Public, private and nonprofit regulation for environmental quality[1]

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Abstract

This paper studies the welfare implications of different institutions certifying environmental quality supplied by a monopoly. The monopolist can voluntarily certify the quality of the product through an eco-label provided either by an NGO or a for-profit private certifier (PC). The NGO and the PC may use advertisement to promote the label. We compare the NGO and PC regimes with the regime where the regulator imposes a minimum quality standard. The presence of a private certifier in the market decreases the scope for public intervention. The availability of green advertisement reinforces the above result.

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1 Introduction

Beside the traditional "command and control" approach and the market based instruments to regulate the environment, voluntary actions for abating pollution have been undertaken by firms. One reason for "self-regulation" is the emergence of green consumers, at least in developed nations, willing to pay a higher price for products of less impact on the environment.[1] Firms, expecting higher profits by differentiating their products in terms of environmental performance and thereby charging a higher price to these green consumers, have voluntarily reduced pollution. To be effective, such a differentiation in terms of environmental performance has to be credibly signalled to consumers. In effect, environmental quality of a product which involves production process, product components and raw materials is usually observable neither before nor after purchase and use, being a *credence attribute* of the product. We focus our analysis on environmental quality but this could apply also to problems like child labor, fair trade, etc; whenever consumers care about features of the good that are not observable from consumption. The most effective way to solve this type of information problem and to signal product quality is to rely on third party certification (Cason and Gangadharan, 2002). *Certification* is a process where a third party verifies the fulfilments of a firm to certain criteria or standards. Certification programs can be sponsored and/or administrated by governments or private companies (for profit and non-profit). These organizations provide information in different ways. While private companies tend to provide information by setting up voluntary codes of conduct and then providing labels to firms that comply, the regulator has the possibility to exclude from the market products that do not fulfill some standards.

Among the voluntary schemes promoted by private firms we have (eco)-labels. *Eco-labels* signal the products of less impact from production and use on the environment and can command a higher market price. This price premium gives producers an economic incentive to incur the additional costs associated with meeting the standards (Blend, p.1). Eco-labels provide an opportunity to inform consumers about product characteristics that may not be readily apparent.[2]

[1] Khanna (2001) presents a very comprehensive review of the current theoretical and empirical literature on voluntary cooperative environmental programs.

[2] A distinction should be made between self-label, where the interested party certifies the claim of the product and third party eco-labels where verification is carried out by an independent source that awards labels to products based on certain environmental criteria or standards.

The aim of our paper is to understand the multiplicity and the diversity of the institutions regulating environmental quality. We study the welfare implications of the coexistence of public and private environmental quality certification schemes.

The public certifier is a regulator, the private certifier may be either an NGO[3] which is a non profit institution or a for-profit private certifier (PC).[4] These certifiers mainly differ in the way of providing information and in the mandatory character of their certification schemes. The regulator maximizes social welfare and sets a mandatory minimum quality standard. The NGO and the private certifier propose a non compulsory label. The NGO maximizes environmental quality whereas the private certifier maximizes her profit. The NGO and the PC may use green advertisement to promote the label. The *green advertisement* aims at educating (persuading) consumers to buy more environmentally friendly goods. It is widely observed that private certifiers use the media to make consumers aware of the impact of buying polluting products, among other green issues.

Our paper builds mainly on the literature of self-regulation and certification. We focus mainly on Auriol and Schilizzi (2003), Alexander and Harding (2003) and Heyes and Maxwell (2004). Alexander and Harding (2003) also compare public and private certification schemes but they rather focus on firms' incentives to adhere to a label provided by a private certfier. Auriol and Schilizzi (2003) compare the performance of a privately funded certification against a public funded certification. Our focus goes beyond the incentives of the monopolist to voluntarily adhere to a private label, moreover, we study the incentives of a public or private (for-profit and not for profit) certifier to participate in the market and we allow for strategic interaction between them.

The closest to us in spirit is Heyes and Maxwell (2004). They compare the environmental and welfare implications of having either a public compulsory policy (a MQS) set by a World Environmental Organization (WEO) or a voluntary label certification set by an NGO. We differ in their approach by including in our analysis the persuasion made by the private certifier through the green advertisement. As

[3]Examples of non-profit institutions awarding eco-labels can be found in the Global Ecolabelling Network (GEN), an international non-profit association of third-party, environmental performance labelling organizations.

[4]Ecocert is an example of a for-profit private certifier. It highlights the organic attributes of a product by delivering a label to producers that fulffill some environmental criteria. For more information on Ecocert see http://www.ecocert.com. Another example is the Scientific Certification Systems (SCS), a commercial firm whose Environmental division certifies a wide variety of claims related to environmental achievement in product manufacturing and natural resource extraction.

a consequence, we develop a vertical differentiation model à la Mussa and Rosen (1978) with consumers differentiated by their willingness to pay for environmental quality and a multi-product (quality) monopoly.

The green advertisement can be an informative or a persuasive instrument. *Informative advertisement* only conveys information about the product attributes (Ibanez and Stenger, 2000 and Petrakis et al., 2005). We rather follow the second strand of the literature where advertisement, done by the labeler, is persuasive. *Persuasive advertisement* convince consumers to buy more environmentally friendly goods. Similar to Yu (2005) we stress the relevance of persuasion to shift policy towards the ideal outcome of the NGO. The green advertisement increases the utility of consumers buying the label independent of the quantity of consumers buying it. In this sense it is not a social norm (Lombardini-Riipinen, 2002). It is rather an individual norm but differs from the work of Brekke et al. (2003) as we do not compute any morally ideal behavior. The effect of such an advertisement on consumers' preferences is taken into account when the regulator interacts with a private certifier. Otherwise the optimal standard policy would be misrepresented (Bar-Gill and Fershtman, 2005). When comparing the MQS with the NGO label we study the indirect effects of the green advertisement on prices and quality. Comparisons are also made when the advertisement level is set at zero.

We first look at scenarios where there is only one certifier in the market and we make social welfare comparisons. The NGO sets, in all cases, a higher quality level than the PC or the regulator. Afterwards, we allow for interactions between the certifiers and look at the changes of optimal standard setting in the presence of a private ecolabel alternative and green advertisement. When the regulator is alone in the market the MQS corrects the externality problem by increasing average environmental quality. When the regulator interacts with a private certifier the MQS decreases average environmental quality, since it decreases demand for the high quality variant. The role of the MQS, when interacting with the NGO or the PC, is rather to correct for the excessive differentiation in order to increase consumer surplus and profits. We show that there is less public intervention in the presence of an eco-label alternative.

When the regulator interacts with a private certifier, the green advertisement decreases the scope for public intervention. Optimal standard setting clearly depends on the institution the regulator interacts with.

The rest of the paper is organized as follows. In section 2, we present the model.

In section 3, only public certification is available. We study the optimal MQS chosen by the regulator. Section 4 explores the NGO regime. The NGO sets a quality level at which a label is awarded to the monopolist. We study the effect on welfare of the label package constituted by a given level of environmental quality and a level of green advertisement. We next allow for strategic interaction between the regulator and the NGO. Section 5 shows what would be the label settled by a for-profit private certifier. We also explore the consequences on quality when the PC and the regulator interact in the market. Section 6 concludes.

2 The model

We develop a monopoly model of vertical differentiation. Environmental quality is our vertical differentiation variable. Consumers, then, prefer high environmental quality products to low quality ones when offered at the same price. The supply side consists of a monopoly selling at most two environmental quality variants of its product. The monopoly chooses the quality q of its variants in the range of environmental qualities technically feasible given by $[\underline{q}, \overline{q}]$. The monopoly can charge different prices for the good to reflect the differential in cost made for environmental quality. The production technology involves marginal cost of production independent of the quantity of good produced but strictly increasing and convex in the environmental quality q and is represented by $C(q) = cq^2$.

The demand side of the market consists of a continuum of consumers indexed by θ. The taste parameter θ can be interpreted as the marginal willingness to pay for environmental quality and is uniformly distributed on $[\underline{\theta}, \overline{\theta}]$. Each consumer either buys one unit of the differentiated commodity or does not participate at all in the market. If he does not buy the good, he has a reservation utility which is normalized to zero. Adapting from Cremer and Thisse (1999), the indirect utility of a consumer of type θ who buys a variant of perceived environmental quality q at price p is given by

$$V_\theta(p, q, E) = \theta q - p + \gamma E \tag{1}$$

where E is the average environmental quality over all consumers. The parameter $\gamma > 0$ measures the marginal social benefit of the externality associated to the average environmental quality.[5] To build up our model we assume that the consumer

[5] We suppose that the externality affects all consumers' utility in the same way.

with the highest valuation for quality is willing to pay twice the marginal cost of the lowest quality variant: $\overline{\theta} > 2c\underline{q}$. Private certifiers can make use of green advertisement, denoted by λ with $\lambda \in [0, \frac{\overline{\theta}}{3})$.[6] Using $q(\theta)$ to denote the quality consumed by a θ consumer, we have

$$E = \frac{1}{\overline{\theta} - \underline{\theta}} \int_{\underline{\theta}}^{\overline{\theta}} q(\theta) d\theta \tag{2}$$

The externality term is a constant for the consumer who is not aware of the impact of her decision on the environment. Thus the externality term does not affect consumer's maximization problem. However, it will not be a constant for the regulator who maximizes social welfare. Social welfare is utilitarian and is defined as the sum of consumer surplus, monopolist's profit and average environmental quality weighted by γ.

For notational simplicity, let us denote W_i (resp. π_i, CS_i, E_i) the social welfare (resp. the profit, the consumer surplus and the average environmental quality) when there is only one quality q_i available on the market, and $W_{i,j}$ (resp. $\pi_{i,j}$, $CS_{i,j}$, $E_{i,j}$) the social welfare (resp. the profit, the consumer surplus and the average environmental quality) when the qualities q_i and q_j are available on the market. Let p_i be the price of the variant i.

3 Public intervention

Consider that the regulator sets a MQS denoted by q_S. Such a standard is compulsory. The monopolist either supplies a quality at least equal to q_S or exits the market. The monopolist may supply a lower quality than the standard and pretend not to do so. Thus the regulator has to monitor and certify product quality. We assume that regulator's monitoring is almost perfect. In this setting, the probability that the regulator catches the monopolist when cheating on quality is almost one. The fixed cost of monitoring, denoted by K, is paid by the monopoly. We model the interaction between the regulator and the monopolist as a Stackelberg game: first the regulator fixes a standard q_S; second the monopolist decides to produce or not at this level. Last, if it stays on the market, the monopolist chooses a price p_S. We solve the model backwards. Given the information problem, consumers do not expect a quality level higher than q_S, so, the monopolist produces a unique quality

[6] This guarantees equilibrium existence when the regulator interacts with a private certifier.

variant q_S or exits the market. The problem of the monopoly is the following:

$$\max_{p_S} \pi_S = \left(p_S - c(q_S)^2\right) D(q_S) - K$$

Where $D(q_S)$ is the demand for variant q_S. Given a standard q_S, the profit of the monopoly is maximum for a price $p_S = \frac{q_S}{2}\left(\overline{\theta} + cq_S\right)$.

Note that since quality is a credence attribute of the product in the absence of third party information disclosure on quality, under the unregulated equilibrium, consumers would not expect but the lowest quality variant, $\underline{q}$. The monopolist would supply then, the lowest environmental quality level $\underline{q}$ at a price $\underline{p} = \frac{\underline{q}}{2}\left(\overline{\theta} + c\underline{q}\right)$.

The regulator chooses q_S that maximizes social welfare, W_S, under the monopolist pricing rule, p_S. After computations we obtain the following value for the minimum quality standard:

$$q_S = \frac{6\overline{\theta} + 4\gamma - \sqrt{9\overline{\theta}^2 + 12\overline{\theta}\gamma + 16\gamma^2}}{9c} \tag{3}$$

The introduction of the standard affects the quality and the price of the monopolist product. Its impact on consumer surplus, monopolist's profit and average environmatal quality is summarized in Proposition 1.

Proposition 1 *(i)With the introduction of the MQS, average environmental quality, E, increases with respect to the unregulated equilibrium. Consumer surplus and profits may also increase for $\underline{q}$ sufficiently small. (ii) For γ sufficiently large we have a range of K for which the monopolist will not participate although it is optimal.*
Proof. *In the appendix.* ■

The MQS increases social welfare by increasing average environmental quality, E. Since the hedonic price $(\frac{p_S}{q_S})$ of the good increases with q_S, less consumers are active in the market and consumers buying it benefit from a higher quality. The benefit of a higher quality level is particularly high when $\underline{q}$ is small, in which case, both, profit and consumer surplus increase with the introduction of the MQS.

4 The NGO regime

In the absence of public intervention, we want to investigate the impact of the existence of an NGO label on profits, consumer surplus and environmental quality.

The NGO is a green nonprofit institution which objective is to maximize average environmental quality. To realize such a task, the NGO has two instruments: the label and the green advertisement. The label awarded by the NGO certifies that the monopolist product satisfies certain quality standards. It provides consumers with credible information on the environmental quality of the labelled variant otherwise unobservable. We assume that the certification technology is the same for all the institutional frameworks, i.e. monitoring is almost perfect and the cost of monitoring equals K. It is widely observed that environmental nonprofit organizations use the media to promote a label and increase awareness of consumers toward environmental issues.[7] The green advertisement persuades consumers to buy the labelled quality variant. We denote by λ the level of green advertisement. We assume an exogenous level of green advertisement. The NGO can choose $\lambda_N \in \{0, \lambda\}$. The impact of the green advertisement on the utility of consumers that buy the labelled variant with quality q_N is $\lambda_N \left(q_N - \underline{q}\right)$. The cost of the advertisement is $\frac{1}{2}\lambda_N^2$. The NGO charges a fee to the monopolist that voluntarily adheres to the label. Given the nonprofit nature of the NGO the fee equals the cost of monitoring plus the advertisement cost.

The stages of the game are the following: first the NGO announces a quality level, q_N to label and λ_N. The NGO charges a fee: $K + \frac{1}{2}\lambda_N^2$. In a second stage, the monopolist either accepts or rejects the label. In case of acceptance, to benefit from discrimination, the monopolist produces the lowest quality variant and the labelled one, and set differentiated prices for both. In the third and last stage, consumers buy the product and profits are realized.

To understand the impact of the green advertisement we develop the consumers choice stage. The green advertisement does not affect the consumer θ_1, indifferent between buying the product with the lowest quality or not buying it: $\theta_1^N = \frac{\underline{p}}{\underline{q}}$. A consumer θ_2 is indifferent between buying the labelled variant q_N or buying the lowest quality variant $\underline{q}$ when:

$$\begin{aligned} \theta_2 q_N + \lambda_N(q_N - \underline{q}) - p_N + \gamma E_N &= \theta_2 \underline{q} - \underline{p} + \gamma E_N \\ \Rightarrow \theta_2^N &= \frac{p_N - \underline{p} - \lambda_N(q_N - \underline{q})}{q_N - \underline{q}}. \end{aligned} \tag{4}$$

[7] Examples of institutions making green advertisement can be found in the Global Ecolabelling Network (GEN), an international non-profit association of third-party, environmental performance labelling organizations. See the mission statement of GEN at http://www.gen.gr.jp. See also Eco-Action, Citizen Campaign for the Environment (CCE) among others.

The equilibrium price of the lowest quality variant is, $\underline{p} = \frac{q}{2}\left(\overline{\theta} + c\underline{q}\right)$. However, the price of the labelled variant increases with the green advertisement allowing the monopolist to get an extra green premium from the labelled good, $p_N = \frac{1}{2}$ $\left(q_N(\overline{\theta} + cq_N) + \lambda_N(q_N - \underline{q})\right)$.

Average quality under the monopolist pricing rule is:

$$E_{u,N} = \frac{q_N\left(\overline{\theta} - cq_N\right) + \lambda_N(q_N - \underline{q})}{2\left(\overline{\theta} - \underline{\theta}\right)} \tag{5}$$

The monopolist will accept to buy the label only if profits are higher than in the unregulated equilibrium. The monopolist participation constraint is given by $\pi_{u,N} - \pi_u - K - \frac{1}{2}\lambda_N^2 > 0$. We assume the monopolist participation constraint is satisfied. General conditions are described in Lemma 1. Therefore, the equilibrium quality variant for the labelled product chosen by the NGO is q_N that maximizes $E_{u,N}$:

$$q_N = \frac{\overline{\theta} + \lambda_N}{2c} \tag{6}$$

The green advertisement allows to increase average environmental quality boosting the demand of the high quality variant, see (5). It also increases the price at which the labelled variant is sold, so it increases monopolistic revenues but high levels of λ may decrease monopolist's profit by the fee. The following Lemma proves the profitability of a (small) green advertisement.

Lemma 1 *If the cost of monitoring K is sufficiently small, the monopolist always accepts to buy the label for a sufficiently small level of green advertisement, $\lambda > 0$. If moreover $\underline{q} < \frac{3\overline{\theta} - 16c(\overline{\theta} - \underline{\theta})}{6c}$, the monopolist participation constraint is satisfied for all λ.*

Proof. In the appendix. ■

At this point we want to compare the performance of an eco-label certified by the NGO and a MQS set by the regulator. The social welfare comparison of these two regimes gives ambiguous results provided the many effects we have to take into account. Obviously since environmental quality is maximized under the NGO regime, the eco-label awarded by the NGO will generate higher social welfare the higher the marginal social benefit from average environmental quality, γ, is. On the consumers and monopolist side, both benefit from the higher variety under the

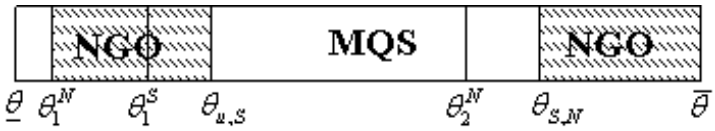

Figure 1: Consumers' ranking over regimes as a function of willingness to pay.

NGO regime but it is probably too much differentiation. The next Proposition summarizes our results.

Proposition 2 *(i) The labelled quality level is higher than the MQS set by the regulator: $q_N > q_S$. (ii) Middle-high willingness to pay consumers are better off under the MQS regime than under the NGO eco-label for sufficiently small levels of green advertisement. (iii) The monopolist is better off under the MQS regime than under the NGO regime for $\underline{q}$ small or γ small.*

Proof. In the appendix. ■

The gain from differentiation, in the NGO regime, will be smaller the lower the lowest quality available, $\underline{q}$, is. The probably excessive differentiation explains why the middle type consumer, with willingness to pay between $\theta_{u,S}$ and $\theta_{S,N}$ in Figure 1, is better off under the MQS regime, she finds $\underline{q}$ very small and q_N too high. The monopolist, though, may prefer such excessive differentiation for high levels of γ since q_S approaches q_N as γ increases.

4.1 Interaction between the NGO and the regulator

In this section we suppose that both the NGO and the regulator are active in the market. We study the effects of the presence of an NGO on the optimal standard setting. We assume the regulator and the NGO play simultaneously. The monopolist buys the label if the profit from selling two variants, the labelled one and the MQS, is higher than the profit from selling a unique quality variant at the MQS level. In case the monopolist chooses to produce the two quality levels, he has to pay $2K + \frac{\lambda_N^2}{2}$ (the monitoring cost to the NGO and the regulator plus the cost of the

green advertisement). The NGO's problem is:

$$\max_{q_N} E_{SN,N} = \frac{q_N\left(\overline{\theta} - cq_N\right) + \lambda_N(q_N - q_{SN})}{2\left(\overline{\theta} - \underline{\theta}\right)} \tag{7}$$
$$s.t.\ \pi_{SN,N} - \pi_S - \frac{1}{2}\lambda_N^2 - 2K \geq 0.$$

For the moment, we ignore the monopolist participation constraint, indeed for K sufficiently low the monopolist participation constraint will be satisfied at $\lambda = 0$. First note that the NGO will propose to label the product at the same quality level $q_N = \frac{\overline{\theta}+\lambda_N}{2c}$, as without regulator intervention. Second, notice that the average environmental quality $E_{SN,N}$ decreases with the regulator's MQS, q_{SN}.

The regulator chooses the MQS given the level of green advertisement and the labelled quality variant. Under the regulator policy, it is compulsory to produce at least at the MQS. The regulator's problem is:

$$\max_{q_{SN}} W_{SN,N} = CS_{SN,N} + \pi_{SN,N} + \gamma E_{SN,N} - dK - \frac{1}{2}\lambda_N^2$$

with $d = \{1, 2\}$. It equals 1 in case the regulator decides not to intervene and 2 otherwise [8]. Since $\lambda < \frac{\overline{\theta}}{3}$, $W_{SN,N}$ is concave and the MQS will be smaller than the labelled quality.

The best response of the regulator is $q_{SN} = \max\left\{\frac{3c^2(q_N)^2 - \lambda_N\left(6\overline{\theta}+4\gamma+3\lambda_N\right)}{6c(cq_N - 2\lambda_N)}, \underline{q}\right\}$. Evaluated at $q_N = \frac{\overline{\theta}+\lambda_N}{2c}$ it is:

$$q_{SN}\left(\lambda_N\right) = \max\left\{\frac{3\overline{\theta}^2 - \lambda_N\left(18\overline{\theta} + 16\gamma + 9\lambda_N\right)}{12c\left(\overline{\theta} - 3\lambda_N\right)}, \underline{q}\right\} \tag{8}$$

The regulator's MQS is a decreasing and concave function of λ. Given that the MQS chosen by the regulator is decreasing in λ the NGO is able to reduce the standard level by making use of the green advertisement, λ. The highest value for the MQS is $q_{SN}\left(0\right) = \frac{\overline{\theta}}{4c}$.

If the standard is stringent, $q_{SN} > \underline{q}$, K still needs to be sufficiently small to

[8] We do not consider $d = 0$ because for any value of q_{SN} it will be profitable for the NGO to introduce a label (whenever the monopolist participation constraint is satisfied). Notice that $E_{SN,N}$ in (7) could be rewritten as $\frac{q_N\left(\overline{\theta}-cq_N\right)}{2\left(\overline{\theta}-\underline{\theta}\right)} + \frac{\lambda(q_N - q_{SN})}{2\left(\overline{\theta}-\underline{\theta}\right)}$, which is unambiguously higher than $E_S = \frac{q_S(\overline{\theta}-cq_S)}{2\left(\overline{\theta}-\underline{\theta}\right)}$, given that $q_S \leq q_N$ and $q_{SN} \leq q_N$.

guarantee that $W_{SN,N} > W_{u,N}$.

The next Proposition compares the optimal MQS in the presence of a label alternative with the MQS set by the regulator in the absence of the NGO (see Figure 2 below).

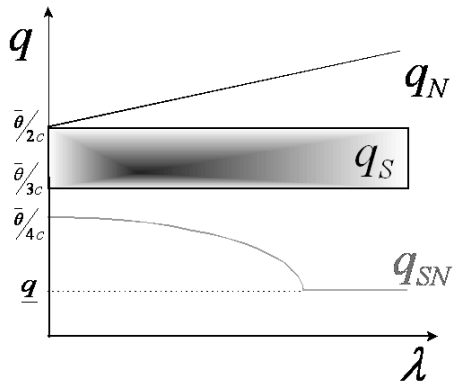

Figure 2: Comparison of quality levels.

Proposition 3 *The highest possible standard level in the presence of the NGO is smaller than the lowest standard level under the MQS regime. The NGO alternative then decreases the scope for public intervention. The availability of green advertisement reinforces the above result. Indeed for λ sufficiently high the regulator prefers not to intervene.*

Proof. In the appendix. ■

The introduction of the MQS decreases the demand for the labelled variant compared to the NGO regime and this causes a decrease in average environmental quality. The NGO then prefers the standard to be as low as possible. Both instruments, the label and the green advertisement reduces the level of the optimal MQS set by the regulator.

We expected to have less public intervention for γ low, but the opposite happened (q_{SN} is decreasing in γ for $\lambda_N > 0$). The higher γ is the better the NGO regime is in terms of social welfare, since it maximizes average environmental quality. Thus, it is natural to have less intervention for γ high.

In the presence of a private certifier the MQS task is to correct for the excessive differentiation imposed by the NGO that sets q_N irrespective of $\underline{q}$. For γ high, such

a task would be of lesser importance than to correct the externality associated with quality.

Although eco-labels can be performed by any third party able to monitor and certify the quality of the product, many choose to be non-profit. The mission statement of many of the nonprofit institutions awarding eco-labels is to increase environmental quality. There is evidence that nonprofit institutions follow their mission (Steinberg, 1986; Salamon et al., 2000), which strongly validates our previous analysis.

Nevertheless, given the variety of institutional arrangement certifying environmental attributes: public, NGO and private for-profit; in the next section we also explore what would be the equilibrium in quality and green advertisement if the private certifier would be a profit maximizing certifier.

5 Private Certifier regime

In this section we consider the possibility that the label is awarded by a profit maximizing certifier. Following Alexander and Harding (2003) we assume the private certifier has all the bargaining power, so she can extract all the monopoly's surplus. The private certifier faces the same fixed monitoring cost as the NGO and the regulator, and may invest in green advertisement whenever profitable. We assume, for simplicity, that the green advertisement has the same effect as in the previous section and that it is equally costly.

The game goes as follows: first, the private certifier announces a quality level, q_P, a green advertisement level $\lambda_P \in \{0, \lambda\}$ and a fee for the label, F. In a second stage, the monopolist either accepts or rejects the label. The monopolist, in case of acceptance, produces two variants, the lowest quality and the labelled one,[9] and set differentiated prices for both. In the third and last stage, consumers buy the product and profits are realized.

The monopolist voluntarily adheres to the label and pays a fixed fee, F. He accepts to get the label whenever $\pi_{u,P} - F \geq \pi_u$. Since the private certifier has all the bargaining power the fixed fee equals the profits gain with respect to the unregulated equilibrium, $F = \pi_{u,P} - \pi_u$. The PC profits are:

$$\pi_P^{PC} = F - \frac{1}{2}\lambda_P^2 - K \tag{9}$$

[9] It is easy to check that if the monopolist accepts the label it is optimal for him to propose also the low quality variant. Computations available upon request.

The private certifier chooses q_P that maximizes π_P^{PC} under the monopolist's pricing rule. After computation, we obtain:

$$q_P = \frac{\overline{\theta} + c\underline{q} + \lambda_P}{3c}$$

Note that if $\lambda_P = \lambda_N = \lambda$ the labelled quality is higher under the NGO regime than under the PC regime, indeed $q_N - q_P = \frac{\overline{\theta} - 2c\underline{q} + \lambda}{6c}$.

The objective of the private certifier is analogous to the monopolist's objective. She maximizes profits by differentiating enough the two quality variants. The NGO, instead, maximizes environmental quality. The NGO sets a higher quality level because she does not take into account the cost of quality, only indirectly through prices and demand. The relative performance of one regime with respect to the other depends on the impact of both regimes on the consumer.

In the absence of a regulator, we next summarize the gain or loss from having a PC instead of the NGO certifying environmental quality.

Proposition 4 *For $\lambda_P = \lambda_N$, (i) The NGO benefits high willingness to pay consumers. (ii) The private certifier performs better $(W_{u,P} - W_{u,N} > 0)$ if the social marginal value of average environmental,γ, is sufficiently small or the highest willingness to pay is sufficiently high, that is $\gamma < \frac{5}{8}\left(\overline{\theta} - 2c\underline{q}\right)$.*

Proof. In the appendix. ■

When both the NGO and the private certifier set the same level of green advertisement we get a natural result. Social welfare is higher under the NGO regime, compared to the PC regime, if the marginal social benefit of average environmental quality is sufficiently high. High willingness to pay consumers are better off under the NGO regime since q_N is higher than q_P. The identity of the $\theta-$consumer that would derive the same utility under the NGO and the PC regime[10] is increasing in $\overline{\theta}$. Then, the proportion of consumers that are better off under the NGO regime decreases with $\overline{\theta}$. Consumer surplus under the NGO regime also decreases with $\overline{\theta}$.

[10] By equalizing the indirect utility from buying the label under the NGO regime with the indirect utility from buying the label under the PC regimen, with equal levels of green advertisement, we find the consumer $\theta_{P,N} = \frac{1}{2}\left(\lambda + \overline{\theta} + c\left(q_N + q_P\right)\right)$ that is equally well under either of the regimes. The proportion of consumers better off under the NGO regime is $1 - F\left(\theta_{P,N}\right)$. Provided that both q_N and q_P are increasing functions of $\overline{\theta}$, the proportion of consumers better off in the NGO regime decreases with $\overline{\theta}$.

5.1 Interaction between the PC and the regulator

Suppose this time, that the private certifier and the regulator are active in the market. We assume that the regulator and the PC play simultaneously. The PC chooses the level of the quality variant, q_{PR}, and green advertisement, $\lambda_{PR} = \{0, \lambda\}$, to maximize its profit $\pi^{PC}_{SP,PR}$ given the MQS chosen by the regulator, q_{SP}.

The reaction function of the PC and regulator are $q_{PR}(q_{SP}) = \frac{\overline{\theta}+cq_{SP}+\lambda_{PR}}{3c}$ and $q_{SP}(q_{PR}) = Max\left\{\frac{3c^2(q_{PR})^2-\lambda_{PR}\left(6\overline{\theta}+4\gamma+3\lambda_{PR}\right)}{6c(cq_{PR}-2\lambda_{PR})}, \underline{q}\right\}$, respectively. If we restrict to values of q_{SP} and q_{PR} that satisfy $q_{SP} < q_{PR}$, the relevant reaction function of the regulator implies $cq_{PR} - 2\lambda_{PR} > 0$.

We first explore what happens for $\lambda_{PR} = 0$. We find that there exists a unique equilibrium characterized by $q_{SP} = \frac{\overline{\theta}}{5c}$ and $q_{PR} = \frac{2\overline{\theta}}{5c}$, exactly the same quality levels that maximize profits in the absence of information problem.[11] This comes from the fact that q_{SP} is independent of γ when λ_{PR} tends to zero. In our setting if $\gamma = 0$ the monopolist would offer the social optimal quality levels if quality was observable.[12] In this setting the MQS is useless. The regulator does not need to correct the quality distortion, and with the introduction of a MQS total demand decreases (it worsen the quantity distortion). The equilibrium qualities coincide then, with the qualities chosen by the monopolist in the unregulated equilibrium if quality was observable. Those quality levels coincide with the outcome of this game given that the PC maximizes monopolists profit. The difference comes from the cost of the information revelation: $2K$.

The next Proposition describes the equilibrium quality levels in the general case when $\lambda_{PR} > 0$. When λ_{PR} is sufficiently high the regulator prefers not to intervene since the demand for the MQS variant decreases with λ.

Proposition 5 *For $\lambda_{PR} > 0$, the equilibrium levels of the MQS and the label are:*
(a) The public intervention case $\left(\lambda < \widetilde{\lambda}\right)$.

$$q_{SP} = \max\left\{\frac{1}{5c}\left(16\lambda_{PR} - 2\overline{\theta} + \sqrt{3\left(3\overline{\theta}^2 - 48\overline{\theta}\lambda_{PR} - 20\gamma\lambda_{PR} + 72\lambda^2_{PR}\right)}\right), \underline{q}\right\}$$

$$q_{PR} = \max\left\{\frac{1}{15c}\left(21\lambda_{PR} + 3\overline{\theta} + \sqrt{3\left(3\overline{\theta}^2 - 48\overline{\theta}\lambda_{PR} - 20\gamma\lambda_{PR} + 72\lambda^2_{PR}\right)}\right), \underline{q}\right\}$$

[11] Computations from authors available upon request.
[12] See Spence (1975) and Lambertini et al. (1999).

(b) The no public intervention case $\left(\lambda > \widetilde{\lambda}\right)$.

$$q_{SP} = \underline{q}; \qquad q_{PR} = \frac{1}{3c}\left(\overline{\theta} + \lambda_{PR} + c\underline{q}\right)$$

Where $\widetilde{\lambda} = \frac{1}{4}\left(\sqrt{3\left(3\gamma^2 + 8\gamma\overline{\theta} + 6\overline{\theta}^2\right)} - \left(3\gamma + 4\overline{\theta}\right)\right)$.
For λ *sufficiently high the regulator prefers not to intervene.*

Proof. In the appendix. ■

Note that $q_{SP} < q_{SN}$ at $\lambda_{PR} = 0$. Since $q_{SP} - q_{SN}$ is decreasing in λ_{PR} at $\lambda_{PR} = 0$ then, for λ sufficiently small, the optimal MQS level will be smaller if the regulator interacts with a PC than with an NGO. In the presence of an NGO or a PC the role of the MQS is no longer to increase average environmental quality, but to correct for the otherwise excessive differentiation $\left(q_i - \underline{q},\, i = N, PR\right)$ in order to increase profits and consumer surplus. In the PC regime such differentiation is smaller since the PC maximizes monopolist profits. This explains why there is even less public intervention ($q_{SP} < q_{SN}$) when the regulator faces a PC.

6 Conclusion

When environmental quality has credence attributes, certification is needed to produce other quality variant than the lowest one. Many agents can participate in such a certification process. The private certifiers may be for-profit or nonprofit institutions. We divide these two by their objectives. We assume, as we observe in the market for eco-labels, the NGO and the PC do green advertisement, whenever profitable. The NGO may make use of the green advertisement to avoid undesirable regulation. Indeed, high levels of green advertisement reduces the MQS level.

In the absence of a regulator we give general conditions under which the NGO performs better than the private certifier. We find that the NGO always label a higher quality variant than the private certifier.

For any level of green advertisement the presence of a private certifier in the market decreases the scope for public intervention. The role of the MQS changes, it has to correct for the otherwise excessive differentiation that decreases profits and consumers surplus. Optimal environmental regulation depends upon the institution interplaying with the regulator. When voluntary schemes (the label) are available,

the regulator may be tougher in regulation (higher standard) in the presence of an NGO since differentiation is higher under the NGO regime. On the contrary, she should be more lax in the presence of a PC.

Throughout this paper we assume an exogenous level of green advertisemnt though being the objectives of both private certifiers different it is natural to expect both will choose different advertisement levels.[13] An endogenous level of advertisement will allow us to study its strategic choice by private certifiers. We leave it for further research. Some other questions remain to be answer. We can consider other public policy instruments when monitoring is not perfect, trying to understand under which circumstances the regulator will offer a MQS or a more flexible policy like a label. If both NGOs and the government compete offering different labels the information problem is crucial. Who consumers trust? A nonprofit organization or a governmental agency to certify the quality of a product? Who may be easily captured by the monopolist? Here the fund-raising problem and reputation of the NGO should be reconsidered.

Appendix: Proofs of Propositions and Lemmas

Proof of Proposition 1:

Note that q_S is increasing in γ. Evaluating the limits of q_S as γ approaches zero and infinity we find that $q_S \in [\frac{\overline{\theta}}{3c}, \frac{\overline{\theta}}{2c})$. *(i)* Consumer surplus and monopolist's profit are both concave in q and reach a maximum at $q = \frac{\overline{\theta}}{3c}$. For $\underline{q}$ sufficiently small both CS and profits increase with the introduction of the standard, both may decrease if γ and $\underline{q}$ are sufficiently high. *(ii)* Whenever the standard is stringent and provided that $q_S \leq \frac{\overline{\theta}}{2c}$, environmental quality increases with the introduction of the MQS: $E_S - E_u = \frac{1}{2}\left(q_S - \underline{q}\right)\left(\overline{\theta} - c\left(q_S + \underline{q}\right)\right) > 0$ *(iii)* Define $\widetilde{K} = \pi_S$ and $K^* = W_S - W_u$. For $K \in [\widetilde{K}, K^*]$ the monopolist prefers to exit the market, though the MQS is efficient. K^* can be rewritten as $K^* = \widetilde{K} + X$, with $X = -\pi_u + (CS_S - CS_u) + \gamma(E_S - E_u)$. From a simple enveloppe theorem argument we note that X is increasing in γ. There exist γ^* such that $\widetilde{K} < K^*$ for $\gamma > \gamma^*$, for $K \in [\widetilde{K}, K^*]$ it will be optimal to subsidize the monopolist to pay the fee. ∎

Proof of Lemma 1

The monopolist extra profits from the label with green advertisement is, $Net\pi\left(\lambda\right) = \pi_{u,N} - \pi_u - \frac{1}{2}\lambda_N^2 - K$. We first consider the case without green advertisement to

[13] We thank an anonymous referee for pointing out this to us.

understand what determines the participation of the monopolist and the interplay between the NGO and the monopolist. $Net\pi(0) = \frac{\left(\overline{\theta}-2c\underline{q}\right)^3}{32c\left(\overline{\theta}-\underline{\theta}\right)} - K$; since $\overline{\theta} > 2c\underline{q}$, $Net\pi(0) > 0$ for K sufficiently small. The NGO could always set $\lambda_N = 0$ and sell the label since the monopolist participation constraint will be satisfied. Moreover $Net\pi(\lambda)$ is increasing at $\lambda = 0$. Thus, net profits are positive for λ and K sufficiently small. They will be positive for all λ if $\underline{q} < \frac{3\overline{\theta}-16c(\overline{\theta}-\underline{\theta})}{6c}$, for which $Net\pi(\lambda)$ is convex at $\lambda = 0$. ∎

Proof of Proposition 2:

(i) See the proof of Proposition 1, $q_S < \frac{\overline{\theta}}{2c} \leq q_N$. *(ii)* Let $\theta_{u,S}$ being the indifferent consumer between the public MQS and the lowest quality variant, $\theta_{u,S} = \frac{1}{2}\left(\overline{\theta} + c\left(q_S + \underline{q}\right)\right)$; and $\theta_{S,N}$ the indifferent consumer between the public MQS and the private label, $\theta_{S,N} = \left(\overline{\theta} + c\left(q_N + q_S\right)\right) - \frac{\lambda_N\left(q_N-\underline{q}\right)}{2(q_N-q_S)}$. For λ sufficiently small the following ordering is satisfied: $\theta_1^N < \theta_{u,S} < \theta_{S,N}$. Since $q_S \leq q_N$ and $q_S > \underline{q}$, all consumers with willingness to pay $\theta_{u,S} < \theta < \theta_{S,N}$ are better off under the MQS regime. Consumers with wilingness to pay $\theta_1^N > \theta > \theta_{u,S}$ and $\theta > \theta_{S,N}$ are better off buying the labelled quality variant under the NGO regime than buying the MQS quality. *(iii)* At $\lambda = 0$, $\frac{\overline{\theta}}{3c} \leq q_S \leq \frac{\overline{\theta}}{2c} = q_N$; when $\underline{q} = 0$, there is only one variant in the market, profits under the NGO regime are, then, lower than under the MQS regime provided that profits are decreasing in q for $q > \frac{\overline{\theta}}{3c}$. If $\underline{q}$ is sufficiently high, profits under the NGO regime are larger due to the gain in differentiation from the label. Then, in general for $\lambda, \underline{q} > 0$, profits under the NGO regime will be higher than under the MQS regime for γ high (because q_S approaches q_N) and for $\underline{q}$ high (from quality differentiation). ∎

Proof of Proposition 3:

Since q_{SN} is decreasing in λ_N it reaches its maximum level at $\lambda_N = 0$, thus $q_{SN} \leq \frac{\overline{\theta}}{4c} < \frac{\overline{\theta}}{3c} \leq q_S$. To prove the second statement note that q_{SN} equals zero for $\lambda = \frac{2}{9}\sqrt{27\overline{\theta}^2 + 36\overline{\theta}\gamma + 16\gamma^2} - \frac{1}{9}\left(9\overline{\theta} + 8\gamma\right) < \frac{\overline{\theta}}{3}$. There exist $\lambda < \frac{\overline{\theta}}{3}$ such that for any value of $\underline{q}$ the regulator prefers not to intervene. ∎

Proof of Proposition 4:

Assume that $\lambda_N = \lambda_P = \lambda$.*(i)* We have that $\theta_{N,P}$ is the indifferent consumer between the NGO regime and the PC regime and is defined by $\theta_{N,P} = \frac{1}{2}\left(\overline{\theta} + c\left(q_N + q_P\right) - \lambda\right)$. Remember that $q_N > q_P > \underline{q}$ and that $\theta_{u,N} = \frac{1}{2}\left(\overline{\theta} + c\left(q_N + \underline{q}\right) - \lambda\right)$ and $\theta_{u,P} = \frac{1}{2}\left(\overline{\theta} + c\left(q_P + \underline{q}\right) - \lambda\right)$; thus $\theta_{N,P} > \theta_{u,N} > \theta_{u,P}$. Consumers with willingness to pay $\theta_{u,P} < \theta < \theta_{N,P}$ are better off under the PC regime. Consumers with

willingness to pay $\theta > \theta_{N,P}$ prefer the NGO regime over the PC regime. Thus the NGO serves high willingness to pay consumers. *(ii)* Social welfare comparison,

$$W_{u,P} - W_{u,N} = \frac{\left(\lambda + \overline{\theta} - 2c\underline{q}\right)^2 \left(5(\overline{\theta} - 2c\underline{q} + \lambda) - 8\gamma\right)}{576c\left(\overline{\theta} - \underline{\theta}\right)}$$

If $\left(5(\overline{\theta} - 2c\underline{q} + \lambda) - 8\gamma\right) > 0$, then, $W_{u,P} - W_{u,N} > 0$. The NGO regime, then, is socially preferred to the PC regime for $\overline{\theta}$ sufficiently low and γ is sufficiently high. ∎

Proof of Proposition 5:

Here we determine the equilibrium when the regulator faces a private certifier. The regulator best response, $q_{SP}(q_{PR})$, is increasing and concave for $cq_{PR} > 2\lambda_{PR}$. We just consider the concave part provided that $q_{SP} < q_{PR}$. Figure 3 (case a) and Figure 4 (case b) shows the shape of the best response function of the regulator.[14]. The best response of the PC is a straight line. Let A be the value of q_{PR} satisfying $q_{SP}(q_{PR}) = 0$ and B the value of $q_{PR}(q_{SP})$ when $q_{SP} = 0$. Define $\widetilde{\lambda}$ as the value of λ such that $A = B$, $\widetilde{\lambda} < \frac{1}{4}\overline{\theta} + \frac{1}{6}\gamma$. For $0 < \lambda < \frac{1}{4}\overline{\theta} + \frac{1}{6}\gamma$ the slope of the PC's best response is higher than the slope of the regulator's best response at A. It is easy to check that, for $\lambda > \frac{\overline{\theta}}{4} + \frac{\gamma}{6}$, q_{SP} defined as in Proposition 5 (case a) is smaller than zero, implying a non intervention of the regulator. The two possible cases are represented below.

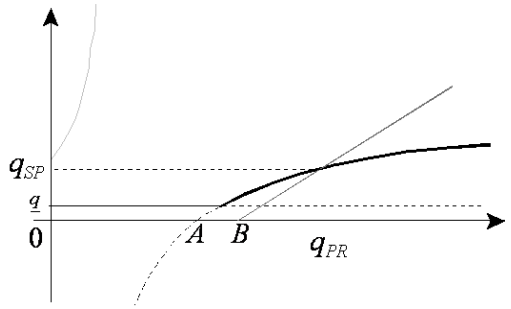

Figure 3: Case a

[14] The first derivative of $q_{SP}(q_{PR})$ tends to $\frac{1}{2}$ when q_{PR} tends to infinity (in the concave part) this means that the best response of the regulator is increasing in q_{PR} for all $q_{PR} > \frac{2\lambda}{c}$.

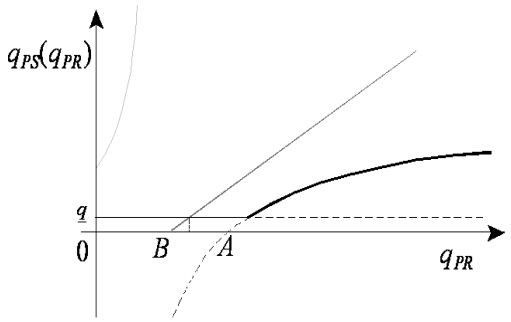

Figure 4: Case *b*

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