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Abstract

We analyze the effect of collective action vs green/environmentally aware consumers on ambient environmental quality and market equilibrium. We consider a model with two types of consumers who differ in their willingness-to-pay for a good available in two different environmental qualities, and two competing firms: one selling the good of high environmental quality and the other of low environmental quality. We show that collective action by green consumers reduces competition and leads to higher prices for the good of both qualities. Though it improves the ambient environmental quality, it may reduce the welfare of both types of consumers.

Keywords: green consumers, collective action, environmental quality, differentiated duopoly, firm profitability.

JEL Classification: H23, Q20, L13

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Green Consumerism and Collective Action

1. Introduction

An increasing number of consumption goods such as organic food are perceived to be of higher environmental quality. Consumer's preference to buy goods from less polluting firms is well known, especially in developed countries, and is often revealed through increased willingness-to-pay for goods viewed as "green", that is, those produced with the help of environmentally friendly technologies or with the use of less polluting inputs.

Consumption of green goods often generates both private and public benefits. For example, a consumer benefits directly from consuming organic food because it is more nutritious and healthier with fewer risks to personal health from pesticides and herbicide residues.[2] Another example is organic skin-care products like organic soap which is perceived to be less harmful to the skin than conventional soap containing synthetic ingredients/chemicals. Arora and Cason (1995, 1996), Henriques and Sadorsky (1996), Khanna and Damon (1999), and Anton, Deltas, and Khanna (2004) show that such private benefits from the consumption of a green good can induce consumers to pay more for it and firms to invest in cleaner technologies. However, Erikkson (2004) shows that though this may internalize the negative externalities from the production of the good to some extent, it may have only a modest impact and lead to only a small reduction in total pollution.

Besides the direct private benefits to individual consumers, consumption of green goods also generates indirect public benefits as it helps in preserving the environment. Continuing with the example of organic food, organic farms are more sustainable and environmentally better than conventional farms because they do not release synthetic pesticides or herbicides into the environment. Thus, consumption of organic food not

[2] This is different from the "warm glow" effect (see Andreoni (1989) and Ribar and Wilhelm (2002)) when a consumer drives additional utility from the consumption of a cleaner good simply from knowing that it will not contribute to pollution.

only directly benefits a consumer, but also helps in preserving and sustaining diverse ecosystems which indirectly benefit all consumers.

Cremer and Thisse (1999), Bansal and Gangopadhyay (2003), Erikkson (2004), and Conrad (2005) consider models of price competition and product differentiation when consumers are environmentally aware. These models address many important questions concerning the impact of green consumerism on market equilibrium and the role of various economic instruments for bringing improvements in the ambient environmental quality. However, they all assume individual action by environmentally aware consumers. Since each consumer acting individually cannot be assumed to take into account the impact of his consumption on total pollution or the ambient environmental quality, as it is negligible, the ambient environmental quality in these models is assumed to be exogenously given. For instance, when a consumer buys organic food, he is unlikely to think that it will help preserve the environment or the ecosystem in any significant way. But he buys it because of its health benefits to him. Accordingly, each consumer in these models is assumed to think that it is the aggregate and not the individual consumption that determines the ambient environmental quality and the public benefits from the consumption of cleaner goods are ignored from the analysis.

However, if consumers come together and decide collectively whether or not to buy a good, then they can influence the total pollution level or the ambient environmental quality. For instance, if all consumers sharing a common economic-ecological system come together and collectively decide to buy only organic food, then besides the private benefits from the consumption of the organic food the consumers will also benefit from an improved ambient environmental quality.[3] In fact, this might be the reason why consumers sometimes do come together and decide collectively to buy only organic food. The Organic Consumers Association (OCA) in the US is one such example of

[3] The underlying assumption here is that the consumers share a common environment in which both consumption and production take place.

mobilization of hundreds of thousands of consumers who buy only organic food.[4] How does such collective action by environmentally aware consumers affect the ambient environmental quality and prices of a good available in different environmental qualities? Does such collective action decrease or increase the profits of firms? This paper begins to analyze the impact of such collective action by green consumers on market equilibrium, ambient environmental quality, and consumer welfare.

We consider a model with two types of consumers: one with a high willingness- to- pay for a good available in different environmental qualities and the other with a low willingness- to- pay, and two competing firms: one selling a good of high environmental quality and the other of low environmental quality. We assume that the consumers with the high willingness-to pay may decide collectively to buy the good of high environmental quality so as to encourage cleaner production. Since such collective action by the consumers can improve the ambient environmental quality, we treat ambient environmental quality as a choice variable in the consumer's utility maximization problem.

Our analysis throws up some interesting results. We show that collective action, especially by the consumers with a high willingness-to-pay for the good of higher environmental quality, reduces competition and leads to higher prices for the good of both qualities. This comes from the fact that coming together of the consumers and collective action by them internalizes the negative externalities from the production of the good to a greater extent and allows the firm producing the good of higher environmental quality to charge a higher price. Though such collective action improves the ambient environmental quality and provides the firms stronger incentives to adopt cleaner technology, it may reduce the welfare of both types of consumers. This obviously has some important policy implications: rather than opposing collective action by green consumers, the firms may be better off supporting it. Collective action is equivalent to

[4] It is an association of consumers to promote a more responsible and sustainable approach to food production. Similarly, consumers have come together to stop buying PVC (polyvinyl chloride) products from retailers like Wal-Mart who sell such products.

foregoing free riding which allows the firm to charge the consumers for the positive externality from its cleaner production of the good.

The rest of the paper is organized as follows. We describe the model in section 2. In section 3, we characterize the market equilibrium under the assumption that the consumers act individually. In section 4, we characterize the equilibrium when the consumers act collectively to decide the quality of the good they should buy. Section 5 analyzes the impact of such collective action by the consumers on the market equilibrium, the ambient environmental quality, and consumer welfare. Section 5 draws the conclusion.

2. The model

We consider a model with two firms both of which produce a physically homogeneous good of different environmental qualities. The environmental quality of the good depends on the cleanliness of the technology used to produce it - the cleaner the technology, the higher the perceived environmental quality of the good.

We assume that the cost of producing one unit of the good of environmental quality s is $c(s)$ with $c'(s)>0$ and $c''(s)>0$. To keep matters simple, we assume that the good can be produced in only two environmental qualities: high, to be denoted by s_H, and low, to be denoted by s_L. Let $c_H \equiv c(s_H)$ and $c_L \equiv c(s_L)$. Without loss of generality, we assume that firm 1 produces the low quality s_L, and firm 2 produces the high quality s_H.

We consider a population of consumers (who share the same economic-ecological system) with different preferences/willingness-to-pay for the good of both qualities. We assume that each consumer buys either none or one unit of the good. The consumers are environmentally aware and willing to pay a higher price for the good if it is of higher environmental quality. The utility of a consumer who buys one unit of the good of quality s is

$$U = \theta s - p + S$$

where p is the price of one unit of the good of quality s, θ is consumer's preference for the good, and S represents the average ambient environmental quality. To keep matters simple, we assume that there are only two types of consumers with preferences as θ_H and θ_L with $\theta_H > \theta_L$. Let λ denote the proportion of consumers with low preference for quality of the good and $1-\lambda$ the proportion of consumers with high preference for quality of the good.

If s and t are the qualities of the good purchased by the low- and high- type consumers, respectively, the average ambient environmental quality $S = \lambda s + (1-\lambda)t$. Under our assumption, $s, t \in \{s_L, s_H\}$.

Let p_L and p_H denote the prices of one unit of the good of low and high environmental qualities, respectively. We assume that firms set prices of the good of high and low qualities so as to maximize their profits, given the preferences of the consumers. In order to rule out cases in which a firm may not find it profitable to sell its product to some consumers, we make the following assumption:

Assumption 1: $\theta_L s_L - c_L > 0$ and $\theta_L s_H - c_H > 0$.

Since $\theta_H > \theta_L$, Assumption 1 also implies $\theta_H s_L - c_L > 0$ and $\theta_H s_H - c_H > 0$. Furthermore, if $\theta_L s - p \geq 0$, then $\theta_H s - p > 0$, which means that if a low-type consumer is willing to buy the good of quality s, then so is a high-type consumer. Thus, it is never the case that the low-type consumers buy the good of some quality, but the high-type consumers do not buy the good of any quality. Since $\theta_H > \theta_L$ and $s_H > s_L$, the two inequalities $\theta_L s_H - p_H > \theta_L s_L - p_L$ and $\theta_H s_L - p_L > \theta_H s_H - p_H$ can never hold at the same time whatever be the prices p_L and p_H. Thus, it is never the case that the low-type

consumers buy the good of high quality and the high-type consumers buy the good of low quality.

In order to ensure the existence of an equilibrium, we make the following assumption:

Assumption 2: $\theta_H \leq \lambda\theta_L + (1-\lambda)\dfrac{c_H - c_L}{s_H - s_L} < \theta_H + 1 - \lambda.$

Since $\theta_H > \theta_L$, Assumption 2 is satisfied *only* if $\theta_H(s_H - s_L) < c_H - c_L$, i.e., if the cost of production increases by more than the willingness-to-pay.

3. Individual action and equilibrium prices

In this section, we adopt the standard assumption in this literature that each consumer acting individually takes the ambient environmental quality as given and ignores it from his utility function, even though his utility depends on it. As noted in the introduction to the paper, consumption of green goods by a consumer generates both private and public benefits as it reduces total pollution and improves the ambient environmental quality. However, when consumers act individually, each one thinks that the impact of his consumption on the total pollution or the ambient environmental quality is negligible, that is, it is the aggregate, rather than the individual consumption that affects the ambient environmental quality. A consumer's decision to buy a green good is then motivated entirely by his own private benefits from its consumption. Accordingly, in this section, we will ignore the average ambient environmental quality S from the utility functions of both types of consumers.

There are five types of equilibriums possible: (1) the high-type consumers buy the good of low quality and the low-type consumers do not buy the good of any quality, (2) both types of consumers buy the good of low quality, (3) the low-type consumers buy the good of low quality and the high-type consumers buy the good of high quality, (4) the low-type

consumers buy the good of high quality and the high-type consumers buy the good of low quality, and (5) both type consumers buy the good of high quality.

These do not include the possibility of an equilibrium in which the low-type consumers buy the good of low-quality, but the high-type consumers do not buy the good of any quality, since, as noted, it is never the case that the low-type consumers buy the good of some quality, but the high-type consumers do not buy the good of any quality. Equilibrium of type (4) is ruled out by Assumption 1, which, as noted, implies that it is never the case that the low-type consumers buy the good of high quality and the high-type consumers buy the good of low quality.

Existence of type (5) equilibrium requires $\theta_L s_H - p_H \geq \theta_L s_L - c_L$ or $\theta_L(s_H - s_L) \geq p_H - c_L \geq c_H - c_L$, which is ruled out by Assumption 2. We thus consider only type (1), (2), and (3) equilibriums.

It is convenient to first prove the existence of a type (2) equilibrium in which both types of consumers buy only the good of low quality. Such an equilibrium is a pair (p_L, p_H) such that

$$\theta_L s_L - p_L \geq 0,\ \theta_H s_L - p_L \geq 0,\ p_L \geq c_L, \text{ and } p_H = c_H. \quad (1)$$

$$\theta_L s_L - p_L \geq \theta_L s_H - p_H \text{ and } \theta_H s_L - p_L \geq \theta_H s_H - p_H. \quad (2)$$

Since $\theta_H > \theta_L$, inequality (1) implies $\theta_H s_L - p_L > 0$. Thus, in this equilibrium both types of consumers buy the good of low quality and the profit of firm 1 is $p_L - c_L$. Since $\theta_H > \theta_L$ and $s_H > s_L$, the first inequality in (2) is weaker than the second inequality in (2).

Substituting, from the first inequality in (2) and using $p_H = c_H$, $\theta_L s_L - p_L \geq$

$\theta_L s_L - \theta_L s_L + \theta_L s_H - c_H > 0$ (using Assumption 1). Since, as already noted, the first inequality in (2) is weaker than the second, this means that $\theta_L s_L - p_L > 0$ and thus $\theta_H s_L - p_L > 0$ for all prices p_L that satisfy the second inequality in (2). Since the firms maximize profits, the second inequality in (2) must hold with equality. Thus, this equilibrium is defined by the inequalities (1) and

$$\theta_H s_L - p_L = \theta_H s_H - c_{H.} \tag{3}$$

Furthermore, it should not be possible for firm 1 to raise its price and obtain higher profits. Define p'_L such that

$$\theta_L s_L - p'_L = \theta_L s_H - c_H. \tag{4}$$

Comparing (3) and (4) and using $s_H > s_L$ and $\theta_H > \theta_L$, it follows that $p'_L > p_L$. If firm 1 raises its price of low quality good to p'_L, then only the low-type consumers will buy from it and high-type consumers will switch to the good of high quality sold by firm 2. Thus, the profit of firm 1 will be then equal to $\lambda(p'_L - c_L)$. Since (p_L, p_H) is an equilibrium, it must be the case that

$$\lambda(p'_L - c_L) \leq p_L - c_L. \tag{5}$$

Substituting from (3) and (4), inequality (5) is equivalent to

$$\lambda(\theta_L s_L - \theta_L s_H + c_H - c_L) \leq \theta_H s_L - \theta_H s_H + c_H - c_L.$$

That is,

$$(\theta_H - \lambda\theta_L)(s_H - s_L) \leq (1-\lambda)(c_H - c_L).$$

Assumption 2 implies that this inequality is indeed true. Using equality (3), the profit of firm 1 is

$$\pi_1 = p_L - c_L = \theta_H s_L + c_H - \theta_H s_H - c_L = c_H - c_L - \theta_H (s_H - s_L). \quad (6)$$

By Assumption 2, $\pi_1 > 0$.

Since the maximum price at which firm 1 can sell its product to the high-type consumer is $\theta_H s_L$, type (1) equilibriums is ruled out if $\pi_1 > (1-\lambda)(\theta_H s_L - c_L)$. Substituting from (6), this inequality is equivalent to $(c_H - \lambda c_L) > \theta_H (s_H - \lambda s_L)$. In view of Assumption 2, this inequality clearly holds if the distribution parameter λ is sufficiently large, but less than 1, i.e., if the proportion of low-type consumers is sufficiently high.

We now drive the condition which rules out the existence of type (1) equilibrium. Such an equilibrium is possible only if $(1-\lambda)(p_L - c_L) \geq \pi_1 = c_H - c_L - \theta_H (s_H - s_L)$. By Assumption 2, the right hand side of this inequality is strictly positive. Type (1) equilibrium is thus ruled out if the distribution parameter λ is sufficiently large, but less than 1.

We show next that Assumption 2 rules out the possibility of type (3) equilibrium in which the low-type consumers buy the good of low quality and the high-type consumers of high quality. Such an equilibrium, if it exists, is a price pair (p_L, p_H) such that,

$$\theta_L s_L - p_L \geq 0,\ \theta_H s_H - p_H \geq 0,\ \ p_L - c_L \geq 0,\ \ p_H - c_H \geq 0 \quad (7)$$

$$\theta_H s_H - p_H \geq \theta_H s_L - p_L \quad (8)$$

$$\theta_L s_L - p_L \geq \theta_L s_H - p_H \quad (9)$$

The inequalities in (7) denote the participation constraints of the consumers and the firms. Inequalities (8) and (9) represent the self-selection constraints of the high- and low-type consumers, respectively.

Since (p_L, p_H) is an equilibrium, it should not be possible for firm 1 to lower its price such that, besides the low-type consumers, the high-type consumers also prefer to buy the good of low quality and the profit of firm 1 is higher. Thus, if $p'_L < p_L$ and $\theta_H s_L - p'_L \geq \theta_H s_H - p_H$, then $p'_L - c_L \leq \lambda(p_L - c_L)$. This means that (p_L, p_H) must be such that

$$\theta_H s_H - p_H \geq \theta_H s_L - \lambda p_L - (1-\lambda)c_L \tag{10}$$

Similarly, firm 2 should not be able to lower its price such that its profit is higher. That is, $p'_H < p_H$ and $\theta_L s_H - p'_H = \theta_L s_L - p_L$, then $p'_H - c_H \leq (1-\lambda)(p_H - c_H)$. Substituting for p'_H and reorganizing, this inequality is equivalent to

$$\theta_L s_L - p_L \geq \theta_L s_H - (1-\lambda)p_H - \lambda c_H \tag{11}$$

Comparing inequalities (8) and (10), it is seen that inequality (8) is implied by inequalities (10) and $p_L \geq c_L$, as in (7). Similarly comparing inequalities (9) and (11), it is seen that inequality (9) is implied by inequalities (11) and $p_H \geq c_H$, as in (7). Therefore, type (3) equilibrium, if it exists, is a price pair (p_L, p_H) that satisfies inequalities (7), (10), and (11).

Since firms maximize profits, we solve for the equilibrium prices by taking (10) and (11) as equalities. Thus the equilibrium prices are

$$p_L = \frac{(s_H - s_L)((1-\lambda)\theta_H - \theta_L) + (1-\lambda)^2 c_L + \lambda c_H}{1-\lambda+\lambda^2}, \tag{12}$$

$$p_H = \frac{(s_H - s_L)(\theta_H - \lambda\theta_L) + (1-\lambda)c_L + \lambda^2 c_H}{1-\lambda+\lambda^2}. \tag{13}$$

After some algebra and using Assumption 2, it can be verified that the so-defined prices p_L and p_H satisfy the participation constraints (7) if the distribution parameter λ is sufficiently large, but less than 1. Thus, the profit of firm 1 is

$$\pi_1 = \lambda(p_L - c_L).$$

After substitution from equation (12),

$$\pi_1 = \lambda \frac{(s_H - s_L)((1-\lambda)\theta_H - \theta_L) + \lambda(c_H - c_L)}{1-\lambda(1-\lambda)} > 0,$$

by Assumption 2. Similarly, the profit of firm 2 is

$$\pi_2 = (1-\lambda)(p_H - c_H).$$

After substitution from (13),

$$\pi_2 = (1-\lambda)\frac{(s_H - s_L)(\theta_H - \lambda\theta_L) - (1-\lambda)(c_H - c_L)}{1-\lambda+\lambda^2}.$$

However, Assumption 2 implies $\pi_2 < 0$. This shows that there exits no type (3) equilibrium.

Hence, we have shown that, if consumers act individually and the proportion of low-type consumers is sufficiently large, then there exists an equilibrium of type (2) which is unique. It is defined by inequalities (1) and (3).

4. Collective action and equilibrium prices

Having defined the equilibrium for the case when the consumers act individually, we analyze next the case in which the consumers act collectively. As noted in the introduction to the paper, environmentally aware consumers may mobilize themselves and decide collectively to buy only the good of higher environmental quality. The consumers realize that when they act collectively they can influence the total pollution or the ambient environmental quality.

Such collective action is likely to lead to an improvement in the ambient environmental quality. But it is not clear how it might affect the market prices, profits of the firms, and consumer welfare.

We assume that the high-type of consumers form a group and decide collectively whether to buy or not the high quality good. They realize that they can influence the ambient environmental quality. Hence, the high-type consumers no longer take the ambient environmental quality S as exogenously given, and it now enters their utility as a choice variable. The aggregate environmental quality $S = \lambda s + (1-\lambda)t,$ if s and t are the qualities of the good purchased by the low- and high- type consumers, respectively. Under our assumptions, $s,t \in \{s_L, s_H\}$. Let p and q be the prices of the good of qualities s and $t,$ respectively. Then, the utility of a low-type consumer who buys one unit of the good of quality s is $U = \theta_L s - p + S = (\theta_L + \lambda)s - p + (1-\lambda)t$ and the utility of a high-type consumer who buys the good of quality t is $U = (\theta_H + 1 - \lambda)t - q + \lambda s.$

Since $\theta_H > \theta_L,$ if $\theta_L s - p \geq 0$ then $(\theta_H + 1 - \lambda)s - p > 0$, which means that if a consumer with the low preference for quality and acting individually is willing to buy

the good of quality s, then so is a consumer with the high preference for quality and acting collectively. Thus, it can never be the case that the low-type consumers buy the good of some quality, but the high-type consumers do not buy the good of any quality. Since $\theta_H > \theta_L$ and $s_H > s_L$, whatever be the prices (p_L, p_H) the two inequalities $\theta_L s_H - p_H > \theta_L s_L - p_L$ and $(\theta_H + 1 - \lambda)s_L - p_L > (\theta_H + 1 - \lambda)s_H - p_H$ cannot hold at the same time. In words, whatever the prices p_L and p_H it is never the case that the low-type consumers acting individually buy the good of high quality, but the high-type consumers buy the good of low quality.

We assume that while the high-type consumers form a group and engage in collective action, the low-type consumers continue to act individually. In order to analyze the effect of such collective action by the high-type consumers on the prices and profitability of the firms, we first characterize the market equilibrium.

An equilibrium is a pair (p_L, p_H) such that

$$\theta_L s_L - p_L \geq 0, \quad p_L - c_L \geq 0, \quad p_H - c_H \geq 0 \tag{14}$$

$$\theta_L s_L - p_L \geq \theta_L s_H - p_H \tag{15}$$

$$\theta_H s_H - p_H + (1 - \lambda)s_H \geq \theta_H s_L - p_L + (1 - \lambda)s_L \tag{16}$$

Inequality (16) highlights the fact that the high-type of consumers decide collectively whether to buy the good of high or low quality taking as given the quality bought by the low-type consumers.

Since the firms engage in price competition, firm 2 should not be able to lower its price such that, besides the group of the high-type consumers, the low-type consumers also prefer to buy the good of high quality and firm 2 finds it profitable to sell the good of

high-quality to both types of consumers than to only the high-type consumers, that is, if p'_H is such that

$$\theta_L s_H - p'_H > \theta_L s_L - p_L \text{, then } p'_H - c_H \leq (1-\lambda)(p_H - c_H). \tag{17}$$

Thus, (p_L, p_H) should be such that

$$\theta_L s_L - p_L \geq \theta_L s_H - (1-\lambda) p_H - \lambda c_H. \tag{18}$$

Similarly, it should not be possible for firm 1 to lower its price such that, besides the low-type consumers, the high-type consumers also collectively decide to buy the low-quality good and its profit is higher, that is, if p'_L is such that

$$\theta_H s_L - p'_L + (1-\lambda)s_L > \theta_H s_H - p_H + (1-\lambda)s_H \text{, then } p'_L - c_L \leq \lambda(p_L - c_L). \tag{19}$$

Note that we can ignore the constraint $\theta_L s_L - p'_L > \theta_L s_H - p_H$ because it is weaker than inequality (19). Thus, (p_L, p_H) should be such that

$$\theta_H s_H - p_H + (1-\lambda)s_H \geq \theta_H s_L - \lambda p_L - (1-\lambda)c_L + (1-\lambda)s_L. \tag{20}$$

Clearly, inequalities (15) and (16) are weaker than inequalities (18) and (20), respectively. Thus, inequalities (14), (18) and (20) define the equilibrium. Since the firms maximize profits, inequalities (18) and (20) must hold with equality in equilibrium. Thus, (p_L^*, p_H^*) is an equilibrium if

$$p_L^* = \frac{(s_H - s_L)((1-\lambda)(\theta_H + 1 - \lambda) - \theta_L) + (1-\lambda)^2 c_L + \lambda c_H}{1 - \lambda + \lambda^2} \tag{21}$$

$$p_H^* = \frac{(s_H - s_L)((\theta_H + 1 - \lambda) - \lambda\theta_L) + (1-\lambda)c_L + \lambda^2 c_H}{1 - \lambda + \lambda^2}. \qquad (22)$$

As in the case of prices p_L and p_H, defined in (12) and (13), it can be verified that the so-defined prices p_L^* and p_H^* also satisfy the participation constraints (14) if λ is sufficiently large, but less than 1. In fact, the larger the λ, smaller the difference between p_L and p_L^* or p_H and p_H^*.

Assumption 2 implies $p_H^* > p_L^* > 0$. Substituting from (21) and (22), the profit of firm 1 is

$$\pi_1^* = \lambda(p_L^* - c_L) = \lambda\frac{(s_H - s_L)((1-\lambda)(\theta_H + 1 - \lambda) - \theta_L) + \lambda(c_H - c_L)}{1 - \lambda + \lambda^2},$$

and that of firm 2 is

$$\pi_2^* = (1-\lambda)(p_H^* - c_H) = (1-\lambda)\frac{(s_H - s_L)((\theta_H + 1 - \lambda) - \lambda\theta_L) - (1-\lambda)(c_H - c_L)}{1 - \lambda + \lambda^2}.$$

Proposition 1: Collective action by high-type consumers leads to higher prices of the good of both qualities.

Proof: Using Assumption 2,

$$p_L^* > \frac{(s_H - s_L)((1-\lambda)(\lambda\theta_L + (1-\lambda)\frac{c_H - c_L}{s_H - s_L}) - \theta_L) + (1-\lambda)^2 c_L + \lambda c_H}{1 - \lambda(1-\lambda)}$$

$$= \frac{(1-\lambda)^2(c_H - c_L) - (1 - \lambda(1-\lambda))\theta_L(s_H - s_L) + (1-\lambda)^2 c_L + \lambda c_H}{1 - \lambda(1-\lambda)}$$

$$= c_H - \theta_L (s_H - s_L). \qquad (23)$$

Since $\theta_H < \theta_L$, it follows from (3) that $p_L^* > p_L$. Similarly, using Assumption 2,

$$p_H^* > \frac{(1-\lambda)(c_H - c_L) + (1-\lambda)c_L + \lambda^2 c_H}{1-\lambda(1-\lambda)} = c_H .$$

It follows from (1) that $p_H^* > p_H$.

When high-type consumers collectively decide which quality of the good to buy, they internalize the externality associated with the consumption of the good. This impacts the market equilibrium in two different ways.

First, it allows the firm producing the good of high quality to charge a higher price. Accordingly, this firm now earns positive profits, which are equal to $(1-\lambda)$ $(p_H^* - c_H) > 0,$ as shown.

Second, it reduces competition and as a result the firm producing the good of low quality is also able to charge a higher price. However, the impact of this on the profit of firm 1 is ambiguous. On the one hand, the profit of firm 1 should be higher because it is able to charge a higher price for the good produced by it, but on the other hand, the profit should be lower because fewer consumers buy the good. The profit of firm 1 in the two cases are $(p_L - c_L) = (c_H - c_L - \theta_H (s_H - s_L))$ and $\lambda(p_L^* - c_L)$ which, using (22), is not less than $\lambda(c_H - c_L - \theta_L (s_H - s_L))$. Since $\theta_L < \theta_H, s_H > s_L,$ and $\lambda < 1,$ the profit of firm 1 may be higher or lower depending on the distribution parameter $\lambda,$ the difference in the willingness- to- pay θ_H - θ_L of the two types of consumer, and the difference in the quality $s_H - s_L$. If the number of consumers with higher willingness-to-pay is small (i.e. λ is large), the profit of firm 1 is more likely to be higher. It was shown above that collective action by the consumers leads to a positive profits for firm 2. This means that

both firms stand to gain from collective action by the high-type consumers, especially if the proportion of such consumers is not high.

5. Collective action and consumer welfare

We have shown that collective action by high-type consumers leads to higher prices for the good of both qualities, and higher profits for both the firms if proportion of the low-type consumers is sufficiently high. Since the high-type consumers switch to the good of high environmental quality, it also leads to an improved ambient environmental quality. We now examine whether the improvement in the ambient environmental quality is sufficient to outweighs the increase in prices and improve the overall welfare of the consumers.

Proposition 2: Collective action by the high-type consumers may lower the welfare of both types of consumers.

Proof: Since in the absence of collective action by the high-type consumers only the good of low quality is produced and consumed, the average ambient environmental quality $S = s_L$. The welfare of a low-type consumer is then

$$W_L = \theta_L s_L - p_L + s_L,$$

and that of a high-type consumer is

$$W_H = \theta_H s_L - p_L + s_L,$$

Substituting for p_L from (3)

$$W_L = \theta_L s_L + \theta_H (s_H - s_L) - c_H + s_L, \tag{24}$$

$$W_H = \quad \theta_H s_L + \theta_H (s_H - s_L) - c_H + s_L = \theta_H s_H - c_H + s_L .$$

When the high-type consumers act collectively the average ambient environmental quality $S = \lambda s_L + (1-\lambda) s_H$. The welfare of a low-type consumer is then

$$W_L^* = \theta_L s_L - p_L^* + \lambda s_L + (1-\lambda) s_H ,$$

and that of the high-type consumer is

$$W_H^* = \theta_H s_H - p_H^* + \lambda s_L + (1-\lambda) s_H ,$$

where, as shown, $p_L^* > p_L$. Using Assumption 2 and inequality (23),

$$W_L^* < \theta_L s_L - c_H + \theta_L (s_H - s_L) + \lambda s_L + (1-\lambda) s_H . \qquad (25)$$

Comparing (24) and (25), $W_L^* < W_L$ if $\theta_L + (1-\lambda) \le \theta_H$. Since $\theta_L < \theta_H$, this is indeed true if λ is sufficiently large.

Next, we compare W_H and W_H^* are not generally comparable. Substituting from (22),

$$W_H^* = \theta_H s_H - \frac{(s_H - s_L)((\theta_H + 1 - \lambda) - \lambda\theta_L) + (1-\lambda)c_L + \lambda^2 c_H}{1 - \lambda + \lambda^2} + \lambda s_L + (1-\lambda) s_H .$$

Thus, $W_H^* \ge W_H$ if and only if

$$(1-\lambda)(s_H - s_L) \ge \frac{(s_H - s_L)((\theta_H + 1 - \lambda) - \lambda\theta_L) + (1-\lambda)c_L + \lambda^2 c_H}{1 - \lambda + \lambda^2} - c_H .$$

$$= (s_H - s_L)\frac{\theta_H + (1-\lambda) - (\lambda\theta_L + (1-\lambda)\frac{c_H - c_L}{s_H - s_L})}{1-\lambda(1-\lambda)}. \qquad (26)$$

Assumption 2 implies that the right hand side of this inequality is positive. Therefore, this inequality is not true, if the distribution parameter λ is sufficiently large, but less than 1. This completes the proof of Proposition 2.

We have shown that collective action by high-type consumers may reduce the welfare of both types of consumers, especially if the proportion of low-type consumers is sufficiently large. However, we obtained this result by ignoring the profits of the firms from our calculation of consumer welfare. It is more reasonable to assume that the consumers with a higher preference for environmental quality are share holders of the cleaner firm and thus include the profit of this firm in the calculations for the welfare of these consumers. Doing so does not reverse Proposition 2 except that the parameter λ should be larger. This is seen as follows:

Let $W_H^{**} = W_H^* + (1-\lambda)(p_H^* - c_H)$ where $(1-\lambda)(p_H^* - c_H)$ is the profit of firm 2. Then, $W_H^{**} \geq W_H$ if and only if

$$(1-\lambda)(s_H - s_L + c_H) \geq \lambda(s_H - s_L)\frac{\theta_H + (1-\lambda) - (\lambda\theta_L + (1-\lambda)\frac{c_H - c_L}{s_H - s_L})}{1-\lambda(1-\lambda)}.$$

This inequality, like inequality (26), does not hold, if λ is sufficiently large, but less than 1.

6. Conclusions

Our model begins with the observation that consumption of green goods may generate both private and a public benefits. It departs from the standard models of product

differentiation which take the ambient environmental quality as exogenously given. To the best of our knowledge this is the first model in which the ambient environmental quality is determined endogenously. It is also the first model that introduces and analyzes collective action by consumers in a differentiated duopoly model. Obviously, similar analysis is possible in many other contexts. For example, if agents decide collectively to choose between two alternative networks differing in quality. Such collective action can raise the quality of the network they join.

Our analysis shows that collective action by consumers is equivalent to their foregoing free riding which internalizes the externality to a greater extent. This enables the less polluting firm to charge a higher price for its product which reduces competition and allows the more polluting firm also to charge a higher price. Collective action thus leads to higher prices and profits for both the firms. We have identified sufficient conditions under which collective action leads to higher ambient environmental quality, but lower consumer welfare.

We assumed that both types of consumers have the same preference for the ambient environmental quality. It may seem more reasonable to assume instead that the high-type consumers have a higher preference for the ambient environmental quality. However, introducing such an assumption does not change the qualitative nature of our results except that collective action will have a stronger impact on equilibrium prices.

Our analysis is driven by the assumption that there is only one firm producing the good of each quality. If there are several firms producing the good of low quality, collective action by consumers may not reduce competition much. However, it may still lead to higher prices and profits for the firms if their number is finite.

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