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MARKETABLE POLLUTION PERMITS

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The approach of marketable pollution permits is one of the pollution control techniques. In this approach the authority sets the maximum level of pollution and issues permits (or certificates) for this amount. The regulating body can either distribute the permits freely or sell them. Once the permits are obtained by the polluting firms the exchange can take place.

There exists a market in which polluters buy and sell the certificates. If a firm is operating below the standard level of pollution, which is set by the environmental agency, and has some spare permits it can sell them in the market. On the other hand, if there are some other firms which need more certificates for their production level they demand those papers from the others. Hence, the pollution permits are tradeable(1).

There are two alternative systems of marketable pollution permits, namely ambient-permit system (APS) and emissions-permit system (EPS)(2).

Let us consider a particular region in which there are m sources of pollution fixed in location. Environmental quality is defined in concentration of the pollutant at receptor j. Let us define a diffusion matrix (D) whose elements (d_{ij}) represent the contribution of source i's one unit of emissions at point j.

$$D = [.... d_{ij} ...]$$

The aim of the permit systems is to attain some preselected levels of pollutant concentration. These standards are doneted by a vector $Q = (q_1^*,...,q_n^*)$.

(1) The pressure groups (which worry about the environment) can buy and sell the permits as well as the polluters. They can have the access to the permit market.

(2) Turner & Peace (1990), Baumol & Oates (1988).

Hence the problem is to

$$\text{minimise} \sum_i c_i\,(e_i)$$

$$\text{s.t.} \quad ED \leq Q^* \qquad E \geq 0$$

where $E = (e_1,\ldots,e_m)$ is a vector of emissions (e_i) from m sources and c_i represents the abatement costs.

The APS requires the environmental authority to issue q_j^* permits at each receptor point. These permits allow the polluter to discharge their wastes up to a certain concentration level. Thus, there exists a separate market for each receptor's permits. This system forces the polluters to hold a portfolio of permits from various receptors at which their emissions affect the pollution. Under the APS the permits are not traded on a one-to-one basis.

The environmental authority can introduce an EPS instead of the APS to secure the quality of the environment. Under the EPS the permits are defined in terms of the levels of emissions and the region is divided into zones in which the polluters can exchange the permits on a one-to-one basis. Here the entire region is a single market and a fixed number of permits for the region is issued.

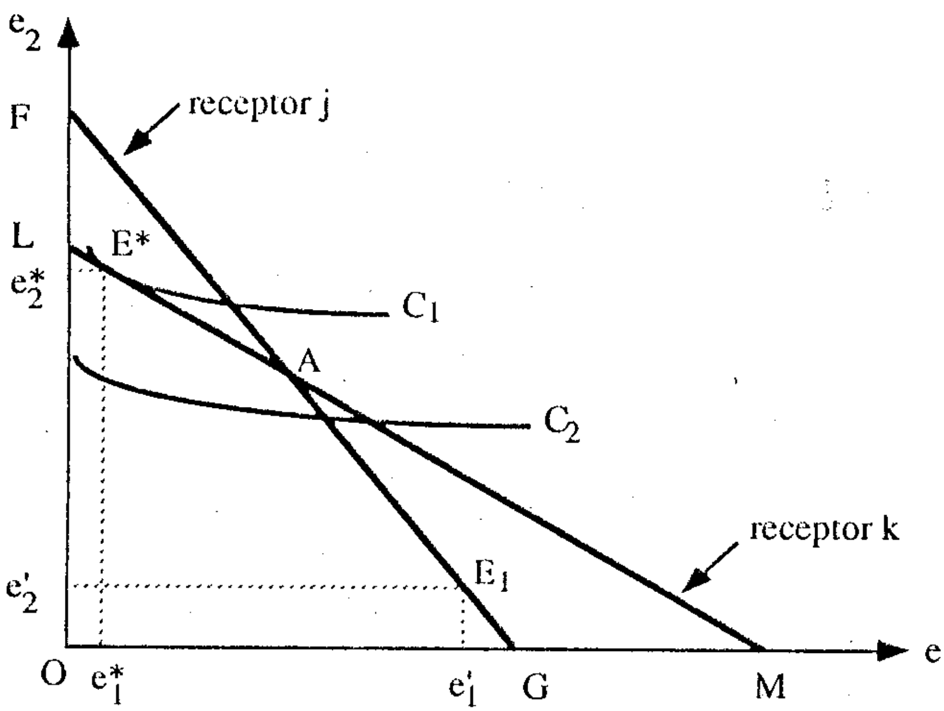
Both systems have some advantages and disadvantages for the authority and the polluters.

The APS system unlike the EPS, can in principle achieve the least-cost outcome since the competitive bidding for the permits would generate an equilibrium solution that minimises the total abatement costs. Because the officials need not have any information about the abatement costs and they only issue the required number of permits at each receptor point, the APS system is not cumbersome for the environmental authority. From the viewpoint of polluters the system is quite complicated since they have to keep a portfolio of permits from every receptor point they affect. Hence the transaction costs may be high.

With the EPS system the life is simpler for the polluters. Each source is assigned to a single zone within which they exchange the permits on a one-to-one basis that ignores the differences in the concentrations of the pollutants. Hence the price of emissions does not show the shadow price of the binding pollution constraint. Therefore, the least-cost solution is not a very likely outcome. Another disadvantage of the EPS system is that the environmental agency needs the complete solution to assign the permits to each zone.

The third alternative, the Pollution Offset system(PO), is a kind of combination of the APS and the EPS(3). In this approach permits are in terms of emissions and they are not allowed to be traded on a one-for-one basis. In other words, the exchange of permits is subject to the restriction that the transfer does not violate the environmental quality standard at any receptor point. Under the PO system, mutually beneficial trades among the polluters result in the least-cost outcome regardless of the initial allocation of permits.

In Figure 1 the horizontal and vertical axes measure the emissions from firm 1 and 2 (e_1 and e_2), C_1 and C_2 represent the isocost curves for pollution abatement costs with $C_1 < C_2$. The lines FG and LM indicate the pollution constratins associated with receptors j and k. Points on those lines depict the combinations of e_1 and e_2 such that $q_a = q_a{}^*$ is satisfied. The slopes can be read as the substitution rate (the ratio of transfer coefficients) between the emissions of firm 1 and firm 2. Therefore, the feasible set is OLAG.



Pollution Offset System
Figure 1(4)

(3) This system is introduced by Krupnic et al. (1983).
(4) Krupnic et al. (1983).

At E* the ratio of marginal abatement costs equals the ratio of transfer coefficients. So E* is the optimum and also the market equilibrium under perfect competition. If the initial allocation were at E_1 firm 2 would pay firm 1 to reduce its emissions from e'_1 to e_1^* in order to increase its own emissions to e_2^*. This transaction would move the system from E_1 to E*. At E* the potantial gains from the trade would be exhausted. Under the PO system firms are free to buy and sell the permits as long as they do not violate the standards at any receptor point.

Mc Gartland and Oates (1985) modified the pollution offset system in a way that the new system tries to attain the preselected standards that are now equal to either predetermined standards established by the environmental authority or the initial level of environmental quality (whichever is higher).

The policy problem is that of achieving the standards set beforehand at a minimum total abatement cost without deteriorating the environmental quality in areas where the pollutant concentration is already below the allowed levels, i.e.

$$\text{minimise} \sum_i c_i\,(e_i)$$

$$\text{s.t.} \quad ED \le \min\,(Q^*, Q^0)$$
$$E \ge 0$$

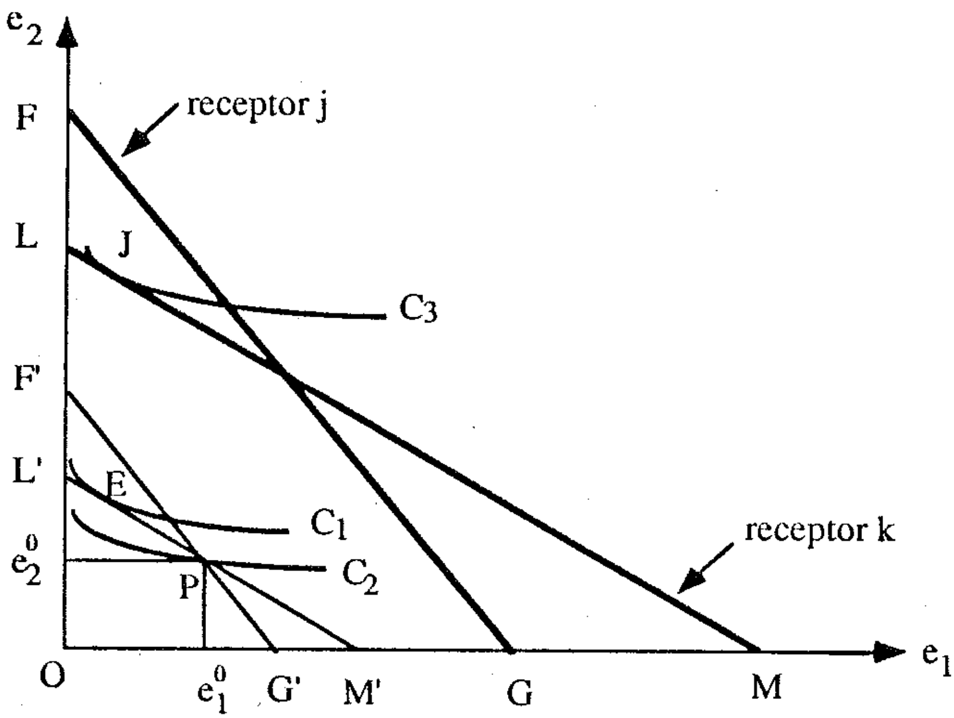
where $Q^0 = (q_1^0,...,q_n^0)$ represents the level of pollutant concentration.

The difference from the previous formula is the inclusion of the vector Q^o. Before, the increases in pollutant concentrations were treated as costless to the society so long as the national standards were not violated. That means, up to the threshold the pollution damages are zero which cannot be acceptable in principle.

Moreover the new offset system requires an initial distribution of permits for attainment areas (where the national standards have been met) to validate the current level of emissions of the polluters.

The offset system in question has the least-cost property as well as it improves the environmental quality and reduces the costs for the case where the initial equilibrium has attained the national standards. However, for the non attainment case sources of pollution may face an increace in costs.

Assume under the prevailing system the national authority holds the pollutant concentration below the national standards at both receptor points such as at point P in Figure 2. If the modified offset system is introduced the polluters 1 and 2 receive e_1^0 and e_2^0 amounts of discharge permits. Thus the contraints become F'G' and L'M'



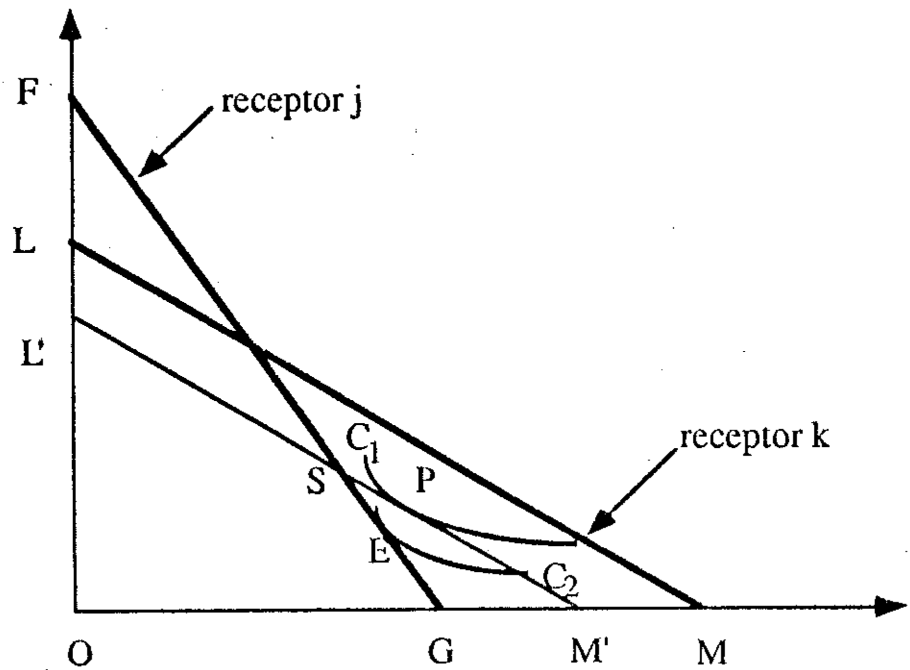
Modified Offset System
Figure 2[5]

The least-cost solution is now at E. E is attained at a lower cost than P, so mutually profitable trading is possible. At E the potential gain is exhausted. Apart from the cost saving the new system has led to a cleaner environment since the environmental quality is improved at receptor j while there is no change at receptor k.

Under the pollution offset system introduced by Krupnic et al. the final equilibrium would be at J with further cost savings, but the environmental quality would deteriorate up to the national standard.

In Figure 3, if the initial state is at P where the national standard has not been met at receptor j the environmental authority tightens the standard at receptor k. The trading equilibrium E yields high costs relative to the point P. If the point E were on the L'S line a Pareto improvement would be achieved for all sources with lower abatement costs.

(5) Mc Gartland & Oates(1985).

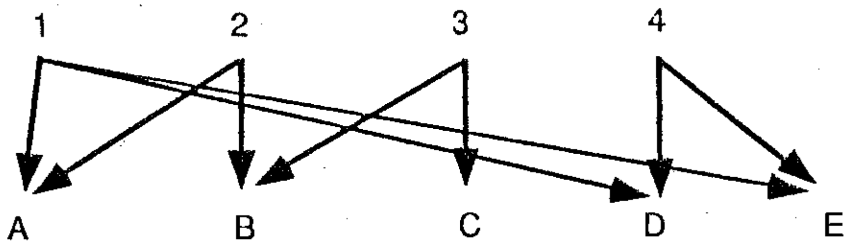


Nonattainment Case
Figure 3[(6)]

Under perfect competition the APS and the PO systems are equivalent. The permits in the PO system represent the right to pollute by a certain amount at a set of receptors. Under the APS the polluters can group their permits and sell them as a single commodity. Therefore, the PO and the APS yield the same least-cost result.

In an imperfectly competitive world these two systems are not identical[(7)]. With an APS system a polluter has to make transactions in all receptors he affects. However, under the PO system the polluter is supposed to deal with the markets of binding receptors only (By binding it is meant that the environmental quality is violated as a result of an increase in the emissions levels). The number of markets of concern is smaller under the PO system at a cost of a free rider problem. Some polluters can benefit from the others' transaction even though they are not involved in the trade.

(6) Mc Gartland & Oates (1985).
(7) Mc Gartland A. (1988).



Let the polluter 1 discharge emissions at receptors A, D and E. Assume there is a room for trade at receptor A. Firm 1 would be better off by increasing its emissions at that receptor.

Under the APS polluter 1 would enter bids at each of the receptors it operates. It needs concentrate on obtaining offsets at receptor markets throughout the region.

In contrast to the APS, the PO system repuires the polluter to enter bids at binding receptors only. If, due to an increase in the discharge level of firm 1, the environmental qualities at receptors A, D and E are subject to deteriorations, firm 1 is supposed to obtain offset permits from firms 2 and 4. Here there is a problem of free riding. When firm 2 reduces its production the quality of life at receptor B gets better. However, polluter 3 does not have to bargain with polluter 2 over the shares of receptor B. Polluter 3 would be better off by not buying the shares from polluter 2. Since the trade occurs simultaneously under the PO system, there will be an incentive for polluters to be free riders. Thus, polluter 2 can hold onto the shares of receptor B until somebody demands those offset permits. Binding receptors create spillover effects. If there is not any binding receptor the spillover effects will be almost zero since buyers do not have to get offsets for receptors. Imperfect competition provides a strong incentive to the polluters to benefit from the transactions of others.

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