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Environmental Quality Provision and Eco-labelling: Some Issues

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ABSTRACT

This paper is a literature survey of some relevant issues arising from environmental quality provision and eco-labelling schemes. First of all it is shown how the two topics are strictly related. Firms adopting a production process (or producing a good) more environmentally friendly than others (environmental quality provision aspect) may want to make it public (eco-labelling aspect). The survey addresses the question of optimal environmental quality provision (also as a policy tool) and firms compliance. With regard to eco-labelling, its impacts on market structure are analysed. It hasn't been possible to consider all issues, like for example that of moral hazard in providing non truthful information. Different issues related to trade are also analysed, even if the literature is not abundant on this yet.

In the literature both aspects, of environmental quality provision and eco-labelling, are analysed using product differentiation models. The usual result is that multiple equilibria arise depending also on the parameters. Models are also not robust to different assumptions.

Environmental quality provision and eco-labelling are also compared to more traditional policy instruments like taxes (or subsidies) and standards. From the empirical evidence it can be concluded that information plays a crucial role both for consumers' and producers' decisions. Consumers are willing to pay a higher price to be informed about the greenness of a good, and a label can really be a determinant in their choice of which brand to purchase. On the supply side, disclosing information about the environmental performance of a firm can affect investment decisions and its stock value.

Environmental quality provision and eco-labelling: some issues

LAURA VALENTINI[1]

1. Introduction.

In the last years we have been observing:

- A growing demand for environmental care. Consumers demand goods which are more environment-friendly or which are produced with more environment-friendly techniques. Consumers are also willing to pay a higher price for this, and strictly prefer a 'green' good to a 'brown' one even if the two have equal physical characteristics apart from the environmental attribute.

- A growing use of ecological labels. On the one hand consumers need to know which products are 'green' in order to decide what to buy. On the other hand, given that usually 'green' goods are more expensive to produce and thus are sold at a higher price than brown goods in the market, firms need to inform their costumers about the 'greenness' characteristics of the good and the reason of the higher price.

- A growing use of different eco-labelling schemes and number of countries adopting them. Goods can be distinguished depending on their environmental characteristics. Some products are physically green in the sense that they are clearly more environment-friendly in their use, and this is a characteristic that can be observed before purchase or after[2]. For both search and experience goods consumers get the information from the good itself. However, there are some other products which do not really have green characteristics but which are produced using more environment-friendly techniques. Similarly, there are other products that have green characteristics, but these are not easily observable by the consumer. A label on the former type of products cannot be misleading as consumers would recognise it immediately and would choose not to buy the good or not to buy it a second time. On the contrary, for the latter type of goods there is a problem of asymmetric information, as consumers cannot really observe the production process. Labelling schemes satisfy this need by providing reliable information to consumers.

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[2] Goods can be divided in three main categories: i) search goods are those goods whose attributes can be checked before purchase (e.g. cloths); ii) experience goods are those goods whose attributes can be seen only after purchase (e.g. food); iii) credence goods are those goods whose attributes cannot be checked neither before or after purchase, consumers believe that these goods satisfy some characteristics based on some information they need to rely on. It is the characteristics of a good which are search experience and credence rather than the good itself . A good may be a search good with regard to some characteristics and a credence good with regard to some other characteristics.

Of course consumers need to be able to rely on the label. This gives rise to a broad distinction of labels. Private labels are a self declaration made by the producer itself to provide some information, often these are verifiable and thus reliable labels. Labels can also be imposed by a governmental agency. In this case there are some requisites the producer needs to satisfy and it is the agency that checks the requisites satisfaction and grants the label. This should solve the reliability problem, as the agency alone can grant that specific label.

Firstly, the adoption of eco-labelling schemes is advocated by producers first of all. With voluntary applications of eco-labelling, companies hope to build a green reputation that brings many different positive externalities. Apart from market power considerations, with eco-labels firms hope to avoid the implementation of other environmental policy instruments, like taxes which are always very unpopular, and usually considered more costly. Firms also hope to avoid monitoring and controls by environmental agencies or by the government. Moreover, they hope not being refused a credit by private lenders (banks) or by the public (bonds) because of being considered too environmentally risky or having a bad risk credit.

From the consumers' perspective, eco-labels (considering for the moment only that they are truthful (legitimate) labels) have a positive direct effect on consumers' surplus in that it increases their information, the number of varieties supplied in the market (as long as 'brown' products still survive) and thus a better matching of goods' attributes with consumers' preferences. The scheme may also have some other positive indirect effects, such as increasing the awareness of workers and managers in the firm applying for the label. Consumers initially not aware of the environmental damage created by a product may eventually become more aware and careful in their consumption decisions.

Of course all this comes at some costs. First of all, eco-labelling creates some sort of product differentiation and enables green producers to charge more for their product. The increase in price is justified by the fact that it is more expensive to produce the green good. However, there is no doubt that firms often increase their price well above the marginal abatement cost. This is clearly a loss in consumers' surplus. Moreover eco-labelling changes the structure of the market (from competitive it may become imperfectly competitive), and not all firms are affected in the same way. In particular, the effect is going to differ between domestic and foreign firms due to home biased consumers' preferences[3]. It is also important that there is some control mechanisms on what firms declare on their products. In fact if this is not the case (or if the penalties in case of false declarations are too low) then we end up with moral hazard behaviours and a welfare loss.

These issues will be addressed in this report. Before proceeding let us see in slightly more detail what eco-labelling is and how it is modelled in the literature. A subsequent section will contain a survey of different issues and how they are addressed by economists. Finally, conclusions from the survey will be drawn. Some questions will remain unanswered and they may be the topic of additional research, with the conclusions providing some directions.

[3] Usually for the same type of goods, demand for the domestic good is less price elastic than the demand for the foreign good.

2. What is Eco-labelling?

Eco-labelling is a voluntarily adopted certification of the environmental performance of a firm. It is a label placed on a good that identifies its overall environmental performance characteristics within a given category. Usually a good is analysed in its whole life cycle, as it is said from cradle to grave, considering the resources used for its production, the production process, its use and its disposal. Depending on the scheme, a good is granted a label if it satisfies at least some minimum (or maximal in some cases) requisites of environmental performance. Of course there are different types of labels and not all of them consider the good in its whole life cycle. It must be agreed on which definition of eco-labelling one wants to focus.

There are different types of environmental labels and declarations. The International Organisation for Standardisation (ISO) identifies three types of voluntary labels, with eco-labelling fitting type I.

Type I: voluntary, multi-criteria based, third party program that awards a license that authorises the use of environmental labels on products indicating the overall characteristics of a product within a certain class, based on life cycle considerations.

Type II: informative self-declaration claims.

Type III: voluntary programs that provide quantified environmental data of a product, under pre-set categories of parameters set by a qualified third party and based on life cycle assessment, and verified by a qualified third party.

The objective of eco-labelling is to affect production and supply through the demand. The idea is to encourage the demand of those products and services which are less harmful for the environment.

At the moment there isn't a standard universally accepted for eco-labelling, and different countries have adopted their own. Technically the adoption of an eco-labelling scheme does not constitute discrimination against foreign firms, as long as a country applies these standards to all goods, domestically produced or imported from abroad. However already an equal application of the eco-labelling scheme may have different effects on domestic and foreign goods. Usually it is developed countries that push for the adoption of the scheme while developing countries oppose it and the reason is precisely that the scheme is bound to harm them unnecessarily and inefficiently. First of all, the environmental problems that developed countries face are different from those faced by developing countries. For example developing countries do not have the same problems of resource scarcity as developed countries, so a label that focuses on resource savings irrespective of where the good is produced will bias consumption decisions against the good produced in the developing countries. Second, the costs associated with applying for the eco-labelling may be too high for the poorer country. Last, developing countries fear that they will not have a voice in determining the standards according to which the eco-label is granted.

3. Survey of the economic literature.

3.1 Modelling

In the literature the usual approach followed to model eco-labelling schemes is that of product differentiation, either vertical or horizontal. The idea is that goods can be characterised also for their environmental attributes (in terms of different amounts of emissions generated by the production process or in terms of different environmental performances linked to the use or disposal of the good). Goods with different environmental characteristics (but otherwise with equal physical attributes) are considered as differentiated by consumers. It is thus straightforward to assume that consumers have different preferences over the environmental content of goods (horizontal differentiation) or that, despite consumers agree on the ranking of the different environmental varieties, they buy different ones because of price differences (vertical differentiation). Eco-labels serve to inform consumers that the labelled product has a different environmental content relative to non labelled products. In this subsection an outline of the general framework is given. In the next subsections a literature survey of some relevant papers is provided. Many of these papers are not directly related to the eco-labelling issue, but rather on environmental quality provision. However, the issue of environmental quality provision is strictly related to eco-labelling and provides the basis on which eco-labelling schemes are analysed. Moreover, models of environmental quality provision are useful to understand how markets work when environmental quality is considered as a characteristic of the good by consumers, how free markets fail to provide the efficient environmental varieties of the good and how different policies can change this outcome and move to a more efficient allocation.

It is standard to model consumers as described by a parameter θ that represents their environmental preferences (in case of horizontal differentiation) or differences in income levels (in case of vertical differentiation). Consumers are distributed along a line within an interval $[\underline{\theta},\overline{\theta}]$ according to a given distribution function $F(\theta)$, usually assumed uniform within the interval. The parameter θ enters in the utility function in a way that it represents the consumer's marginal willingness to pay for the environmental quality. If, for example, we think of environmental quality as the amount of pollutant generated by the production process, a good that is produced with lower emission levels is considered of higher quality than a good produced with higher emissions; θ is then the marginal willingness to pay for having one unit less of emissions, or the marginal willingness to pay for one unit of abatement.

Similarly, firms produce different varieties of a good according to a given production function. It is usually assumed that each firm produces a single variety denoted by q. Firms are also distributed along a line, within the interval of feasible varieties $[\underline{q},\overline{q}]$. A higher value of q represents a good with a lower content of emissions. To produce the variety of higher environmental quality is costly and costs are such that: $C'(q) \geq 0, C''(q) \geq 0$. These costs enter in different ways in the various models seen in the literature. If they are fixed with regard to the amount produced, then $C'(q)$ is the marginal abatement costs. In some cases

C(q) is the marginal cost of production [4], in this case it represents how marginal costs increase when one unit of emissions is abated.

3.3 Environmental quality provision, minimum standards, subsidies and taxes.

Cremer and Thisse (CT) (1999) analyse the provision of environmental quality in differentiated oligopolies. The model is one of vertical differentiation, in which various brands, of an otherwise homogeneous good, differ only for their environmental content, being the good of higher environmental quality the one that pollutes less (or that is produced with a least damaging process). Consumers agree on the ranking of the different varieties and strictly prefer the one of highest quality, and if it weren't for the higher price would choose it. Consumers thus decide what variety to buy trading off a higher environmental quality for a lower price. The utility each consumer gets from purchasing one unit of variety *i* is given by:

$$U(p,q,q^a) = \theta q_i + \gamma\,\theta\, q^a + y - p_i \qquad (1)$$

where θ identifies the consumer's preference, q is the environmental quality of variety i, p_i the relative price, y is income and q^a the average environmental quality over all consumers:

$$q^a = \int_{\underline{\theta}}^{\bar{\theta}} q(\theta)\, f(\theta) d\theta \qquad (2)$$

q^a represents a positive externality: consumers realise that they cannot affect it with their own choice (so that it is a constant in each consumer's maximisation problem), but that they are better off if all the other consumers choose a higher environmental quality variety. γ is just a weight. As said before, θ represents the marginal willingness to pay for environmental quality.

There is an infinite number of potential firms that can enter the market at a fixed entry cost, which is let vary as a parameter so as to represent different market situations. Marginal production costs *C(q)* do not depend on the amount produced but only on the environmental quality and are increasing and convex in q (remember that q is the feasible environmental variety). In the paper it is assumed that all consumers buy the good and for this θ and *C(q)* must satisfy the condition:

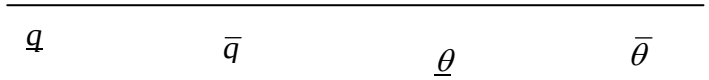
$$C(\bar{q}) < \underline{\theta}\bar{q} \qquad (3)$$

Moreover, if all varieties are priced at their marginal costs, then consumers rank them in the same way and:

$$C'(\bar{q}) < \underline{\theta} \qquad (4)$$

[4] Note that *C(q)* is a marginal cost of production which is constant with regard to the amount produced, but it varies with regard to quality.

This assumption simply means that the marginal willingness to pay for the lowest environmental variety is more than the increase in marginal costs to provide the highest variety. It has an immediate consequence: the first best is to provide environmental quality $\bar{q}$ for all consumers, and sell the good at $p = C(\bar{q})$. In graphical terms this means that the set of feasible varieties lies completely on the left of the set of most preferred varieties.



This represents a rather extreme situation , where the marginal abatement cost is relatively low or when consumers are very much concerned about the environment. It is important to stress that clearly it is Pareto-efficient to supply the highest environmental quality given that for the society the additional cost to increment quality is lower than the marginal benefit. This would be the social planner allocation.

Firms will either provide $\bar{q}$ or less (given that it is not feasible to provide more than $\bar{q}$). If there is a finite number *n* of firms[5], they will tend to provide different varieties in order to avoid competition on the price. This means that at least *n*-1 firms will provide a lower environmental quality than $\bar{q}$, and that if one firm supplies the largest quality it will charge a price above the marginal cost. So even if $\bar{q}$ is available in the market, some consumers buy varieties of lower quality because of the lower prices.

CT prove that the number of firms that enter the market is indeed finite. Policy makers can change this outcome by introducing a tax. Given that the distortion arises because of the environmental externality, the optimal policy would be a unit tax on emissions (Pigouvian tax) or a subsidy on higher quality varieties. However, these types of taxes or subsidies are not used very much, and for this reason CT consider an ad-valorem commodity tax instead. The tax is inefficient for two reasons: first, it is levied not on emissions[6] but on the price of the good and so it does not directly tackle with the distortion; second, because it is an ad-valorem tax, producers of the higher environmental quality variety (sold at a higher price) will pay more tax, per unit of emissions, than producers of the lower quality variety. This is a second distortion, and ceteris paribus it will create an incentive to produce lower environmental quality goods, increasing emissions rather than abating them. Nevertheless, CT show that under some assumptions this type of tax can induce the market to reach Pareto-efficiency. This outcome is reached because the commodity tax changes the number of active firms and the market structure. In order to have a finite number of firms, the cost function and the marginal willingness to pay must satisfy condition (4). The finiteness property continues to hold as long as the tax rate is:

$$t < 1 - \frac{C'(\bar{q})}{\underline{\theta}} \qquad (5)$$

[5] It is always possible to find a configuration of costs such that only a finite number of firms enter the market.
[6] A unit tax on output is equally efficient when there exists a strict relationship between output and emissions.

The number of firms increases as *t* tends to the right hand side, while if *t* becomes larger, the number of firms is limited only by entry costs. The commodity tax also changes the structure of the market. Without the tax we have a vertically differentiated oligopoly, with the tax the number of active firms increases and so does competition. This counterintuitive outcome arises because even if the tax increases costs, it also changes the range of marginal costs associated to the set of feasible qualities. The mechanism is the following: the tax increases marginal costs and so prices; this reduces the most preferred qualities. If the tax is large enough the most preferred qualities fall within the range of feasible qualities. The type of market also switches from vertical to one that resembles horizontal differentiation. From a welfare point of view a too high tax rate reduces welfare but if *t* is close to $1-\frac{C'(\bar{q})}{\underline{\theta}}$ then the range of consumers buying varieties with inefficient levels of environmental quality is smaller than in the no tax case. So the main conclusion is that the problem of under-provision of environmental qualities can be solved with an appropriate commodity ad-valorem tax, despite the fact that this is not a Pigouvian tax.

In this model it is really optimal to introduce a tax and decrease the environmental qualities. This happens because the feasible qualities are always lower than the preferred qualities (in CT). The tax rate has the effect of shifting the preferred qualities to the left and fall at least partially within the feasibility interval.

Arora and Gangopadhyay (AG) (1995) ask a very similar question. However, they make some different assumptions that give rise to different outcomes. In particular they show that under particular conditions some firms do over-comply to environmental regulation and provide an environmental quality which is higher than the legal minimum standard. Moreover, a tax reduces the market environmental quality while the subsidy increases it. It must be noted that this is not really opposite to CT. The difference lies in the fact that in CT the range of preferred qualities lies completely on the right of the range of feasible qualities; and the tax rather than increasing the feasible varieties, decreases the preferred varieties. AG show that with publicly available information, firms always over-comply with minimum environmental standards.

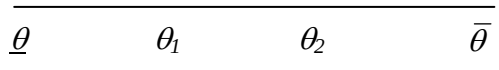
AG consider a model of vertical differentiation. Consumers are uniformly distributed in the interval $[\underline{\theta},\bar{\theta}]$, and θ is now a function of income (a higher value of θ corresponds to a higher income), and $1/\theta(y)$ is the marginal utility of income. The utility function used by AG is not very different from before, the main difference being that the quality externality is missing:

$$U(q,p,\theta)=y+q-\frac{p_i}{\theta} \qquad \text{where } \theta=\theta(y) \qquad (6)$$

The differences in utilities are due only to differences in income.

Production generates emissions $\bar{e}$ which can be abated. The net level of emissions is $\bar{e}-q$. As before the abatement cost function is increasing and convex in *q*. AG assume that there are only two firms and no entry; firms compete in abatement levels and prices. In equilibrium

the two firms will offer different varieties, and the market will be divided in three different regions:



Consumers who lie within the interval $[\underline{\theta}, \theta_1]$ do not buy the good, those within $[\theta_1\ \theta_2]$ buy the lowest environmental quality and those between $[\theta_2\ \bar{\theta}]$ buy the highest variety[7]. From the utility function it possible to determine first the indifferent consumers between buying good 1 or not buying any good, or between buying good 1 or 2 (θ_1 and θ_2 respectively) and then the demand functions for the two firms. It is then possible to write the profit functions of the two firms and maximise them with regard to environmental qualities and prices. AG find that the reaction functions of the two firms, with regard to e, are upward sloping, that is, environmental qualities are strategic complements, and if one firm reduces emissions (or increases abatement) the other will follow. Moreover, the two functions intersect below the 45° line, which means that in equilibrium the firms differentiate and firm 1 provides the lowest quality (the higher emission level).

One important outcome is how the equilibrium qualities change when income changes: if θ shifts to the right (e.g. $\theta+a$), so that all consumers have more income, then the equilibrium qualities supplied by both firms increase. This is a direct consequence of the fact that the qualities are strategic complements. An increase of income implies that consumers are willing to pay a higher price for the environmental quality. And if a firm supplies a higher quality the other will react by increasing its level as well. Note that this also increases the average market environmental quality. This outcome is true also if the number of people with low income decreases (that is if $\underline{\theta}$ shifts to the right). This result seems to explain why environmental quality is higher in developed countries than in developing countries. Also, it has important consequences in terms of environmental policy. If the government decides to impose a standard q^* (that is a minimum level of abatement, or maximum amount of emissions) higher than the one set by the dirtier firm, then the first firm (the dirtier) will just comply with the regulation and provide quality q^* , while the cleaner firm will also increase its abatement and differentiate from firm 1, so it will provide an environmental quality above q^*. That is, the second firm will over-comply with the regulation. Moreover, with a standard the proportion of consumers actually buying the good increases. This means that it is the lowest income consumers that now enter the market. The mechanism is the following: the consumer indifferent between buying good 1 or not buying anything is given by $\theta_1 = \frac{p_1}{q_1}$. In the minimum standard case, the quality of good 1 must be at least equal to q^* which is larger than q_1. Then firm 1 will have to abate more, this implies a larger price, but also a larger q, the ratio p_1/q_1 however decreases and θ_1 shifts to the left. Alternatively, the government can decide to use taxes or subsidies. Similarly to CT, AG also use ad-valorem commodity taxes and subsidies. The subsidy has the same effect as an increase of income, that is environmental qualities increase in equilibrium. The tax has the opposite effect.

[7] For simplicity the firm producing the low quality has been denoted by 1 and the firm producing the high quality has been denoted by 2.

With regard to the minimum standard it must be noted that q_1 has to increase more than p_1, otherwise θ_1 shifts to the right and not to the left. This happens if the standard q^* is slightly above q_1 but not too much. In the paper however there is no welfare analysis so it is not clear if the standard is really welfare improving or if determined at an optimal level. The same holds for taxes and subsidies (even without taking into account that the latter are not the efficient fiscal policies).

Bansal Gangopadhyay (BG) (2003) extend the previous paper by considering different tax/subsidy schemes. In particular they compare uniform with discriminatory policies. Given the type of uniform taxes (ad valorem commodity taxes) considered, it is obvious that firms producing the highest quality and thus charging the highest price are going to pay more taxes than the more polluting firms. This is clearly not efficient and thus BG suggest to use discriminatory taxes. The inefficiency is due to the fact that the value of the good is taxed and not emissions (see also footnote 4). The model is similar to the previous paper and to CT (in this case also the environmental externality enters in the utility function, as in CT). Sensitivity analysis shows that an increase in the uniform tax rate reduces the abatement levels of both firms and the profits of the 'dirty' firm, while it has an ambiguous impact on profits of the clean firm. A reduction of the tax rate has the opposite effect. The subsidy goes in the opposite direction. An increase in the uniform subsidy rate is equivalent to a reduction of the tax rate. Moreover BG may also have a case in which the subsidy increases environmental quality and decreases demand. This implies a lower environmental damage, but then the net effect on consumers' surplus is not clear. As in CT the uniform tax (and subsidy) unfairly hurts the cleaner firm more than the dirty one. BG consider two types of discriminatory policies to solve this problem (but the inefficiency issue still remains): in the first case the dirty firm is taxed while the cleaner firm is not; in the second case the cleaner firm is subsidised while the dirtier is not. Taxes and subsidies are still ad-valorem.

The discriminatory tax, relative to the non intervention situation, on the dirtier firm reduces the clean up levels of both firms, the demand for each firm, the profits of the dirtier firm and consumer surplus, while it increases the cleaner firm's profits. The discriminatory subsidy on the cleaner firm increases the abatement levels of both firms, but reduces the demand for both firms, it increases profits of the dirtier firm and has an ambiguous impact on profits of the cleaner firm. Thus a small discriminatory subsidy increases welfare, while the tax has ambiguous impacts.

It must be noted that the analysis is on unit emissions and sometimes on demand, but since there is no direct link between production and emissions, the impact of each policy on total environmental damage (which is the relevant issue from the government point of view) is not clear. It is probably possible to say that when both unit emissions and demands (for each firm) decrease then total damage also decreases, but otherwise the behaviour of environmental damage depends on how the demand for each variety changes. Take the case of a subsidy: it has an immediate effect of reducing unit emissions, but it also increases total demand, and so emissions. The net effect on total damage depends on how unit emissions fall compared to the increase of output. Moreover, if the demand for the dirtier good increases more than that for the cleaner firm, total damage may even increase. These are issues that must be taken carefully into account before designing any policy scheme.

Conrad (2003) considers a horizontally differentiated duopoly and compares the environmental quality provisions emerging from competition with those derived from welfare maximisation. There are different Nash equilibria outcomes depending on the values taken by some parameters. In general a duopoly will provide too little or too much environmental quality compared to the social optimum. The government can respond to this by using subsidies, taxes or by adopting an information campaign that alters the parameters representing consumers' awareness. This paper cannot be directly compared with the previous ones as the model used and the assumptions made are different. Also, different policies are not really compared with each other, analysing their impacts on welfare, but are just outlined or suggested. This time it is consumption that generates the externality and not production; emissions are still missing. The model considered by Conrad follows strictly a standard spatial duopoly model with quadratic transport costs[8].

Consumers are uniformly distributed along the linear segment [0,1] and have a most preferred variety θ but can choose only between two available varieties, and for this face a disutility quadratic in the distance between θ and q_i. In the classical differentiation model the equilibrium outcome is maximum differentiation, Conrad shows that when a negative externality is also introduced and consumers are aware of it, maximum differentiation may still arise, but it is no longer the unique equilibrium. In fact there are cases in which firms do not differentiate and others in which there is intermediate differentiation. The utility function is thus given by:

$$U(\theta, q, p) = v - t(q_i - \theta)^2 - d(1 - q_i) - p_i \qquad (7)$$

The first term is the intrinsic utility, the second is the cost of not buying the most preferred variety, while the third represents consumer's awareness, or bad conscious, it is the cost for not buying the most environment friendly variety but a different one.

Here there are some points to be noted. First, it seems clear that underlying the utility function there is the idea that the right extreme, 1, represents the most environment friendly feasible variety, and 0 the least friendly. If all consumers face a cost $d(1- q_i)$ for not buying the most friendly variety, then it seems that they all agree on the ranking of the environmental characteristics of the available varieties, and a vertical differentiation model should be used instead. It is not clear then what is the role of the quadratic cost factor in the utility function, which denotes that consumers have different preferences on the environmental characteristics. Second, Conrad denotes $d(1- q_i)$ as a negative externality, but this is not an externality generated by a consumption decision, it is really more a bad conscious cost. Third, it is not clear why if the most friendly variety is not available in the market (as it is the outcome in some situations) consumers should feel bad for not purchasing it, even if they strictly prefers the most friendly variety (for whom the cost is already given by the quadratic factor). Moreover in Conrad the alternative of not buying the good, if not environment friendly enough, is ruled out as v is assumed large enough that all consumers buy the good.

[8] It is Hotelling's model as modified by D'Aspremont. In Hotelling's model transport costs are linear and if firms choose both prices and varieties there isn't an equilibrium with a finite number of firms. In D'Aspremont case transport costs are quadratic and there is a unique equilibrium in locations with maximal differentiation, that is firms locate at the two extremes of the line.

With regard to the supply side, producers face production costs equal to:

$$C_i = c \cdot q_i \cdot D_i \qquad (8)$$

where c is a constant, q is the environmental quality and D is the demand faced by firm i.

The cost function shows that production costs are a linearly increasing function of environmental quality. Solving for the equilibrium the main results that emerge are the following:

1) Consumers' awareness lowers the price of the dirtier good and increases the price of the cleaner good. Similarly for the corresponding market shares.
2) An interior solution (such that the two firms locate within the interval and not at the two extremes) does not exist and at least one firm locates at one end of the interval. Location choices, and prices, depend on the values taken by the various parameters, and so we have a characterisation of the different equilibria, which are:
    - both firms produce the most friendly variety and sell the good at the marginal cost;
    - both firms produce the least friendly variety;
    - the two firms totally differentiate (one locates at 0 and the other at 1);
    - one firm produces the most friendly variety and the other locates inside the interval; and
    - the converse case where one firm produces the least friendly variety and the other locates inside the interval.

In all cases, apart from the ones in which there is no differentiation, prices are above marginal costs and firms earn positive profits. Comparison with welfare analysis leads to the conclusion that in some cases the dirtier firm produces a lower quality compared to the social optimum (for example when firm 2 locates at point 1 and firm 1 locates at point 1/3). Conrad suggests to introduce an uniform subsidy or, as an alternative, to act on the parameter d which represents consumers' awareness. A possibility would be to increase d through information or advertising campaigns. In our case this could correspond to introducing an eco-labelling scheme.

The opposite case occurs when one firm locates at the lower end of and the other inside the interval. In this case the cleaner firm produces a too friendly variety. The policy would be to tax production. Alternatively, one could think of policies directed at reducing consumers' awareness). In the last case the Nash equilibrium leads firms to maximise differentiation, while social welfare would require the two firms to locate both inside the interval, this means that one firm produces a too dirty good and the other a too clean good. Conrad shows that in this case there is no (uniform) policy that makes the two firms produce the efficient varieties; the only possibility is then to affect the environmental awareness of consumers, so that the equilibrium changes in one of the two firms. Once the market equilibrium has changed the government can intervene to move towards the efficient solution.

In Moraga-Gonzalez and Padron-Fumero (MP) (2002) the environmental quality is measured by emissions e, so the cleaner firm (firm 2) is the one with lower emissions. The only costs

firms face is abatement costs, which are decreasing in e, $C'(e)<0$. The abatement technology also exhibits decreasing returns. Consumers and firms are uniformly distributed along the interval $[0, \bar{\theta}]$, and consumers either buy one unit of the good or none. The relative degree of product differentiation is given by the ratio of the two emission levels: $\lambda=e_1/e_2$. Firm 2 is the one wit lower emissions, so λ is greater than 1. MP show that total emissions increase as the degree of product differentiation decreases, that is the more similar the two goods are in terms of emissions, the higher the total level of pollution. To explain this result the different forces at work must be considered. As it was already pointed out before, total emission levels are determined by emissions per unit of output and total output produced. When the degree of product differentiation decreases it means that either firm 1 decreases unit emissions or firm 2 increases unit emissions. So we can have an increase or decrease of unit emissions. In either case lower product differentiation means higher price competition and thus lower prices. This means that total output increases. When unit emissions increase, total pollution also increases. When unit emissions fall, total pollution may go up or down depending on how unit emissions decrease relative to the increment of the demand (this depends on how much prices fall, given that in any case lower unit emissions also imply higher costs). In MP the increment of output dominates the fall in unit emissions. It must be outlined that this is a special case, which will probably change according to parameter values.

MP then compare different environmental policies. Consistent with the previous papers, MP consider uniform ad valorem taxes, technology subsidies and emission standards. Also in this case emission levels are strategic complements, which drives the results. If the government decides to impose an emission standard below the level of emissions of the dirtier firm, then that firm will have to lower emissions, at least up to the standard level. The cleaner firm will follow and reduce its emissions level as well. Given the decreasing returns of the abatement technology, the degree of product differentiation decreases (the cleaner firm will reduce emissions but not to the same extent as the dirtier firm). This means that aggregate emissions go up. Thus the effect of an emission standard is perverse and total pollution increases rather than decrease[9]. It must be noted that the assumption of decreasing abatement technology is clearly crucial, because all the effects depend on the fact that the degree of relative differentiation decreases. It must be also proven that the increase of output more than outweighs the fall in unit emissions in a more general case. Besides standards, subsidies on clean up technology may be used. In this model a subsidy on technology costs does not affect the degree of product differentiation. Both unit emissions fall (in equal proportions) and in equilibrium sales increase in a way that prices and total emissions remain constant. Again the purpose of introducing the subsidy seems to have failed. Welfare increases, however MP do not include the cost of the subsidy in the welfare function. Lastly uniform ad valorem taxes are considered. The effect of the tax is that unit emissions of both firms increase but aggregate pollution falls.

3.3. Environmental quality provision and eco-labelling.

Clark (2003) strictly follows CT and AG, however in Clark consumers have preferences over relative measures of environmental performances and not absolute as in CT or AG. According to Clarke the reason for doing so is that certifying a certain product variety may

[9] Total welfare may increase or decrease depending on how consumers' surplus changes relative to profits and damage.

place a disutility for consumers of a different variety. This issue is relevant as it gives a first indication of the welfare impacts of implementing an information-based policy scheme rather than other more traditional policy instruments. As usual it is assumed that there are two firms that can choose the level of environmental quality *q*. Production costs are increasing and convex in *q*; Clark assumes a specific quadratic function: $C_i = q_i^2 / 2$, and *q* can take any value between [0,1]. In the absence of any information program (or certification scheme) consumers consider the two varieties as homogeneous and buy the cheapest. On the other hand producers minimise costs of production and will produce the lowest environmental variety they can. Thus the market equilibrium in absence of any information will be both firms producing the lowest environmental variety, q=0, prices equal to marginal costs (zero in this case), and profits equal to zero. On the other hand it is assumed that if a variety is certified then the information is truthful. Given the increasing costs of producing higher quality varieties and that information is costly, firms will decide to improve the environmental performance of their products only if they can communicate this to consumers.

The utility function of consumer *i* who buys variety *j* is given by:

$$U(q, p, \theta) = v + \theta_i (q_j - q_k) - p_j - E \qquad (9)$$

Remember that Clark, differently from the others, considers the case in which preferences are over relative measures of environmental performances. *E* is the environmental damage, which is a function of qualities and the relative demands for the two varieties:

$$E = (1 + \frac{q_1^2}{2} - q_1) D_1 + (1 + \frac{q_2^2}{2} - q_2) D_2 \qquad (10)$$

Where D_i is relative demand for good *i*. After having defined all the functional forms, the approach is as usual, first the consumer who is indifferent between the two goods is found, and from this the demands for the two goods; maximising profits with regard to prices and qualities the Nash equilibria are determined. Independent on the location choice, for certification purposes there are three possible outcomes:

i) the two firms differentiate, with firm 2 producing the higher quality; in this case firm 2 will get the certification and firm 1 will not[10];

ii) the two firms will produce the same lower quality variety; neither will get the certification and the standard Bertrand equilibrium arises; and

iii) both firms produce the higher quality and get the label; prices will be equal to marginal costs (higher than 0), and profits will be zero.

Thus firms will differentiate only if profits will be greater than 0. In this case the non certified (labelled) firm will produce q_1=0, substituting this in the reaction function of firm 2 determines the equilibrium value for the labelled variety q_2.

The minimum environmental quality standard above which a label is granted is determined by maximising social welfare with regard to q_2. The social welfare is given as usual by

[10] In Clark there are only two possibilities: a firm gets certified if it produces above a certain standard, otherwise it will not. In principle it is possible to consider cases in which the certification tells exactly the characteristics of the good, and so have different labels.

consumers' surplus, profits and environmental damage. Given the very specific functional form assumed by Clark, it is possible to find numerical values for the minimum environmental quality standard q^*. In this case it is $q^*=0.73$. Clark also shows that, relative to uniform taxes or emission standards, a labelling scheme generates a higher welfare if environmental characteristics enter in consumers' utility function.

Dosi and Moretto (DM) (2001) consider the issue of the effectiveness of eco-labelling schemes in reducing aggregate pollution levels in a multi-production lines framework. DM show that there may be situations in which eco-labelling may induce an expansion of polluting capital before the label is awarded. This happens under particular circumstances and of course one could think of devices that prevent this from happening. It is assumed that a good can be produced adopting two different technologies: one that uses green capital, which generates lower emissions; and a second one that uses polluting capital with subsequently more emissions. A firm may adopt both technologies at the same time and set up two different production lines. However, investment decisions are irreversible and polluting capital, once acquired, cannot be converted in green capital. Amongst different assumptions a crucial one seems to be the way capital is acquired. In fact it is assumed that the firm purchases polluting capital in the first period, a decision which is irreversible. In the second period the firm decides whether to expand capital or not. If it decides to expand, it must also consider whether to buy additional green capital or additional polluting capital. In the second period the firm can also decide whether to completely abandon the polluting technology and use only green capital or if to keep two production lines, a green and a polluting one. If the firm adopts the green technology then it can apply for an eco-label.

In case the firm maintains the two production lines, the more or less effectiveness of eco-labelling schemes depends on whether there exists a relationship between the two production lines and on the type of this relationship. If there is a complementary relationship between the two production lines, and if obtaining an eco-label gives a positive image to the entire firm (so that the polluting line also benefits from the label), then eco-labelling schemes have perverse effects. Compared to a non labelling scheme, the firm will acquire a higher level of polluting capital in the first period, if it plans to buy also green capital in the second period and expects to obtain the label. On the contrary, if there is a substitution relationship between the two lines and if production of a green product means a decline in the profitability of the polluting line, then the eco-labelling scheme will induce a lower investment in polluting capital in the first period and lower emission levels. It is clear then that eco-labelling schemes should be designed to take account of possible spillovers existing between different production lines of a firm. Also, awarding labels should be considered more strictly when there is a possibility that firms abuse the use of the eco-label. One suggestion could be to grant a label only to those firms that can prove the environmental compatibility of all their lines, but this seems a rather restrictive policy.

Given these assumptions it is not clear why the firm cannot decide in the first period to buy the green capital.. Moreover, also in the case of a complementary relationship, if it is true that the polluting line may benefit from the label of the green line, the opposite may be true where the image of a green line may be damaged from the existence of a polluting line. In this case then the firm should have an incentive to lower polluting investment in the first period.

4. Eco-labelling and trade.

Eco-labels may be an answer to the shortcomings of environmental policies. With globalisation and free trade industrialists fear that the unilateral imposition of environmental policies by one country would put their firms at a competitive disadvantage relative to foreign firms not subject to the same environmental policy, particularly if it is production and not consumption which is subject to the policy. If consumers cannot observe the production process and are not informed, the arguments against environmental policies may have some grounds.

Let us consider the case of environmental taxes and leave aside all issues of strategic behaviour by countries or firms. Consider a domestic and a foreign firm producing a homogeneous product at equal marginal costs and no transport costs. Consider also the case in which the externality derives from production and consumers care about the environment (independent on where the damage occurs) but do not have any information on the production process, thus if it is polluting or not. Also the fact that a firm is subject to a tax does not reveal any information on the environmental quality of the production process. That is, unless otherwise informed consumers believe that the government sets a tax for any other tax raising purposes and not to correct a negative externality. In other words, a tax or a higher price is no signal of a better environmental quality. The equilibrium outcome will arise where the two goods will be supplied in the home market at the same price equal to marginal costs. If the domestic country introduces an environmental production tax, the domestic firm will change its production decisions and will decide either to abate pollution or to pay the tax until the margin abatement costs and tax rate are equalised. In any case this will increase the domestic firm production costs. Given that the environmental tax is placed on production the foreign firm will not be subject to it and will produce at the same marginal costs as before. In this case the equilibrium outcome will be only the foreign firm surviving in the home market, selling the good at a price slightly below the marginal cost of the domestic firm after the tax, but higher that the initial price and higher than marginal costs before the tax. With the environmental tax consumers' surplus will decrease, because consumers will be able to buy a lower quantity at a higher price. Domestic profits will equal zero as will the environmental damage (if the damage is caused only by production). The effects of the environmental policy on welfare will depend on how large the environmental damage is relative to the loss of profits and consumers' surplus. If the decrease of environmental damage is larger in absolute value than the loss of profits and consumers' surplus, welfare increases and the environmental tax is still a beneficial policy. The opposite is true if the loss of consumers' surplus and profits is larger than the decrease of environmental damage. But the argument put forward by industrialists about a loss of their international competitiveness holds.

If instead of an environmental tax the country adopts an eco-labelling scheme the equilibrium outcome may be different when there are environmentally aware consumers and when the tax has any impact on consumers' behaviour. In this case in fact green consumers are willing to pay a higher price for the environmentally friendly good. If the domestic firm decides to abate pollution and charge a higher price because of this, it may still survive in the market thanks to the label, together with the foreign firm. The label would then solve the issue of the competitive disadvantage caused by the environmental policy. The impact on welfare will be the following. Assuming that in the market the two firms survive (with the domestic firm producing the 'green' good at a higher price and the foreign firm producing the 'brown good'

at a lower price) we will have consumers buying products with characteristics that fit better their preferences. The total effect on consumers' surplus depends on how prices and quantities change due to product differentiation. The domestic firm will make positive profits and will keep producing if the revenue is higher than production costs, abatement costs and the eco-labelling fee. The environmental damage clearly decreases compared to the no-scheme case. The net effect on welfare again depends on how all these factors interact. From the point of view of the foreign firm profits may also increase. The introduction of the labelling scheme in fact enables the two firms to differentiate from each other and reduce the extent of competition between them. The foreign firm is going to sell an environmentally inferior good, but may be able to charge a price slightly above marginal costs. How much above depends on demand elasticities and on the reaction of the domestic firm[11].

Of course things are not so straightforward and they can be seen from a different point of view, particularly if we change some assumptions. For example, if there are transport costs,for a foreign firm, which is already at a competitive disadvantage, it may be too costly to produce with a green process and apply for the label since certification costs would be too high. . Or if the effect of the label on consumers' behaviour is very strong so that almost all domestic consumers buy the domestic good, then the label acts as an entry barrier and the foreign firm disappears from the home market.

Greaker (2003) compares welfare and trade effects of eco-labels and of environmental standards. In his model there are two firms, a domestic and a foreign one. Only production is polluting. The domestic government can decide whether to impose an eco-label scheme or an environmental standard. The environmental standard applies only to the domestic firm while both firms can apply for the eco-label. Consumption occurs only in the domestic country. The analysis is carried out through a three stage game of perfect information among the domestic government and the two firms. In stage 1 the domestic government chooses whether to impose an environmental standard (and its strength) or an eco-label scheme (and its criteria). In stage 2 firms decide whether to apply for the eco-label (in case this policy is introduced) and in stage 3 firms compete in prices on the domestic market.

The model is one of horizontal product differentiation. Consumers like green goods independent of where they are produced. However, consumers can observe that a good is green only when the domestic producer is regulated by an environmental standard or when there is an eco-label. It is shown that domestic and global welfare are maximised when an eco-label scheme is adopted, compared to the case when an environmental standard is introduced or no environmental policy is used. It must be noted that there are some assumptions which are crucial for these results to occur. Apart from what has been said previously, in the model it is surprising that despite the foreign firm produces in the domestic market, it is not subject to the same environmental regulation as the domestic firm. This seems odd: the negative externality is generated by production and the foreign firm, producing in the home market, generates it as well as the domestic firm, so apart from capital ownership it is exactly equal to the domestic firm, but nevertheless it is exempt from the environmental regulation, and especially it is exempt from a production tax. It is straight-forward then that the fiscal policy harms the domestic firm too much relative to the foreign

[11] Of course this is only an example of what could happen to trade, a formal model is necessary to check the impacts of eco-labelling on trade patterns.

firm. Second, in this model at the end it is not clear what happens to trade. In equilibrium in fact the government will choose the eco-label scheme (rather than the environmental standard) and both firms will apply for it (which is not surprising given the assumptions). The main result then will be a lower environmental damage but higher consumers' prices.

5. Empirical evidence.

From the empirical evidence it can be concluded that information plays really a crucial role both for consumers' and for investors' decisions. Consumers are willing to pay a higher price to be informed about the green characteristics of a good, and a label can really be a determinant in their choice about which brand to buy. On the supply side of the market, disclosing information about the environmental performances of firms can affect investment decisions and the stock values of those firms.

5.1. Empirical evidence on eco-labelling and consumers' behaviour.

Cason and Gangadharan (CG) (2002) run an experimental analysis[12] to understand the role of certification in improving the provision of environmental quality. The experiments take into account different issues, like for example sellers' reputation or consumers' experience, to isolate the effects of those issues from the mere role of certification. In the experimental analysis CG have a group of sellers providing a good of either higher or lower environmental quality, the good of high environmental quality is more costly to produce and is sold at a higher price. Sellers make an offer price that is posted on a board. Buyers then accept or reject the offer price (and thus purchase the good or not). The environmental quality of the good cannot be observed prior purchase. In the *Baseline* experiment the seller's identity is not revealed and no products claims are allowed. The actual environmental quality of each good sold is revealed only after purchase. In the *Reputation Only* treatment the seller's identification is revealed before purchase, and buyers can keep track of each seller's subsequent price offer and identify if the seller has a history of supplying the good of inferior environmental quality or that of superior quality. In the *Cheap Talk Signalling* treatment the identification of the seller is also revealed and unregulated product claims are allowed. In the experiment the sellers can choose of either not disclosing the environmental variety of the units sold or indicate the grade of the good (if high or low quality) together with the price. The environmental quality they reveal need not be the real one. This represents the situation in which producers make vague claims that are not certified by a third party. In the *Certification* experiment sellers have three options: as before they can decide not to reveal the environmental quality of the units sold, they can make vague unregulated claims or they can have their products certified at a fixed cost by a third party. The certification is revealed with the price and corresponds to the effective quality of the good. Consumers know that the certified quality is the real one. So at the same time we have in the market products of unknown environmental quality, products with vague claims and certified products.

[12] In an experimental analysis a group of people is selected to simulate market situations. In this case people were divided in two subgroups, sellers and buyers. Sellers had to place an offer price on the good supplied and buyers had to accept it or not. The experiment was run several times with the same groups or with different groups.

12% of the units sold in the Baseline experiment are of higher quality, but in general there is a typical moral hazard problem. In the Reputation treatment that percentage increases to 40%. In the Cheap Talk the number of high environmental quality goods fall to about one third (though statistically this percentage is not different from the Reputation experiment). In the Certification experiment more that two thirds of the units sold are of higher quality. When sellers can establish their reputation efficiency (maximum gains from trade realised by the subjects) rises from 65% to 80%. Efficiency rises also with vague claims and certification, but the levels are not significantly different from the Reputation experiment. In the Cheap Talk experiment 49% of the claims were false. False claims (33%) also arise in the Certification experiment. If the seller offers a high environmental quality good he chooses to certify it if he can, to distinguish himself from the other producers (and given the possibility of false vague claims). The main conclusion is that although certification is costly most sellers will opt for it and the number of environmentally superior goods increases. However, given the relatively high certification costs, efficiency does not rise significantly. Still, certification seems to solve the moral hazard problem, and is also a necessary condition for it. Certification has also a significant impact on prices. The results suggest that countries can significantly improve the environmental performance by providing eco-labelling schemes.

Bjorner, Hansen and Russell (BHR) (2004) estimate a model of consumers' choice amongst different brands of three products: toilet paper, kitchen towels and detergents. The purpose is to estimate the effects of the Scandinavian Label (the Nordic Swan) on consumers' decisions. BHR have an extensive panel data set and in the period under consideration different brands obtained the label at different points in time. In this way the data set contains information on consumption decisions before and after the label, and this enables to control for differences in the qualities of different brands. BHR regress the probability of choosing brand *h* over brand *j* on different explanatory variables, that is prices and brands' attributes, amongst which a label indicating if the brand has obtained the Nordic Swan label. From the estimation of the parameters in the consumers' choice regressions it is then possible to obtain the marginal willingness to pay for each attribute, as minus the ratio of the attribute's parameter over the coefficient of price. The estimation indicates that the environmental label has had a significant impact on the choice of which brand of toilet paper to buy, while it didn't have a strong impact on the choice of kitchen towels. For toilet paper the marginal willingness to pay for the certification ranges from 13% to 18% of the price. One reason why the certification was not significant for kitchen towels is that this good is purchased less often than toilet paper, and definitely less often by green consumers in Denmark (who in general choose to avoid using paper kitchen towels). In this case an eco-label cannot be a significant attribute. For the detergents, the impact of certification on the marginal willingness to pay is approximately similar to that of toilet paper. Within the period under consideration a consumer report on the environmental performance of some brands was also published. This made the estimation of the parameters more difficult. On the other hand it was clear that a good environmental reputation obtained from the report had a significant positive impact on sales. From this it can be concluded that in Denmark consumers do respond to the certification. Information on the environmental performance of firms plays an important role on consumers' decisions and thus that there is a positive demand for the information and for the certification.

Teisl, Roe and Hicks (TRH) (2002) use an Almost Ideal Demand System (AIDS) approach, in which a system of demands of different goods is estimated. TRH consider the demand for

canned tuna and three substitute products: two types of canned meat and other canned seafood products. The purpose is to see if dolphin-safe labels on canned tuna have had any impact on tuna consumption. The first thing to note is that there has been a downward time trend in the consumption of canned tuna and other seafood, and a positive time trend for meat. This could indicate changes in preferences, but for canned tuna it could also be a consequence of a lower quality of the tuna used. In fact due to the legislation for dolphin-safe fishing criteria, fishermen began to catch different and smaller types of tuna, less suitable for canned products. One important explanatory variable is also the exposure of the tuna-dolphin issue on different media (television, newspapers and magazines). The coefficient of that variable is significantly negative for canned tuna demand, indicating that consumers' information does play an important role in determining their behaviour. The coefficient on labelling is significantly positive, indicating that the presence of dolphin-safe labels increased sales of canned tuna (it also increased the sales of other canned seafood, while it decreased the sales of meat). So although the sales of canned tuna decreased over time, the label decreased this slowdown. The effects of labelling is however not immediate, for different reasons. First, it takes time for the information to spread sufficiently amongst consumers so to change their behaviour and have a statistically significant impact. Second, consumers who note the label do not react immediately, but want to be sure about monitoring mechanisms and thus about the truthfulness of the label. Moreover, there are stock reasons, shops still have non-labelled canned tuna on their shelf, for some time also after producers have started introducing the label on their products.

These results show evidence that the presence of an eco-label has had a significant impact on consumers' behaviour, and that information also plays an important role. In turn this may affect producers' behaviour. If the share of green consumers is significant in the market, then an eco-labelling scheme may provide firms with the right incentive to change their production decisions and differentiate their product towards one with higher environmental quality characteristics.

5.2. Empirical evidence on environmental performances information disclosure and financial markets.

Konar and Cohen (KC) (1997) ask a different question. They want to se whether publicly provided environmental information (that is information on the environmental performances of firms) is an effective policy instrument and can be used as an alternative to direct environmental regulation, especially in contrast to command and control. To be an alternative instrument of course publicly provided information must provide the right incentives to firms to change their emission levels. If a bad environmental reputation has a negative impact on the financial performance of the firm, then the provision of this information will provide an incentive to the firm to improve its environmental performances and it can be used instead of the more traditional environmental instruments. In the paper KC consider the stock market based financial performances. In principle, under perfect competition assumptions, security prices are the best unbiased estimation of the assets' value of a firm. There are different reasons why the environmental performance of firms may affect its stock value. One possibility is that high emission levels may be an indicator of a waste of resources and thus of poor management. Another possibility is that investors are environmentally aware. A third

possibility is that high emission levels increase the probability of environmental liability and thus reduce the financial returns of the securities. Similarly, if a firm has a bad environmental reputation, consumers may react by not buying the product, again reducing the firm's profits and its financial returns. KC identified firms with abnormal negative returns following announcements on the level of their emissions. From the analysis they found that firms with negative stock price effects as a consequence of the announcements were amongst the largest polluters, and subsequently the ones that reduced the emissions more than any other in the industry. Thus the announcements of a firm's emission levels had a significant impact on its market evaluation, and in turn this induced the firm to abate more.

Foulon, Lanoie and Laplante (FLL) (2002) compare the effects of traditional enforcement mechanisms (like firms having to pay a penalty if found non compliant with the environmental regulation) with those of information strategies (like disclosing information on emission levels or compliance rates of firms). In Canada the Ministry of the Environment publishes twice a year a list of all plants that did not comply with the environmental regulation or whose emission levels were very close to a critical level[13]. This publication has had an important impact on the stock values of those firms, which were significantly reduced after the publication. Aside from this publication the Ministry keeps taking legal actions against the non complying firms. This fact allows measuring the relative contribution of the two types of regulation, and the role of information relative to the command and control standard regulation, in reducing emissions. FLL focus on the pulp and paper industry, given the relevance this industry has in Canada. The disclosure of information on emission levels or on emission rates is a policy that has a little additional cost relative to monitoring and enforcement mechanisms. In addition, it can help the latter reach the emissions reduction target. Monitoring and enforcement mechanisms are always very difficult and costly to implement. Their outcome is also not certain. After a governmental agency has assessed an environmental non compliance by a firm, it will start a prosecution process to get a fine paid. This may involve going to court and wait for a judiciary process that not necessarily will result in a penalty for the firm. The firm may be able to convince the court of the presence of mitigating circumstances, of doubts or procedural circumstances such that the firm will not result liable. In this case providing the information about the non compliance to the public can be seen as a complementary policy tool. FLL regress both emission levels and compliance rates (given by the actual emission levels minus the standard level, over the standard level) of Biological Oxygen Demand (BOD) and Total Suspended Solids (TSS) on different variables. Amongst which variables they include: a variable of *concern* defined as the number of times a plant has appeared on the list as near to a critical level of emissions, a variable measuring the *out of compliance* (defined in a similar way), a variable defined as *prosecution* (again, the number of times a plant was prosecuted in a year), a *fine* variable and other control variables. According to the estimation results, the appearance of a plant in the non compliance list had a negative impact on pollution levels. These plants were induced to reduce their emissions. *Prosecution* did not have a significant impact, while *Fine* had a negative impact only on BOD emission levels. From this an important difference emerges between the effects of information disclosure on the environmental performances of firms and those of monitoring and enforcement. The *out of compliance* variable had a significant negative coefficient for both types of pollutants and for both emission levels and compliance rates. On the other hand *Fine* was significant only for BOD levels. Moreover, it is estimated

[13] This has partially changed and only the non compliance figures appear now.

that the impact of information based policies has a very quick response to correct for the damage, also quicker than the fines. Firms may give a greater weight to the financial implications of appearing in the list rather than having to pay a fine. The two instruments can be used complementarily and not necessarily as an alternative; particularly if one thinks that disclosing environmental performances information comes at a very low additional cost after the monitoring has been done, while the benefit can be a lot larger and the response a lot quicker.

6. Modelling issues and conclusions.

The empirical evidence has shown that information on product characteristics and production processes are valued by consumers and by investors, and plays a relevant role in determining their behaviour. Eco-labelling then becomes an important instrument that can help consumers, producers and governments take better decisions. However, the impacts of eco-labelling must be studied carefully in order to avoid some perverse or undesired effects.

From the above discussion the issues that must be considered when evaluating eco-labelling relative to other environmental policies are the following.

1. The impact of eco-label must not be confused with other effects. So when comparing for example the use of taxes rather than labels we should use the same model and assumptions in both cases, while often different models are used or different implicit assumptions are made. It seems advisable to start from a very simple situation and consider extreme cases. For example, consider an OGM good that has no effects on health or environment to start with (so that there is no reason to introduce an environmental policy). Nevertheless, consider the case where there are still consumers who prefer a non OGM good and others who do not care. Is the introduction of a label welfare improving? The effects on welfare are opposite, on the one hand information improves and consumers can match better their preferences. On the other hand production costs and the price of the non OGM good will increase. Consider then the situation in which the OGM good has some negative effects. In this case the eco-label also corrects the externality. What is the welfare effect in this case? This analysis is important to study what are the incentives for using the labels also for strategic and non environmental purposes.

2. In all the papers seen in the literature consumers are assumed to be aware and to care for the environment, but the negative externality is generated only from the production of the good and not from the consumption. This does not cover the case when consumption is also polluting, in which case the ‘greenness’ of a product is really a characteristic of the good itself and not of the production process. The two cases of production and consumption externalities must then be considered.

3. The impact of environmental policies, and the incentives to use them as a strategic tool or not, changes depending on whether the negative externality is local or global, if consumers care only about what happens in their domestic market, or if they care also about what happens abroad.

4. Compare effects on trade flows of the different instrument policies and the incentives to use environmental policies for strategic reasons. If the eco-label is used as a barrier to trade then appropriate models should be used (for example models of entry barriers).

5. It remains to be seen if it makes any difference who imposes the label, if the 'good guy' or the 'bad guy' and if it makes any difference whether the label is voluntary or mandatory.

6. It is important to consider the question of who assigns the label, if an independent body or the firm itself. This issue introduces the issue of imperfect monitoring, monitoring costs and moral hazard.

7. It is important to understand what is the impact of eco-labelling on total damage, rather than only on unit emissions. In fact if the effects of the eco-label is to switch demand from dirtier to cleaner goods, then apart from welfare analysis there is an immediate benefit in pollution reduction. If on the contrary eco-labels increase demand (or even create a new demand) then the reduction of unit emissions must be compared with the increase in total output in order for the eco-label to have a positive impact on pollution, still apart from welfare considerations.

8. If other factors such as consumers' information and awareness, are taken into account, then the eco-label may be even more beneficial. In contrast if other factors like increase of market power or trade barriers are taken into account then the effects of eco-labels may also be negative.

9. It is important to note that all the models analysed are static models. This is not surprising and not wrong either, particularly since already with static models the analysis is complex given the many different factors that must be taken into account. The theoretical discussion is relatively recent and a lot of work must be done. Yet, it is important to remember that policy makers also have a long run point of view. Eco-labels may fall more in a long run policy category, especially if one of their purpose is to make all consumers more aware and change their behaviour.

In summary, eco-label scheme are used to affect production through consumers' demand. So the eco-label will firstly have different effects on the demand. On the one hand consumers will increase their utility because their preferences are better matched. On the other hand goods that were considered as homogenous before become differentiated in some way and prices will increase. This of course will have different impacts on consumers' surplus. The increase of price will decrease it, while the better matching of good's characteristics with consumers' preferences will increase it. It remains to be seen to what extent prices will be allowed to increase above marginal production costs. This is dictated by the extent to which eco-labels can be used as barriers. On the other hand eco-labels will not make brown goods disappear, and so consumers will always be free to chose the brown product at the old prices. The question then is also how much the label will affect the demand for the brown products.

On the production side, applying for a label is a cost for the firms, which must be compensated (and is compensated) by a higher price. The surplus of green producers should

not decrease, the net effect depends on the elasticity of demand. For brown producers, the price remains the same, the demand for the brown good decreases but also the supply of the competitors, and so again the net effect is not clear, it depends on demand elasticity.

The use of environmental standards and taxes (subsidies) could put the domestic producer at a competitive disadvantage (advantage) if the externality is generated from the production (or if only the production side is regulated). In this case an eco-label scheme is usually welcomed by producers themselves. On the other hand, for all the reasons said before, if applying for an eco-label is costly and if the cost affects marginal production costs in different ways, the scheme can constitute a trade barrier (particularly if the foreign firm comes from a poor country, technologically disadvantaged). However, we could have a situation in which consumption is taxed in order to avoid competitive disadvantages. In this case both the domestic and the foreign goods are subject to the same tax. But the two goods are not considered equivalently by the domestic consumers and so (as was pointed out before) an equal tax will have discriminatory effects. On the contrary the label, even if a discriminatory instrument, may be preferable because foreign firms can always decide not to apply for it, and sell the brown good in the 'old' market at the 'old' price. Again welfare comparisons are not straightforward.

Also, in terms of environmental damage it is not really clear whether the net impact will be positive or negative. It depends on whether we have production or consumption externalities, and whether pollution is local or trans-boundary. In addition, since the effects of imposing environmental regulation depends on demand elasticities and how the structure of the market changes, it is not clear a priory that less of the polluting good is produced.

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