanism ended up providing a public good, even though participants were given incentives to misrepresent their true WTP.

In this paper we study the mechanism underlying this Swedish census project from a game-theoretic viewpoint. In addition, we propose and analyze two revisions of the mechanism. Reporting true WTP is not incentive compatible in the original mechanism because of the incentives to overstate or understate. The incentives to misrepresent are shown to be weakened in the first revision, in which the group assignment is random and participants are uncertain to which group they will be assigned. Moreover, in the second revision, reporting true WTP is participants' weakly dominant strategy and every participant eligible for the public good would at least pay a designated share of the cost.

II. The Swedish Government Project

In Sweden, census data were generally provided without any cost to users. However, in an attempt to reduce government expenditures, the Swedish government designed a method for local governments to share the cost of the census. In 1982, the Swedish government conducted a nationwide census to acquire statistics for various plans of 279 local governments. The local governments involved were stratified with respect to population size and were divided into two groups. Each participant had to report their WTP for the project and shared the cost in the following manner. Those in G1 had to pay a certain percentage of their reported WTP. The percentage could be determined only after the responses had been collected, but it would not exceed 100%. As for G2, members had to pay a fixed fee of $100, which was determined before responses were collected. If those in G1 stated zero, or members in G2 reported less than $100, they would not be offered the statistics nor would they have to pay anything, even if the project were actually carried out. The project would be implemented only if the sum of all respondents' reported WTP was greater than or equal to the total cost, which was about $40,000.

A control procedure was applied to make sure that members of each group had similar population size and housing needs.[1] Therefore, if there was any discrepancy in the reported WTP between G1 and G2, it could be said to originate from their distinct demand for the census data rather than the intrinsic difference in population size or housing needs. The statistics of the reported WTP are given in Tables 1 and 2 taken from Bohm (1982). Since the sum of all local governments' reported WTP exceeded $40,000, the project was carried out.[2]

As the tables show, the percentage of stating zero was higher in G1 than that in G2, 36% to 23%. If we consider the percentage of those not willing to pay for the service by including those reporting less than $100 in G2, then the proportion was about the same for both groups, 36% to 32% for G1 and G2, respectively. At the Sek 500 ($100) level, the percentage of G2 was twice as much as that of G1, 36% to 18%. There were not many differences in other ranges of WTP responses. G2 members had incentives to report as high as possible to increase the chance of getting the statistics, for they had to pay only $100 in any case. In contrast, those in G1 tended to understate their WTP to lower their cost. G1 and G2 could have formed a coalition to report their WTP strategically to minimize their overall cost. But the publication of their responses could make covert collaborations transparent. There was no evidence of any coalition between both groups as the tables show. If we look at the WTP responses above the Sek 500 level and the average reported WTP, the difference was negligible. To analyze the incentive problems faced by participants, we model the situation as a game in strategic form in the following section.

Table 1[3]

Aggregate and average WTP (in Kronor, $1 = Sek 5 approx.)			
	No. of governments	Total	Average

	Total	Responded	WTP	WTP
Group 1	140	137	113,350	827
Group 2	139	137	121,831	889
Total	279	274 (98%)	235,181	

Table 2[4]

Distribution of WTP responses						
	Both groups		Group 1		Group 2	
Sek	number	percentage	number	percentage	number	percentage
0	81	30	49	36	32	23
1-499	26	9	14	10	12	9
500	74	27	25	18	49	36
501-999	12	4	5	4	7	5
1000	34	12	19	14	15	11
1001-5000	44	16	24	18	20	15
> 5000	3	1	1	1	2	1
	274	100	137	100	137	100

III. The Swedish Mechanism: A Special Case

As previously stated, in addition to group assignment, to share the cost of the census, the Swedish central government determined a uniform percentage α imposed on G1's reported WTP and a fixed fee β on G2's. Given the central government's choice of (G1, G2, α, β), the local governments decided on their private provision of the public good simultaneously and independently by reporting their WTP to the central government. The interaction among the local governments participating in the project can be represented by a game in strategic form. In accordance with the central government's choice of (G1, G2, α, β), the game is specified in the following. Note that in this Swedish census project the percentage to be imposed on G1 members was determined after collecting WTP responses. To simplify the analysis, we assume that players knew α before reporting their WTP.

The set of players N = {1,2,...,n} consists of the local governments participating in the project, while the strategy set for player i is $\Sigma_i = \{\sigma_i | \sigma_i \geq 0\}$, where $\sigma_i \in \Sigma_i$ represents player i's reported WTP. Let player i's true WTP be w_i. Player i's payoff function is:

Given $\sigma \in \Sigma = \Sigma_1 \times \Sigma_2 \times \ldots \times \Sigma_n$,

$$U_i(\sigma) = \begin{cases} 0, & \text{if } \sum_{j \in N} s_j < W \text{ or } i \in G1 \text{ and } \sigma_i = 0 \text{ or } i \in G2 \text{ and } \sigma_i < \beta \quad (1) \\ w_i - \alpha\sigma_i, & \text{if } \sum_{j \in N} s_j \geq W \text{ and } i \in G1,\ \sigma_i > 0 \quad (2) \\ w_i - \beta, & \text{if } \sum_{j \in N} s_j \geq W \text{ and } i \in G2,\ \sigma_i \geq \beta \quad (3) \end{cases}$$

If the public good is not offered or players' reported WTP does not satisfy the required threshold, then player i's payoff is zero, as shown in (1). For those assigned to G1, if they report a positive WTP, then the payoff is their true WTP minus their payment when the public good is provided, as (2) indicates. Finally, (3) shows that G2 members eligible for the service will garner a payoff equal to their true WTP minus the fixed fee paid, if the public good is provided.

Symbolically, the game is denoted by $\Gamma = \{\Sigma_i, U_i\}_{i \in N}$, while $\sigma_{-i} = (\sigma_1, \sigma_2, \ldots, \sigma_{i-1}, \sigma_{i+1}, \ldots, \sigma_n)$ and $\Sigma_{-i} = \Sigma_1 \times \Sigma_2 \times \ldots \times \Sigma_{i-1} \times \Sigma_{i+1} \times \ldots \times \Sigma_n$. Note that by simply reporting zero, each player can guarantee himself at least a zero payoff. To see how participants interact under this Swedish mechanism, we now study their best responses.

Lemma 1 Let $\sigma_{-i} \in \Sigma_{-i}$. For $i \in$ G1, the best response mapping $\sigma_i(\sigma_{-i})$ of i is: $\sigma_i(\sigma_{-i}) = 0$, if $W - \sum_{j \neq i} s_j > w_i/\alpha$; $\sigma_i(\sigma_{-i}) = W - \sum_{j \neq i} s_j$, if $0 < W - \sum_{j \neq i} s_j \leq w_i/\alpha$; and $\sigma_i(\sigma_{-i})$ is not well defined, if $\sum_{j \neq i} s_j \geq W$. For $i \in$ G2, the best response mapping $\sigma_i(\sigma_{-i})$ of i is: $\sigma_i(\sigma_{-i}) = [0, \beta)$, if $w_i < \beta$, and $\sigma_i(\sigma_{-i}) = [\max(\beta, W - \sum_{j \neq i} s_j), \infty)$, if $w_i \geq \beta$.

Proof: For $i \in$ G1, if W- $\sum_{j \neq i} s_j$ > w_i/α, then by (2), to enjoy the public good the amount i has to make up is greater than w_i/α, rendering i's payoff negative. Consequently, i's best response is to report zero. When $0 <$ W- $\sum_{j \neq i} s_j \leq w_i/\alpha$, player i has to report at least W- $\sum_{j \neq i} s_j$, to make the total reported WTP not less than the total cost. Since this amount is not greater than w_i/α, (2) implies that it is optimal for i to have the project implemented. Thus, the best response is W- $\sum_{j \neq i} s_j$. Finally, the best response is not well defined, if $\sum_{j \neq i} s_j \geq$ W, since i can get the public good by stating any positive infinitesimal WTP.

For $i \in$ G2, if $w_i < \beta$, (1) and (3) indicate that it is not optimal for i to get the public good and so $\sigma_i(\sigma_{-i}) = [0, \beta)$, since any strategy between 0 and β would yield a zero payoff to player i. If $w_i \geq \beta$, then (3) implies that it is optimal for i to be eligible for the public good and to have the public good provided. Thus, $\sigma_i(\sigma_{-i}) = [\max(\beta, W-\sum_{j \neq i} s_j), \infty)$. Q.E.D.

A Nash equilibrium is a strategy profile $\sigma^* \in \Sigma$ such that $U_i(\sigma^*_i, \sigma^*_{-i}) \geq U_i(\sigma_i, \sigma^*_{-i})$ for all $\sigma_i \in \Sigma_i$ and all $i \in$ N. In a Nash equilibrium every player's reported WTP is incentive compatible, in the sense that no player can gain by alternating his strategy unilaterally. With the above characterization of players' best responses, we are ready to establish some necessary conditions which a Nash equilibrium with the provision of the public good must satisfy.

Theorem 1 Let (G1, G2, α, β) be the central government's selections and σ^* be a Nash equilibrium such that the public good is provided. Then, $0 < W - \sum_{j \in G2} s^*_j \leq \sum_{i \in G1} w_i / a$.

Proof: Let σ^* be a Nash equilibrium such that the public good is provided. Then, $\sum_{i\in G1}\sigma_i^* + \sum_{j\in G2}\sigma_j^* \geq$ W. Suppose $\sum_{j\in G2}\sigma_j^* \geq$ W. Then, for $i \in$ G1, $\sum_{j\neq i}\sigma_j^* \geq \sum_{j\in G2}\sigma_j^* \geq$ W. By Lemma 1, player *i*'s best response is not well defined. Thus, σ^* cannot be a Nash equilibrium. This shows that W - $\sum_{j\in G2}\sigma_j^*$ > 0 must be satisfied. As noted before, the least payoff a player can guarantee himself is 0. This implies that $\sigma^*_i \leq w_i/\alpha$ for all $i \in$ G1, that is, $\sum_{i\in G1}\sigma_i^* \leq \sum_{i\in G1} w_i/\alpha$. Since the public good is provided, W $\leq \sum_{j\in N}\sigma_j^*$. Therefore, W - $\sum_{j\in G2}\sigma_j^* \leq \sum_{i\in G1}\sigma_i^* \leq \sum_{i\in G1} w_i/\alpha$. Q.E.D.

Theorem 1 shows that at any Nash equilibrium, as long as the public good is provided, participants' total contribution must be greater than or equal to the total cost. Additionally, the sum of G1's reported WTP has to be less than $\sum_{i\in G1} w_i/\alpha$ and the sum of all G2's contribution ought to be less than the total cost to avoid G1's strategic infinitesimal response.

Bohm (1984) reported that the percentage imposed on G1 was 100%. Based on this information and the tables, we can test whether the necessary condition is satisfied. The total cost minus the contribution from G2 was equal to Sek 78,169, which is greater than zero and less than G1's reported WTP, Sek 113,350, a lower bound of $\sum_{i\in G1} w_i/\alpha$; the inequality is established. Since Theorem 1 is not violated, it is possible that a Nash equilibrium with the public good provided may exist.

One may argue that theoretically G2 members can report an infinite amount, which will violate the constraint and make the scheme collapse, since no matter how much they report, they only have to pay β. However, practically there seems to be a limit on G2's strategies. If local governments cannot get the data from the central government, they can conduct the census themselves; the cost of providing the data on their own would be the limit of their reported WTP, which will never be infinite. Moreover, every local government has a limited budget; it is not plausible that any local government can report an infinite WTP, considering especially that the reported WTP would be publicized.

The Swedish mechanism's merits lie in the following factors. Firstly, the central government has complete control over the census data and can effectively eliminate the free rider problem. Secondly, the mechanism is simple and easy to implement. Besides, there is a minimum requirement for a Nash equilibrium with the public good provided to exist. To satisfy this necessary condition, all the central government has to do is to establish an appropriate fixed payment, which can be calculated from the total cost of the project. Thirdly, the publication of WTP responses hinders local governments from forming coalitions. Without this hindrance, strategic behaviors may be rampant and make the scheme collapse. Finally, local governments are not sensitive to differential pricing, nor are they profit-oriented. If the project involves individuals or private businesses, the idea of charging different prices for the same service may arouse discrimination concerns. In fact, Bohm (1982) also reported a bus line project which failed because of the union's objection. People could not accept different pricing for the same bus ride even though they might have indeed experienced disparities in benefits.

In this Swedish census project, G2 members were given strong incentives to overstate their WTP. However, the maximum reported WTP is only $2,000, higher than the fixed fee \$100, but far less than the total cost \$40,000, let alone reaching infinity. Only one percent of the local governments reported greater than \$1,000. The theoretical possibility of an infinite WTP did not appear to be a problem. In contrast, 36% in G1 and 23% in G2 reported zero, in other words, 34% as a whole did not want the service, including those who reported less than \$100 in G2. The low demand for the census data, rather than overstated WTP, might have caused the project to fail. In the end, the census was conducted; G1 paid 100% of the reported WTP, G2 disbursed the fixed fee, and the charges to all participants amounted to Sek 160,000. Participants' payment did not cover the total cost (Bohm, 1984).

IV. Random Group Assignment

In this Swedish census project, local governments knew in advance to which group they belonged. We now revise the mechanism by assuming that each local government is randomly assigned to G1 with probability θ, to G2 with probability $(1 - \theta)$, where $\theta \in (0, 1)$. There is, consequently, a positive probability that participants are all assigned to either G1 or G2. Local governments must report their WTP prior to the realization of their assignments, that is, before they are informed to which group they have been assigned. In the original mechanism, participants pay an identical fixed fee when assigned to G2 and a uniform percentage charge when assigned to G1. In contrast, in this revised mechanism, the fixed fee or the percentage charge will be different for every participant.

The central government chooses $(\theta, G1, G2, (\alpha_i, \beta_i)_{i\in N})$, the probability of being assigned to G1, the group assignment, the percentage to be imposed on G1 members, and the fixed fee to be levied on those assigned to G2. Specifically, the rule to allocate the public good and to share the cost is as follows. Given players' strategies $(\sigma_1,...,\sigma_n)$, the public good will be provided as long as $\sum_{j \in N} s_j \geq W$. Player i has to pay $\alpha_i\sigma_i$ if he is assigned to be a G1 member and $\sigma_i > 0$, or β_i if he is assigned to be a G2 member and $\sigma_i \geq \beta_i$, otherwise he neither receives nor pays anything. Player i's expected utility function $U_i: \Sigma_1 \times \Sigma_2 \times ... \times \Sigma_n \rightarrow \Re$ is now given by

$$U_i(\sigma_i, \sigma_{-i}) = \begin{cases} \theta(w_i - \alpha_i\sigma_i) + (1 - \theta)(w_i - \beta_i), \text{ if } \sum_{j \in N} s_j \geq W \text{ and } \sigma_i \geq \beta_i & (4) \\ \theta(w_i - \alpha_i\sigma_i), \text{ if } \sum_{j \in N} s_j \geq W \text{ and } 0 < \sigma_i < \beta_i & (5) \\ 0, \text{ if } \sum_{j \in N} s_j < W \text{ or } \sigma_i = 0 & (6) \end{cases}$$

In case the public good is provided and player i reports not less than β_i, then he will be eligible for the expected payoff from being assigned to either G1 or G2, as shown in (4). Whereas (5) shows that when the summation of reported WTP is not less than the total cost, if i's reported WTP is positive but less than the fixed fee, he will be eligible for the public good only when his realized assignment is G1. For the last case (6), if the public good is not provided or player i's reported WTP is equal to 0, then his expected payoff will be zero.

In this revised mechanism, participants' best response can sometimes be deterministic.

Theorem 2 Let $(\theta, (\alpha_i, \beta_i)_{i \in N}, G1, G2)$ and $\sigma_{-i} \in \Sigma_{-i}$ be given. If $0 < W - \sum_{j \neq i} s_j < \beta_i$ and $w_i > [1 + \theta\alpha_i/(1 - \theta)]\beta_i$, then player i's best response is exactly β_i.

Proof: Let $\sigma_i \in \Sigma_i$ be given. Note that (4) implies that $U_i(\beta_i, \sigma_{-i}) = \theta(w_i - \alpha_i\beta_i) +$

$(1 - \theta)(w_i - \beta_i)$. Since $\beta_i < w_i$ under the conditions of the theorem and $\alpha_i \leq 1$, $U_i(\beta_i, \sigma_{-i}) > 0$. Player *i*'s expected utility will be zero, if he reports zero. This shows that reporting zero is not optimal. If $\sigma_i > \beta_i$, then by (4), $U_i(\sigma_i, \sigma_{-i}) = \theta(w_i - \alpha_i\sigma_i) + (1 - \theta)(w_i - \beta_i)$. Since $w_i - \alpha_i\sigma_i < w_i - \alpha_i\beta_i$, we have $U_i(\beta_i, \sigma_{-i}) > U_i(\sigma_i, \sigma_{-i})$. If $0 < \sigma_i < \beta_i$, then $U_i(\sigma_i, \sigma_{-i}) = 0$ when $\sigma_i < W - \sum_{j \neq i} s_j$ and $U_i(\sigma_i, \sigma_{-i}) = \theta(w_i - \alpha_i\sigma_i)$ when $\sigma_i \geq W - \sum_{j \neq i} s_j$. Since $w_i > [1 + \theta\alpha_i/(1 - \theta)]\beta_i$, we have $\theta(w_i - \alpha_i\sigma_i) < \theta(w_i - \alpha_i\beta_i) + (1 - \theta)(w_i - \beta_i)$, hence, $U_i(\sigma_i, \sigma_{-i}) < U_i(\beta_i, \sigma_{-i})$. Thus, reporting β_i is player *i*'s best response under the conditions. Q.E.D.

Theorem 2 indicates a possibility to treat public goods as private ones, being sold at a pre-set price. As in this case, the central government could practice price discrimination, charging local governments different prices depending on the weight of their population size, housing needs, and other factors. The higher the probability of being assigned to G1, the closer it is to first degree price discrimination. In contrast, this revised mechanism would give participants more consumer surplus as the probability of being assigned to G2 increases.

Assuming the public good is provided, in the original setting, the cost is always the fixed fee for qualified G2 members, while under the random group assignment the expected cost will be $\theta\sigma_i + (1 - \theta)\beta_i$. The difference between the former and the latter is $\theta(\sigma_i - \beta_i)$, which means when $\sigma_i > \beta_i$, he has to pay more in the revision than in the original mechanism. Player *i*, hence, has less incentives to overreport in the revision. For any $i \in$ G1, he always has incentives to understate, since he has to pay a percentage of his reported WTP. However, in the random group assignment setting, he may lose the expected payoff $(1 - \theta)(w_i - \beta_i)$ by reporting $\sigma_i < \beta_i$, when $\beta_i < w_i$. Consequently, the incentive to understate is also reduced.

V. Further Revision

As the former analysis has indicated, participants still have incentives to misrepresent their WTP under random group assignment. In this section we propose still another revision of the Swedish mechanism, trying to induce participants' true WTP. The rule for providing the public good and sharing the cost is as follows. The public good will be provided if the total of reported WTP is not less than the total cost. The central government determines a disparate fixed fee, β_i, for each participant. The fixed fee amounts to participants' designated share of the total cost. Given other participants' strategies σ_{-i}, player *i* has to pay $P_i(\sigma_{-i}) = \max(\beta_i, W - \sum_{j \neq i} s_j)$, if his reported WTP is not less than $P_i(\sigma_{-i})$ and $\sum_{j \in N} s_j \geq W$; otherwise he will not receive or need to pay for the public good.

For $i \in N$, $\sigma'_i \in \Sigma_i$ is a weakly dominant strategy, if for all $\sigma_i \in \Sigma_i$ and all $\sigma_{-i} \in \Sigma_{-i}$, $U_i(\sigma'_i, \sigma_{-i}) \geq U_i(\sigma_i, \sigma_{-i})$ (Campbell, 1995: 143). We now prove that reporting true WTP is participants' weakly dominant strategy under this revised mechanism.

Theorem 3 Reporting true WTP is participants' weakly dominant strategy under this revised mechanism.

Proof: Let σ_i and σ_{-i} be given, according to the revision, player *i*'s payoff is:

$$U_i(\sigma_i, \sigma_{-i}) = \begin{cases} w_i - P_i(\sigma_{-i}), \text{ if } \sigma_i \geq P_i(\sigma_{-i}) \\ \text{zero, otherwise} \end{cases} \quad (7)$$

The proof can be decomposed into four cases. If $w_i < P_i(\sigma_{-i})$ and $\sigma_i + \sum_{j \neq i} s_j \geq W$, then (7) implies that $U_i(\sigma_i, \sigma_{-i}) \leq 0$ and $U_i(w_i, \sigma_{-i}) = 0$. Thus, $U_i(w_i, \sigma_{-i}) \geq U_i(\sigma_i, \sigma_{-i})$. If $w_i < P_i(\sigma_{-i})$ and $\sigma_i + \sum_{j \neq i} s_j < W$, then (7) implies that $U_i(\sigma_i, \sigma_{-i}) = 0$, and $U_i(w_i, \sigma_{-i}) = 0$. Thus, $U_i(w_i, \sigma_{-i}) = U_i(\sigma_i, \sigma_{-i})$. If $w_i \geq P_i(\sigma_{-i})$ and $\sigma_i + \sum_{j \neq i} s_j \geq W$, then (7) implies that $U_i(\sigma_i, \sigma_{-i}) \leq w_i - P_i(\sigma_{-i})$ and $U_i(w_i, \sigma_{-i}) = w_i - P_i(\sigma_{-i})$. Thus, $U_i(w_i, \sigma_{-i}) \geq U_i(\sigma_i, \sigma_{-i})$. If $w_i \geq P_i(\sigma_{-i})$ and $\sigma_i + \sum_{j \neq i} s_j < W$, then (7) implies that $U_i(\sigma_i, \sigma_{-i}) = 0$. Since we have $w_i \geq P_i(\sigma_{-i})$ and $w_i + \sum_{j \neq i} s_j \geq W$, $U_i(w_i, \sigma_{-i}) = w_i - P_i(\sigma_{-i})$. Thus, $U_i(w_i, \sigma_{-i}) \geq U_i(\sigma_i, \sigma_{-i})$. We have thus proved that $U_i(w_i, \sigma_{-i}) \geq U_i(\sigma_i, \sigma_{-i})$ in any case and w_i is a weakly dominant strategy. Q.E.D.

Theorem 3 shows that reporting true WTP is a strategy giving participants at least as much payoff as any other strategies; w_i, as a result, is player *i*'s best response. The rule to provide the public good, $\sum_{j \in N} s_j \geq W$, amounts to $\sum_{i \in N} w_i \geq W$. That is, the provision of the public good would be an efficient result and an equilibrium play of the game. However, whether or not the collection from participants will cover the total cost or whether they would pay a fair share of the cost is another issue. If $\sum_{i \in N} w_i \geq W$, then the public good is provided and the collection from participant *i* is $P_i(w_{-i})$ if $w_i \geq P_i(w_{-i})$, zero otherwise. Therefore, it is possible that the central planner may have to disburse some expenditures because the collection may not cover the total cost.

Those who are eligible for the public good will pay at least a designated share of the total cost, the fixed fee. The payment is max (β_i, W- $\sum_{j \neq i} s_j$), which means that the higher the others report, the less player *i* has to pay, but no less than β_i. A participant, to some extent, may free ride others' contribution, but his payment will never be less than the fixed fee. In other words, participants always have to pay the fixed fee or shore up the burden left by others. Presumably, the central planner would like to set the fixed fee, β_i, equal to the true WTP, w_i. However, if $\beta_i \neq w_i$ at least for one participant, then clearly player *i* does not pay for what the public good is worth to him, not an efficient result. This revision is not a perfect mechanism, but we are able to induce participants' true WTP and let them pay a designated share of the cost using a very simple approach.

VI. Discussion and Conclusion

Samuelson (1954) asserted that the market mechanism is not able to provide public goods optimally, but he recognized that some other possible solutions to the problem do exist. Since then many theoretical frameworks and experiments have been proposed to investigate private provision of public goods. Bohm (1971) devised a mechanism which could reveal people's demand for public goods and an experiment was conducted (Bohm, 1972). The Swedish mechanism used the so-called interval method (Bohm, 1979), trying to estimate the range of the true WTP for a public good.

Other researchers have followed suit and proposed their own mechanisms, such as Clarke (1971), Tideman and Tullock (1976), Walker (1981), Henry (1989: 5-29), Groves and Ledyard (1977), and others. All of these mechanisms are able to induce the demand or true WTP for a public good, nonetheless, they each have some defects. Some of them are difficult to understand, thus, impractical to use in the public sector. Other mechanisms may be easy to implement, but to avoid the free rider problem, the payment is contingent on others' responses rather than one's own valuation. For still others, the issue of sharing costs is not considered. Groves and Ledyard (1977) offer a balanced budget mechanism in allocating public goods, but it requires a complicated information structure, making it not practical. Consequently, these theoretical frameworks fail to create an implementable mechanism which could provide a public good and let the users share the costs commensurate with their valuation.

The Swedish census project, in contrast, represents a serious attempt to find a practical approach to provide public goods. Even though the mechanism could not induce participants' true WTP, it did end up providing a public good in the 1982 Swedish census project. We find a necessary condition under which a Nash equilibrium exists and the public good is provided, though the Nash equilibrium in this game is not unique. The incentive compatible constraint can be easily satisfied, but the possibility of an infinite WTP from those who would pay only a fixed fee makes that argument questionable. However, if the local governments are uncertain to which group they will be assigned, the incentive to overstate or understate their WTP is weakened. In this context, the uncertainty of group assignment reduces players' strategic responses, the possibility of reporting infinite WTP. Though reporting true WTP is not necessarily players' best response under random group assignment, the potential of treating public goods as private ones may give administrators a convenient guideline in establishing payment schemes for public goods.

The revised mechanism in section V, indeed, makes it incentive compatible for participants to report their true WTP. Furthermore, participants will at least pay a designated share of the cost if they are eligible for the public good. The revision seems even more straightforward than the original Swedish mechanism, however, participants' payment is not necessarily equal to their true WTP.

Perhaps the following result is what we expect: each player shares the total cost according to his true WTP weighted by all others' true WTP, $w_i W / \sum_{j \in N} w_j$, which may seem more favorable and equitable. Inducing participants to share the cost commensurate with their true WTP may need a design much more complicated than this Swedish mechanism or what we have proposed. There is still room for improvement; further experiments and research will reveal the potential of the revised frameworks.

End Notes

1. Communication and information from Peter Bohm in November 1996.

2. Sek is Swedish Kronor, the currency of Sweden. One U.S. dollar was about 5 Sek at that time. The sum of reported WTP was Sek 235,181, which exceeded the fixed cost $40,000, i.e., Sek 200,000.

3. Hanusch, H., eds., 1984, *Public Finance and the Quest for Efficiency*, Proceedings of the 38th Congress of International Institute of Public Finance, Copenhagen, 133. Detroit: Wayne State University Press.

4. Ibid. p. 133.

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