Is Community Involvement Beneficial for Public Policy Efficiency?

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Abstract

Community involvement in public policy might have controversial effects on policy efficiency and equity. In this paper we evaluate the involvement of communities in a tradable permit policy, intendent to protect for environmental quality. We show that by integrating communities into the initial allocation of rights, we can achieve higher environmental quality, increase social welfare and correct for structural market failures.

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Introduction

The growing interest in transferable permit (TP) polices as a tool for environmental management suggests that the role of communities in such systems should be investigated further. Traditionally, polluting firms have been regulated entities. When a TP system is implemented, the regulator allocates pollution permits to firms based on criteria such as historical market share. After this initial allocation, firms may buy or sell pollution permits to each other, or to non-polluting third parties, such as environmental groups or consumers. Communities affected by the emitted pollution consume the level of environmental quality associated with the quantity of pollution permits used by the producers, and consume the output produced by the polluting firms.

As currently implemented (US EPA programs [1994], OECD Guidelines [2001]), consumers are involved in tradable permit programs in the following ways: 1) consumers (or affected communities) do not have an initial allocation of rights to freely trade in the pollution permit market, which determines environmental quality; 2) consumers can only *buy* rights (reflecting their demand for environmental quality); 3) As a consequence of (1) and (2), the policy may result in income constraints for consumers, restricting their volume of trade relative to the optimal level. The income constraint is generated by the regulator's decision to allocate property rights to polluting firms.

Trade will be efficient if all involved parties can freely trade. Trade among firms will lead firms that produce more efficiently to buy permits from less efficient firms and produce a larger share of output and/or to reduce the total abatement costs (Dale, [1968]). However, merely allowing post-allocation trade among firms will not correct for any "mistakes" in the level of pollution specified in the initial allocation. For example, if the regulator is uninformed about communities' disutility from pollution, she may specify a pollution level that is efficient in expectation, but not efficient ex post. Trade between polluting firms and consumers can achieve ex post efficiency provided that the first-best level of pollution is less than or equal to the total level of pollution permitted by the regulator, and provided that consumers' trade is not bound by income or wealth restrictions.

We propose to incorporate both polluting firms and non-polluting agents in the initial allocation mechanism. Using a general equilibrium framework, we reassess the importance of the initial allocation of rights, and demonstrate that allocating initial property rights to non-polluting agents can lead to a Pareto improvement, both in environmental quality and in generating cost savings.

The importance of the initial allocation of rights for equity and economic efficiency is well known, although research regarding pollution rights has been done mainly in a partial equilibrium framework, where the analysis focuses on *producers alone*, and ignores consumers' actions in the related markets. Initial economic research followed Coase's approach (1960), and assumed that the initial allocation of rights did not matter for economic efficiency, if markets are perfectly competitive and there are no income constraints and transaction costs (Montgomery 1972).

Later research extended this approach by analysing alternative market structures. Hahn (1984) challenged Montgomery's finding regarding the effects of the initial allocation of permits on total costs and environmental quality by introducing strategic behavior in the permit market. Under that market structure, the initial distribution of rights affects economic efficiency and environmental quality, as well as equity. Malueg (1990), and Fershtman and de-Zeeuw (1995) introduced cases in which firms' output markets are imperfectly competitive. They demonstrate that under these conditions, and for a specified *fixed* initial allocation of rights among polluting firms, allowing trade in emission permits is not necessarily beneficial. Trade may result in a market equilibrium with lower output rates and higher prices. These results are restricted to the case in which trade occures only among firsm. Consumers are not taken into consideration in the trade system.

A different line of research (Montero, 2000) examines the efficiency effects of the allocation of rights among two categories of firms. Incorporating a voluntary opt-in clause for otherwise unregulated firms into the TP may potentially generate a superior welfare outcome.

In this study, we reevaluate the effect of the initial allocation of rights on the efficiency of the tradable rights policy using a more elaborated economic framework, which includes an equilibrium analysis of multi markets. We extend the circle of traders to other parties in addition to affected firms, by including consumers, or affected communities, rather than other producers. Specifically, we evaluate the implications of the following thought experiment: what are the efficiency implications of initially allocating tradable permits to affected communities (who are also the consumers of the good produced), rather than to polluting firms? We demonstrate that assigning communities the right to pollute (equivalently, the right to environmental quality) can lead to a Pareto improvement in environmental quality and welfare, relative to the traditional allocation approach.

The next sections describe the theoretical framework. We begin by defining the regulator's objectives (section 1), and then evaluate the community's utility mazimization problem in the output and pollution markets (section 2). Throughout our analysis, we assume that the community behaves competitively. In section (3) we focus on the competitive firm's responses to changes in the initial allocation of rights, and analyse the resulting competitive equilibrium, from trade among producers and consumers in the rights and output markets. In section (4) we discuss the intuition and main results derived from theoretical analysis. The last section summarizes and discusses the implications of the proposed regulatory mechanism on TP policy.

1. The Regulator

We consider a social welfare-maximizing regulator, where welfare is defined as

$$W \equiv \sum_j U_j \tag{1}$$

where U_j is the agent j utility. The regulator determines a level of pollution rights, $\bar{L}$, to be allocated among J agents, who are polluting productive units and consumers (affected communities). Let the regulator's allocation be described by a share vector $\boldsymbol{\alpha}$, where $\boldsymbol{\alpha} = \{\alpha_1, \alpha_2, \ldots, \alpha_j\}$, and $\sum_j \alpha_j = 1$. Following the allocation of rights, communities and firms can trade among themself the rights allocated, and the good produced. The values of the rights and the good are freely determined in the markets. Denote by L_j the final allocation of rights, after trade, to agent j.

We will primarily consider a perfectly competitive economic environment, and evaluate the impact of the regulator's rights allocation decision on social welfare. We will show that when considering trade among producers and consumers in both rights and output markets, the initial allocation of rights **does** affect the resulting equilibrium, and that by reallocating rights to communities we can achieve a pareto improvement.

2. The Community

The community benefits from its consumption of the final good produced by the firms (Q) and environmental quality, which is negatively affected by pollution, E_p. Denote by $U[Q, E_p]$ the function representing community preferences over the two goods. It is assumed that the partial derivatives of the utility with respect to the first and second arguments are $U_1 > 0, U_2 < 0, U_{11} \leq 0, U_{22} < 0$. For simplicity, assume also $U_{12} = 0$.

The community can affect air quality by reducing the level of rights held by the productive (polluting) agents. We assume that the productive units *use* all of the rights that they hold after trading. Given an initial level of rights allocated, $\bar{L}$, the community demand for rights (L_c) determines air quality. The community chooses the levels of rights and good Q that maximize utility.

$$\{Q, L_c\} \in \; argMax \left\{ U[Q, E_p] \mid \begin{array}{l} E_p = \bar{L} - L_c \\ tQ + p\left(L_c - \alpha_c \bar{L}\right) \leq \bar{w} \end{array} \right\} \tag{2}$$

where $\bar{w}$ is the wealth of the comunity, t and p are the prices of output and rights, respectively. $\bar{L}$ is the level of rights allocated among J agents, α_c is the initial share of rights allocated to the community and L_c is the ex-post trade level of rights hold by the community. The first constraint represents ex-post air quality, given the total level of rights allocated and the final allocation of rights among the community and the firms. The second is the budget constraint faced by the community. The community behaves competitively in both markets throughout our analysis.

The first order necessary conditions for optimality imply the following:

$$tQ + p\left(L_c - \alpha_c \bar{L}\right) = \bar{w} \tag{3}$$

$$U_Q - \frac{t}{p} U_{Lc} = 0 \tag{4}$$

for positive values of Q and Lc, which ensure that the constraints hold with equality.

The community chooses $\{Q, L_c\}$ such that the marginal value of environmental quality is equal to the marginal value of output, Q. Total differentiation of first order conditions yields

$$\begin{bmatrix} U_{QQ} & -\frac{t}{p} U_{L_c L_c} \\ t & p \end{bmatrix} \begin{bmatrix} dQ \\ dL_c \end{bmatrix} = \begin{bmatrix} 0 \\ p\bar{L} \end{bmatrix} d\alpha_c + \begin{bmatrix} \frac{1}{p} \\ -Q \end{bmatrix} dt + \begin{bmatrix} -\frac{t}{p^2} U_{Lc} \\ \alpha_c \bar{L} - L_c \end{bmatrix} dp$$

Using Cramer's rule, we find the effect of a change in the initial allocation on the community demand for the two goods:
The demand for output declines as its price increases,

$$\frac{dQ}{dt} = \frac{\begin{vmatrix} 1/p & -\frac{t}{p}U_{L_cL_c} \\ -Q & p \end{vmatrix}}{\begin{vmatrix} U_{QQ} & -\frac{t}{p}U_{L_cL_c} \\ t & p \end{vmatrix}} < 0. \tag{5}$$

The effect of a change in price of rights on the community's ex-post level of rights depends on the relationship between the quantity it wants to hold and the quantity it received. If the community is a net buyer, then the quantity of rights it will hold decreases with the price of rights.

$$\frac{dL_c}{dp} = \frac{\begin{vmatrix} U_{QQ} & -\frac{t}{p^2}U_{Lc} \\ t & \alpha_c\bar{L} - L_c \end{vmatrix}}{\begin{vmatrix} U_{QQ} & -\frac{t}{p}U_{L_cL_c} \\ t & p \end{vmatrix}} < 0 \qquad \text{if} \qquad L_c - \alpha_c\bar{L} > 0. \tag{6}$$

The demand for output increases with the share of rights allocated to the community,

$$\frac{dQ}{d\alpha_c} = \frac{\begin{vmatrix} 0 & -\frac{t}{p}U_{L_cL_c} \\ p\bar{L} & p \end{vmatrix}}{\begin{vmatrix} U_{QQ} & -\frac{t}{p}U_{L_cL_c} \\ t & p \end{vmatrix}} > 0. \tag{7}$$

The level of rights hold be the community increases with the share of rights allocated to the community,

$$\frac{dL^c}{d\alpha_c} = \frac{\begin{vmatrix} U_{QQ} & 0 \\ t & p\bar{L} \end{vmatrix}}{\begin{vmatrix} U_{QQ} & -\frac{t}{p}U_{L_cL_c} \\ t & p \end{vmatrix}} > 0. \tag{8}$$

3. The Competitive Equilibrium

Consider an economic environment with one community and one competitive firm. The competitive firm maximizes profits by choosing its optimal output level Q_f (e.g. electricity). Emission is a byproduct of production and needs to be controlled. Define $E[Q_f]$ to be emission as a function of production. Two emission control tools are available to the firm: abatement (a) or pollution rights L_f. The emission generated can be abated at an increasing cost $G[a]$, or emitted. The firm can emit (pollute) only if it holds an equivalent amount of pollution rights, L_f. Rights can be traded in a competitive market[1]. Let L^s be the quantity of rights supplied by the firm, and thus $L^s = \alpha_f\bar{L} - L_f$.

[1]Clearly, the assumption of a single competitive firm is questionable if interpreted literally. The single firm may be interpreted as the aggregate of $J-1$ identical firms. The $J-1$ firm analysis would generate the same results, provided firms were allowed to trade freely among themselves, as well as with the community.

The firm's profit function is defined as

$$\Pi_f^1[Q_f, L_f] \equiv tQ_f - C[Q_f] - G[a] - p\left(L_f - \alpha_f \bar{L}\right) \tag{9}$$

where t and p are the prices of output and rights, accordingly. Q_f is the level of production; $C[Q_f]$ are the production costs, assuming $C'[Q] \geq 0, C''[Q] \geq 0$; $G[a]$ are abatement costs, assuming $G'[a] > 0, G''[a] > 0$; L_f is the quantity of rights to be used by the firm; and α_f is the share of rights initially allocated to the firm. Since all pollution must be abated or associated with a pollution right,

$$a = E[Q_f] - L_f.$$

Given the properties above, the profit function is concave in Q_f and L_f. The first order necessary condition for optimality imply

$$t - C'[Q_f] - G'[a] \cdot E'[Q_f] = 0 \tag{10}$$

$$G'[a] - p = 0 \tag{11}$$

Equations (10) and (11) indicate that the competitive firm's decisions for production and pollution control are independent of the initial allocation on rights when the firm is a price taker (Montgomerey, 1972). Thus trade among *firms only* will be independent of the initial allocation of rights. However, this conclusion does not hold when both communities and firms can trade in rights. By total differentiating the firm's first order condition we obtain

$$\begin{bmatrix} -C''[Q_f] - G''[a] \cdot (E')^2 & G''[a] \cdot E' \\ G''[a] \cdot E' & -G''[a] \end{bmatrix} \begin{bmatrix} dQ_f \\ dL_f \end{bmatrix} = \begin{bmatrix} -1 \\ 0 \end{bmatrix} dt + \begin{bmatrix} 0 \\ 1 \end{bmatrix} dp.$$

The firm's response to a change in output and rights prices is derived using Cramer's rule:
The output increases with its price,

$$\frac{dQ_f}{dt} = \frac{\begin{vmatrix} -1 & G''[a] \cdot E' \\ 0 & -G''[a] \end{vmatrix}}{\begin{vmatrix} -C''[Q_f] - G''[a](E')^2 & G''[a] \cdot E' \\ G''[a] \cdot E' & -G''[a] \end{vmatrix}} > 0 \tag{12}$$

and the demand for rights decreases with its price,

$$\frac{dL_f}{dp} = \frac{\begin{vmatrix} -C''[Q_f] - G''[a] \cdot (E')^2 & 0 \\ G''[a] \cdot E' & 1 \end{vmatrix}}{\begin{vmatrix} -C''[Q_f] - G''[a](E')^2 & G''[a] \cdot E' \\ G''[a] \cdot E' & -G''[a] \end{vmatrix}} < 0. \tag{13}$$

Proposition 1 summarizes the impact of the initial allocation of rights in a general equilibrium framework, where the equilibrium is determined by equalizing community demand and firm supply in each market.

Proposition 1. *Suppose that $W(\cdot)$ is a continuous welfare function representing the firm and community preferences, and $M^1 = \{p^1, t^1, L^1, Q^1\}$ is the market equilibrium in perfectly competitive rights and output markets. Then, an increase in the initial share of rights to the community will result in a new equilibrium, $M^{1'} = \{p^{1'}, t^{1'}, L^{1'}, Q^{1'}\}$, that possesses the following properties relative to equilibrium M^1:*

(1) *The volume of rights traded is lower, and the value of rights is lower.*
(2) *The ex-post level of rights used by the firm is lower.*
(3) *Environmental quality is higher.*
(4) *The level of output produced and its price increases.*
(5) *Welfare under the new equilibrium is higher.*

Proof in the appendix. Figure 1 presents the general equilibrium in the competitive environment. The graphs presents the quantities and prices of rights and output *traded* (L and Q accordingly) between the firm and the community.

4. Discussion and Intuition of the Equilibrium Properties

The allocation of rights to the community decreased its willingness to pay for any additional unit of right bought from the firm. That results in a shift down of the community's demand curve for rights. Moreover, the allocation of rights has a positive income effect on consumption of both environmental quality and output produced, and thus it will increase the share of rights ex-post hold by the community and increase demand for output. The community behavior will directly affect the firm's decision for production and abatement. The firms are faced with higher demand for their product, and thus increase production. Side by side, they are induced to abate more given the lower level of rights to pollute available to them. The firm's aggregate costs of abatement and production increases, and so the price of the output on the market. Nevertheless, both consumers and producers increase their gain from trade. the environmental quality will increase due to a lower share of rights to pollute used by the firms.

5. Policy Implications

The partial equilibrium model presented integrated the community's preferences into an analysis of the effects of tradable pollution permits on prices, quantities and social welfare and enables us to reassess the importance of the initial allocation of rights in the tradable permit policy.

We showed that even if markets are perfectly competitive, an increase in the share of rights initially allocated to the community will decrease the level of rights that are held ex-post by the firm and thus will increase environmental quality. The decrease in the share of rights initially allocated to firms *will not* induce a reduction in quantity of output produced, unless other factors, such as market power in the market of rights, are present. A reallocation of rights may increase community welfare and have a positive income effect on the level of output consumed. An additional important implication of the reallocation of rights to communities is related to the potential adoption of new abatement technologies by the firms. As the reallocation of rights to the communities may increase output produced and decrease the level of rights used by the firms, the firms are facing higher incentives to lower abatement costs by adopting advanced abatement technologies.

We did not discuss the effect of the reallocation of rights in cases where markets are not perfectly competitive, although the analysis provided hints on the possibility that re-allocation of rights to communities will affect the final equilibrium in the related markets and thus can be potentially used as a tool to correct for market failures which are due to non-competitive behavior of the firms involved in the trade.

Appendix

Proof. Proof of proposition 1. We establish each of the proposition's properties in turn.

(1) Denote by L^d and L^s the level of rights demanded and rights supplied. By construction,

$$L^d = L_c - \alpha_c \bar{L}, \qquad L^s = \alpha_f \bar{L} - L_f.$$

The comparative statics presented in (6),(8) and (13) included the folowing:

$$\frac{dL_f}{dp} < 0, \qquad \frac{dL_c}{dp} < 0, \qquad \frac{dL_c}{d\alpha_c} > 0.$$

From (6),(8) and (13) it follows that

$$\frac{dL^d}{dp} < 0, \qquad \frac{dL^s}{dp} > 0, \qquad \text{and } \frac{dL^d}{d\alpha_c} = \frac{dL_c}{d\alpha_c} - \bar{L} = \bar{L} \cdot \left(\frac{pU_{QQ}}{pU_{QQ} + \frac{t^2}{p} U_{LL}} - 1 \right) < 0.$$

Thus a shift down of the demand curve will reduce the level of rights traded and reduce prices.

(2) As $\frac{dL_c}{d\alpha_c} > 0$ and $\alpha_c + \alpha_f = 1$, it follows that $\frac{dL_f}{d\alpha_c} < 0$.

(3) As $\frac{dL_c}{d\alpha_c} > 0$ and $E_p = \bar{L} - L_c$, it follows that the pollution level decreases, so environmental quality is higher.

(4) An increase in the share of rights allocated to the community increased its income, which led to an increase in the quantity of output it demanded. $\frac{dQ_c}{d\alpha_c} > 0$ (7). Given the properties of output supply (12), an outward shift of the demand function increases output and prices.

(5) Welfare increases, since both environmental quality and the gain from trade in the output market increases.

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References

Coase, R.H. (1960) "The Problem of Social Cost," *Journal of Law and Economics*, III:1-44.

Dales, J.H. (1968) "Pollution, Property and Prices", University of Toronto Press.

Fershtman, Chaim and de-Seeuw, Aart (1995). "Tradable Emission Permits in Oligopoly," *Tilburg Center for Economic Research,* working paper 9630.

EPA, Title IV: *Acid Deposition Control*.

Hahn, Robert W., (1984) "Market Power and Transferable Property Rights," *Quarterly Journal of Economics,* Nov. 1984: 753-765.

Joskow, Paul L., Schmalensee Richard and Baily, Elizabeth M., (1998). "The Market for Sulfur Dioxide Emissions," *American Economic Review*, Vol. 88 No.4 : 669-685.

Jaskow, Paul L. and Schmalensee, Richard, (1998) "The Political Economy of Market-Based Environmental Policy: The U.S. Acid Rain Program", *Journal of Law and Economics*, Vol. XLI, April 1998: 37-83.

Laffont, Jean-Jacques and Tirole, Jean, (1996). "Pollution permits and environmental innovation," *Journal of Public Economics* 62: 127-140.

Malueg, David A., (1990). "Welfare Consequences of Emission Credit Trading Programs," *Journal of Environmental Economics and management* 18: 66-77.

Montero, Juan-Pablo., (2000) "Optimal design of a phase-in emissions trading program," *Journal of Public Economics* 75: 273-291.

Montgomery, David W., (1972), "Markets in Licenses and Efficient Pollution Control Programs, *Journal of Economic Theory* 5: 395-418.

OECD, *Domestic Transferable Permits for Environmental Management*, 2001.

Peltzman, Sam (1976), "Toward a More General Theory of Regulation." *Journal of Law and Economics* (19): 211-240.

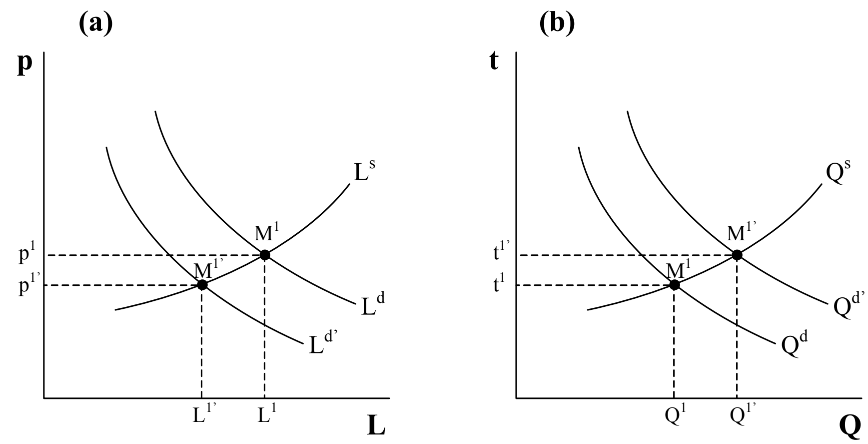

Figure 1: Markets equilibrium in a competitive environment. (a): Equilibrium in rights market. (b): Equilibrium in output market.