"Multipart Pricing of Public Goods" by Edward G. Clarke

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June 29, 2009

Overview

THE PUBLIC PRICING PROBLEM

When distributing public goods (or "natural monopolies"), certain difficulties arise:

- In the absence of taxation devices, policing and exchange costs may be prohibitive to factor into market costs.
  - *E.g.* Policing problems for public goods (*e.g.* bridges) when information is required to exclude non-purchasers. If the information-gathering cost exceeds value, and zero price is charged, information is lost regarding demand (and alternate market inefficiencies may obtain).
- The simplest pricing devices, marginal benefit taxes, lead to strategic behavior (*i.e.* "free rider" or "manipulation") problems.

THE BASIC MODEL

In the basic model, players in society $|N| = n$ independently reveal demand schedules. Taxation correlates to revealed demand schedules, so rationality understating demand dominates. Since vertical sum adds to marginal cost of supply, for i, derived supply price schedule p' will take the form of average price schedule:

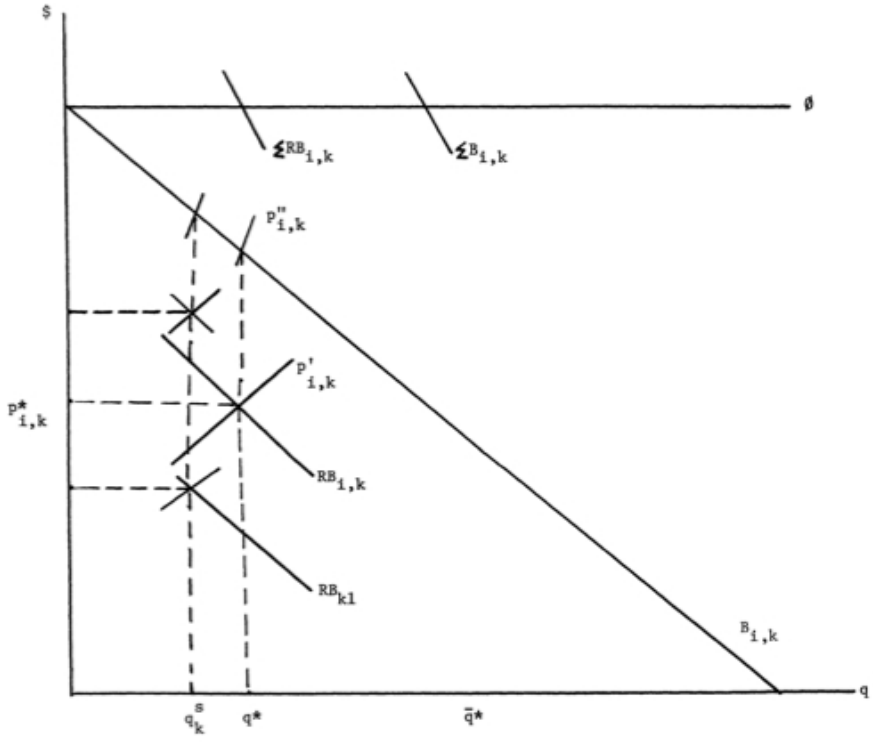
$$p' = \frac{\phi}{n}.$$

The marginal price schedule p'', marginal to p', will be:

$$p'' = \frac{d(p')}{d(q)}.$$

So although i sets revealed demand price to average supply price $RB = p'$, setting supply price $B = p''$ would increase efficiency.

THE BASIC MODEL - DIAGRAM



KEY

∅ 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., $p'_i = ∅ - RB_k$	
$p'' = d(p')/d(q)$	

FIGURE 1

THE STRATEGIC BASIC MODEL

- The independent adjustment equilibrium is stable, but clearly suboptimal.
- Worse, if some player k acts strategically, then he reveals lower demand, reducing k's contribution, and paying marginally less but offsetting the utility lost by generating less output. Other player(s) end up paying larger proportions of the marginal cost of supply,
- but even less welfare is generated if all players act strategically—guaranteeing minimal contributions and sacrificing social benefits in the form of reduced costs.

THE BASIC MODEL - DIAGRAM REDUX

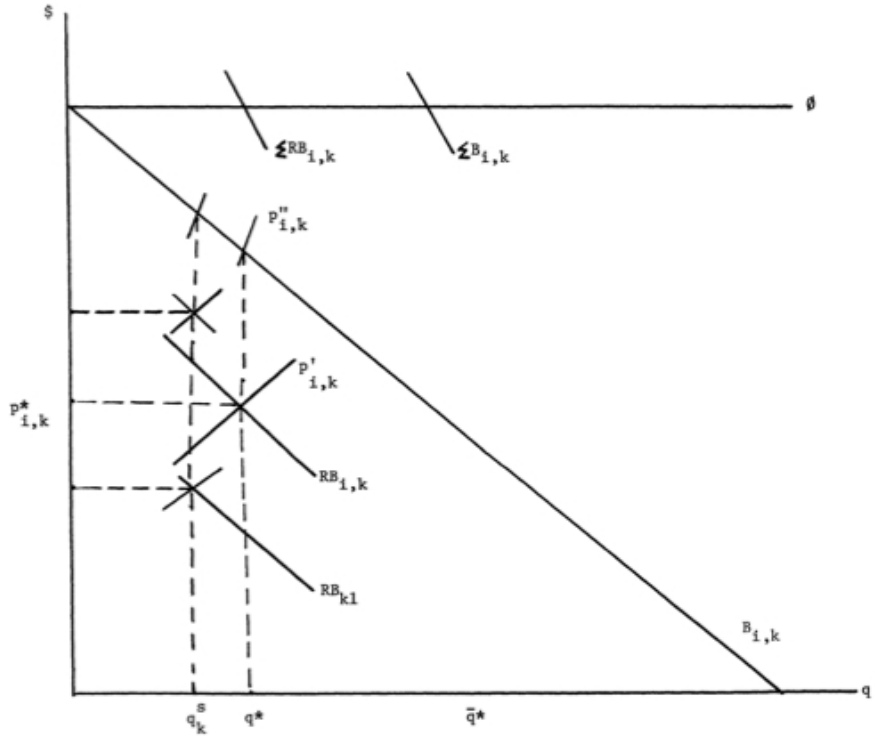


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FIGURE 1

CLARKE'S MECHANISM DESCRIPTION

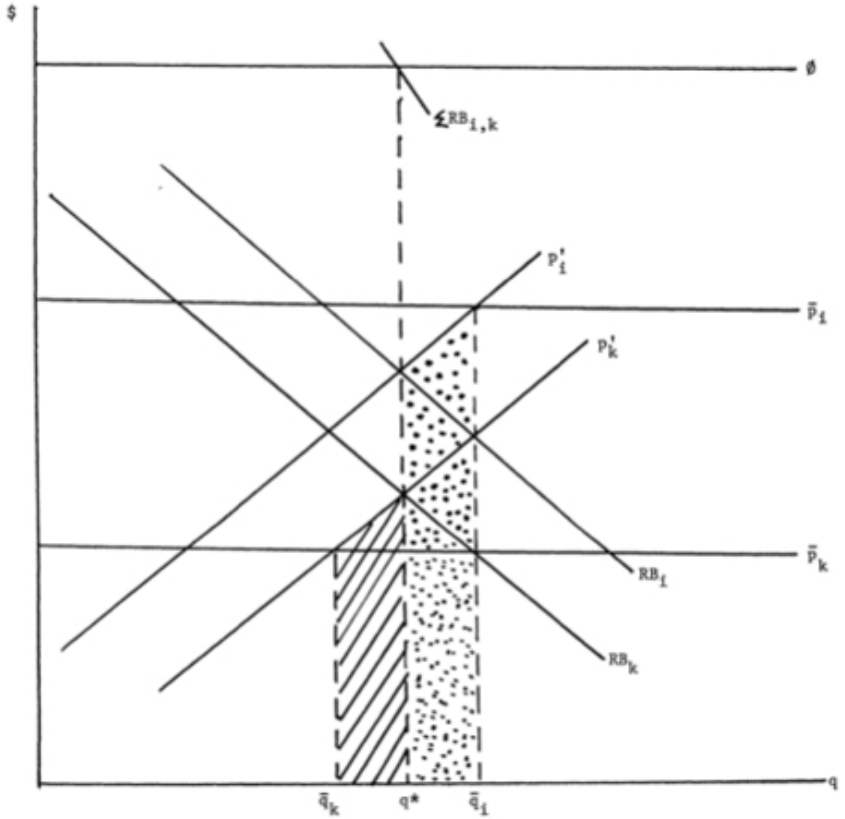
1. Given a marginal cost of supply ϕ, set individual assigned price schedules $\overline{p}_i$ such that $\sum_{i \in N} \overline{p}_i = \phi$.
2. Players reveal demand schedules RB_i, each derived marginal supply price schedule p_i is determined by setting $p_i = \phi - \sum_{i \neq j} RB_j$. This derivation ensures that i cannot affect his *own* pricing schedule.
3. The actual output q^* is where, vertically, $\sum_i RB_i = \sum_i p'_i$. This is where RB_i intersects p'_i. (It is equal for all i!)
4. Where p_i intersects the assigned price schedule $\overline{p}_i$, this determines the assigned output for i, $\overline{q}_i$.
5. Since the marginal cost of supply ϕ is fixed and the assigned price schedules $\overline{p}_i$ are likewise fixed (immutable by the players involved), the Clarke taxes imposed prevent strategic demand reveals.

MECHANISM DESCRIPTION CON'T

1. The individual contribution has two components which Clarke imaginatively calls the fixed cost and the variable cost.
2. The fixed cost is imposed by multiplying the assigned cost $\overline{p}_i$ with the assigned output quantity $\overline{q}_i$. This value is non-manipulable for each individual by changing RB_i.
3. The variable cost (a tax or a rebate) is the area between actual output q^* and assigned output $\overline{q}_i$:

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

THE CLARKE MODEL - DIAGRAM



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

PREVENTING STRATEGIC DEMAND REVEALS

Theorem 1 (Clarke Tax)

Given a marginal cost of supply ϕ and a set of assigned price schedules $\overline{p}_i$ for a player i such that $\sum_j \overline{p}_j = \phi$, and setting i's contribution to $C = \overline{pq}_i + \int_{\overline{q}}^{q^*} p' \, dq$, i does not have incentive to cheat by setting his revealed demand schedule $RB_i \neq B_i$, i's real demand schedule.

INDEPENDENT BEHAVIOR EXPLANATION

- By hypothesis, only variable costs can be changed by individuals.
- In order to maximize utility, the marginal derived cost of supply must be equal to revealed demand schedules.
- If unequal: overpaying marginal cost of supply or utility is lost due to underconsumption:
  - If i overstates his revealed demand schedule, then his rebate is decreased, but extra utility is not sufficient to compensate.
  - If i understates, then his rebate is increased, but forgoes utility of the goods he actually desires.

LEADER-FOLLOWER ANALYSIS

Since independent behavior is resistant to false revealed demand schedules, are there alternate strategic ways to influence one's opportunities? Can an individual reveal in such a way that the other player's derived marginal prices lead to a dominant strategy benefiting the first individual?

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No.

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No.

Suppose that the leader reveals first. They are aware that the follower will reveal a price point in response at an output where his marginal schedule is equal to the true marginal benefit. Furthermore, if the follower's schedule is dependent on the leader's, then the leader can take advantage of this fact. This independence will prevent the leader's strategy succeeding.

MODERN APPLICATIONS OF CLARKE TAX

- Today, Clarke's requirement of "a truly lump sum arrangement" (26) is translated as having agents with quasi-linear utilities
- Several of the real-world factors Clarke mentions are sidelined in modern discussions of Clarke mechanisms. (cf. *e.g.* John Leach's *A course in public economics*, Nolan McCarty's *Political game theory*)
  A few examples:
  - zero income elasticity of demand for the good (26),
  - the cost of policing being prohibitively high (26),
  - cost of determining preference schedules (today, we usually say we are freely given revealed preferences) (32), ...

CONCLUSION

- The Clarke model effectively avoids manipulation and free rider problems.
- One of the most interesting aspects of examining the original papers is the effort required to address pragmatic problems and suggest intuitive justifications, whereas the Clarke-Groves Mechanism is purely technical machinery today.
- Clarke writes, "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 $\overline{p}$" (24). Such revealing may be inefficient when $RB_i \neq \overline{p}_i$, so what reason would an individual have to only partially reveal? Why is this relaxation included in the model?

SELECTED WORKS

- Buchanan, James M. (1968): *The Demand and Supply of Public Goods* (Chicago: McNally).
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- Demsetz, Harold (1964): "The Exchange and Enforcement of Property Rights," **J. Law Econ.** 7:11–26.
- Musgrave, Richard A. (1982): *Public Finance in Theory and Practice* (London: McGraw).