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Desirable Policies in the Green Product market

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Abstract

This paper discusses the relationship between regulation and environmental improvement, contemplating the provision of environmental quality per green product. A Monopolist's pricing and quality selection are simultaneously analyzed, when it is faced with the two types of consumers who choose a green product with different levels of environmental quality. Our model justifies a conventional wisdom that direct regulation on the quality level of green products is desirable for environmental improvement. On the other hand, to reconsider an actual environmental policy, we suggest that the tax abatement policy for consumers whose demand for environmental quality of green products is relatively higher will not affect an increase in environmental improvement.

Keywords: regulation, green products, price and quality discrimination

1. Introduction

Many different types of green products have been supplied by manufacturers, which develop technology to contribute to environmental improvement. Suppliers of green products have strategically designed and developed green products which should be marketable. While consumers are more concerned about those products and more willing to pay for them as a whole, their preferences for green products would be more widespread than before.

In response to such situations, many types of environmental policies have developed. However it might be true that the effects of green products on social welfare or environmental policies have not been sufficiently analyzed and therefore effective

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environmental policies for green products have not been established. This paper attempts to contribute to the discussion of the environmental policy by investigating desirable policies by which environmental quality of green products is controlled. A major suggestion is that direct regulation on the quality level per green product is desirable for environmental improvement and the tax abatement policy for the consumer who has relatively higher demand for the quality per green product does not contribute to promoting environmental improvement.

Our model is devised to analyze the monopolist's pricing and quality selection. The price discrimination and quality selection of suppliers faced with different types of consumers have been analyzed in Mussa and Rosen (1978), Mirman and Sibley (1980), and Tirole (1988). More recently, Cremer and Thisse (1999), and Bansal and Gangopadhyay (2003) have analyzed taxation and subsidy for environmental quality. Our model develops their analyses. Especially we will shed light on several policies for environmental improvement and reveal desirable ways of abating taxes in the green product market.

Section 2 provides the basic model and assumptions for two types of consumers and a monopolist. Section 3 defines the indicators of total environmental quality and solves the optimal levels environmental indicators. Finally we prove the desirability of direct regulation on green products. Section 4 assesses the different types of subsidies as indirect regulation and reveals relevant subsidization policies, by conducting comparative statics. Section 5 summarizes our findings and points out the ways of modifying our analysis.

2. The Basic Model

The economy consists of two types of consumers, *A* and *B*, and a monopolist. It is assumed that the two types of consumers are concerned about environmental improvement, but have different preferences for environmental quality per green product: the one, *A* prefers relatively more the quality per green product and the other, *B* prefers relatively less the quality per green product. We assume that the two types of consumers buy one unit of green product with the different levels of the quality. The monopolist can generate the different levels of the quality per green product and will submit the sets of environmental quality and tariff to each consumer. We assume that environmental improvement is promoted through the consumption of green products. For example, in the automobile industry, a manufacturer sells different levels of

environmental quality per product such as electric car, hybrid car and normal fuel-efficient car. Consumers will choose different types of cars in response to their preferences for environmental quality of green products, even though their budget constraints are equal. Since the different quality is said to bring a different impact on the environment, the consumption of those cars will result in deciding the level of environmental improvement.

The indirect utilities of the two consumers after taxation are composed by environmental quality per green product, environmental improvement, and tariff. The functions are

$$V_A = E(S) + q_A s_A - T_A \quad (1)$$

$$V_B = E(S) + q_B s_B - T_B \quad (2)$$

where

$E(S) = e \ln S$: enviromental improvement, $e > 0$,

$S = l s_A + (1 - l) s_B$: indicator of total environmental quality level

s_i : environmental quality per green product for the type i,

q_i : parameter of the type i, $q_A > q_B$

T_i : tariff for the type i

l : distribution of consumers; $0 < l < 1$

We assume that environmental improvement depends on the indicator of total environmental quality level ***S***. This indicator will show the real effect of the whole consumption of green products on the environment

The monopoly's profit function is

$$p = l(T_A - c \cdot s_A) + (1 - l)(T_B - c \cdot s_B) - R \quad (3)$$

c: marginal cost of environmental quality per green product

$R = rS$: R & D funcntion : $r > 0$

The marginal cost ***c*** is independent of quantity of green products. We specify the R&D function as a linear function with respect to ***S*** for the simplicity of calculation and discussion.

To analyze the price discrimination of the monopolist, we derive the individual rational and incentive compatible constraints. First, individual rational condition for lower demand part of consumer is described. From type B's utility, the individual

rationality condition is

$$e \ln S + q_B s_B - T_B \geq 0 \qquad (4)$$

Second, incentive compatibility condition for the higher demand part of consumer is elicited. From type A's utility,

$$e \ln S + q_A s_A - T_A \geq e \ln S + q_A s_B - T_B \qquad (5)^3$$

Those correspond to the necessary and sufficient conditions which should be satisfied by the monopolist as individual rational and incentive compatible constraints of the two types of consumers[4]. By considering the above conditions, we can derive non-arbitrage tariffs.

$$T_A = q_A s_A - q_A s_B + e \ln S + q_B s_B \qquad (6)$$
$$T_B = e \ln S + q_B s_B \qquad (7)$$

3. Direct Regulation on Green Products

In this section, we attempt to prove that direct regulation on green products is desirable for environmental improvement, by comparing the optimal levels of ***S*** for social welfare and a monopolist. We define the optimal level of ***S*** for social welfare as the derivative of the solution to maximize the sum of the consumers' utilities and the monopolist's profit.

$$\begin{aligned} \underset{s_A, s_B}{Max}\, W \;=\; & l(e \ln S + q_A s_A - T_A) + (1-l)(e \ln S + q_B s_B - T_B) \\ & l(T_A - c s_A) + (1-l)(T_B - c s_B) - rS \end{aligned} \qquad (8)$$

From the first order conditions, we get

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[3] The type A can not take any arbitrage behavior to choose s_A in ***S*** because indicator ***S*** has been recognized by the monopolist.

[4] We give the proof in Appendix 1.

$$S^W = l s_A{}^W + (1-l) s_B{}^W = \frac{e}{-q_A/2 + -q_B/2 + c + r} \qquad (9)$$

By considering equations (6) and (7), we can rewrite the monopolist's maximization problem such as

$$\begin{aligned} \underset{s_A, s_B}{Max}\ p = {} & l(q_A s_A - q_A s_B + e \ln S + q_B s_B - c s_A) \\ & + (1-l)(e \ln S + q_B s_B - c s_B) - rS \end{aligned} \qquad (10)$$

From the first order conditions, we obtain

$$S^* = l s_A{}^* + (1-l) s_B{}^* = \frac{e}{-q_B + c + r} \qquad (11)$$

By comparing equations (9) and (11), we can derive ***Proposition 1***.

Proposition 1

When the two consumers have different preferences for environmental quality of green products, direct regulation on the quality per green product will be desirable for environmental improvement as well as social welfare.

Proof: See Appendix 2

4. The Effects of indirect regulation

Now let us examine the effects of such indirect regulation as subsidy and tax abatement for green products on environmental improvement. To assess those effects, we add the two policy parameters, ***G*** and ***M***. The former expresses the subsidy to the R&D for the quality of green products. The latter implies consumers' tax abatement to environmental quality of green products.

4.1 The effect of subsidy for R&D

Subsidy for R&D: ***G***

When the subsidy for R&D is given to the monopolist, the profit function is

$$\begin{aligned} p = {} & l(q_A s_A - q_A s_B + e\ln S + q_B s_B - cs_A) \\ & (1-l)(e\ln S + q_B s_B - cs_B) - (r-G)S \end{aligned} \qquad (12)$$

Finally, we can derive

$$\frac{dS^*}{dG} \geq 0, \quad (\text{where} S^* = ls_A^* + (1-l)s_B^*) \qquad (13)$$

4.2 The effects of tax abatement for the consumers

Case 1 Tax Abatement for both types: M

When tax abatement is given to type A and B, their utility functions are

$$V_A = E + (q_A + M)s_A - T_A, \qquad (14)$$
$$V_B = E + (q_B + M)s_B - T_B. \qquad (15)$$

We can derive

$$\frac{dS^*}{dM} \geq 0 \qquad (16)$$

Therefore an increase in tax abatement for all consumers is desirable for environmental improvement.

Case 2 Tax Abatement for type A: M_A

We put $\boldsymbol{M_A}$ in the type A's utility,

$$V_A = E + (q_A + M_A)s_A - T_A. \qquad (17)$$

We can derive

$$\frac{dS^*}{dM_A} = 0 \qquad (18)$$

Therefore an increase in tax abatement given only to type A has no effect on environmental improvement.

Case 3 Tax Abatement for type B: M_B

We put $\boldsymbol{M_B}$ in the type B's utility,

$$V_B = E + (q_B + M_B)s_B - T_B . \qquad (19)$$

We can derive

$$\frac{dS^*}{dM_B} \geq 0. \qquad (20)$$

Proposition 2

The tax abatement policy for type A, relatively higher demand for environmental quality per green product, has no effect on environmental improvement, while the tax abatement policy for type B, relatively lower demand for the quality, has a positive effect on environmental improvement.

Proof: See Appendix 3

5. Concluding remarks

We have examined the effects of environmental quality of green products on environmental improvement, and direct and indirect regulation, by specifying two types of consumers' behaviors and the pricing and quality selection of a monopolist. Our analysis estimates that, while direct regulation on, and subsidy for R&D for environmental quality will be desirable for environmental improvement, the tax abatement policy does not necessarily have a positive impact on the environment. Since this conclusion does not coincide with current practices related to environmental policies, it will contribute to setting a new agenda for desirable environmental policies.

Our model should be developed in order to bring more confidential discussion. While the model focused on pricing and quality selection behaviors of a monopolist, it simplified too much the complicated relationships among consumers and the monopolist. The problems of environmental externality might become more difficult to

be dealt with, if the relationships are described more in detail. Moreover since asymmetric information exists between the regulator and a monopolist, we need to analyze an incentive scheme to design a sophisticated regulatory framework for the environment. Those assignments remain to be investigated.

Appendix

Appendix 1

We prove that equations (4) and (5) are the necessary and sufficient conditions for satisfying the individual rational and incentive compatible constraints of the two consumers. Firstly, we prove that the individual rationality condition of high demand types is satisfied with the optimal solution.

$$e\ln S - q_A s_A - q_A s_A + q_A s_B - e\ln S - q_B s_B > 0$$
$$\Leftrightarrow (q_A - q_B)s_B > 0 \qquad \text{(A1)}$$

Next we will prove that the incentive compatible constraint of low demand type is satisfied with the optimal solution.

$$e\ln S + q_B s_B - e\ln S - q_B s_B \geq e\ln S + q_B s_A - q_A s_A + q_A s_B - e\ln S - q_B s_B$$
$$\Leftrightarrow 0 \geq (q_B - q_A)(s_A - s_B) \qquad \text{(A2)}$$

(A1), (A2) are satisfied by assumptions. Therefore equation (4) and (5) represent the individual rational and incentive compatible constraints for the all types of consumers.

Appendix 2

We prove ***Proposition 1***. Let us compare equations (9) and (11). If $S^W > S^*$, direct regulation on the quality level is necessary for environmental improvement because of $dE/dS > 0$.

By calculating, we can get

$$\frac{1}{S^W} - \frac{1}{S^*} = \frac{q_B - q_A}{2e} \qquad \text{(A3)}$$

(A3) is always negative because $q_B < q_A$ is always satisfied by assumption.
Therefore since $S^W > S^*$ is always satisfied, direct regulation on the quality level is desirable in terms of environmental improvement as well as social welfare.

(Q.E.D)

Appendix 3

We prove ***Proposition 2***

The monopolist's profit function with M_A is

$$\underset{s_A, s_B}{Max}\ p = l[(q_A + M_A)s_A - (q_A + M_A)s_B + e\ln S + q_B s_B - cs_A] + (1 - l)[e\ln S + q_B s_B - cs_B] - rS. \quad \text{(A4)}$$

From the first order conditions, we obtain

$$\frac{[l^2 + l(1-l)]e}{S} + lq_A + lM_A - lc - lr = 0 \quad \text{(A5)}$$

$$\frac{[(1-l)^2 + l(1-l)]e}{S} - lq_A - lM_A + lq_B + (1-l)c - (1-l)r = 0 \quad \text{(A6)}$$

By using (A5) and (A6), we can derive $dS^*/dM_A = 0$. Thus we can say $dE/dM_A = 0$, which means no effect of the tax abatement policy for the type A on an increase in environmental improvement.

(Q.E.D)

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