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Bougherara D., Piguet V., 2009, Market Behavior with Environmental Quality Information Costs, Presented at the workshop « Quality promotion through ecolabeling: theoretical and empirical advances on the feasibility of developing social and environmental claims », Nancy, June 29-30.

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Abstract

Formally, eco-labels are modeled as tools that enable to mitigate informational asymmetry on product environmental quality. We argue that even in the presence of an eco-label, markets for eco-friendly products may still be inefficient. We model eco-friendly goods as goods with environmental quality information costs. We induce buyers' preferences in laboratory posted offer markets with information costs on products' quality. We analyze the effect of varying information costs on market efficiency and consumer information demand. We also test for the effect of self-declared labels. We find that a low information cost introduces a friction not high enough to lead to adverse selection whereas a high information cost drives out high quality products. We find self-declared labels have a positive effect on market efficiency but only sellers benefit from self-declared labels. We find that demand for information follows the classic law of demand and that it is a non linear function of product price as theoretically expected. We also find that, when information costs are high, demand for information decreases when sellers use self-declared labels: either buyers use self-declared labels as an information-revelation device or reputational affects feedbacks are a substitute for information demand.

Key words: Information Costs; Credence Goods; Eco-Labeling; Experimental Economics;

1. Motivation and background

Eco-labeling is a market-driven policy tool aiming at internalizing the external effects of production, consumption and disposal of products on the environment. For example, the US eco-label "Green Seal" describes its mission as 'encouraging and assisting individuals and corporations in protecting the environment by identifying those products that are less harmful to the planet than other similar products'[1]. In 2009, the Global Ecolabelling Netwok reports 25 eco-labeling programs that are developed by member organizations and that account for more than 29,000 certified products and services around the world. While the polls frequently report consumers' willingness to pay for eco-labeled products, little evidence exists as to the actual ability of eco-labels to impact on purchase behavior. Notable exceptions are the empirical results of Teisl et al. (2002), Bjorner et al. (2004) and Dhar et Foltz (2005) that respectively show that the "dolphin safe" label on tuna, the Nordic Swan label on toilet paper and the organic label on milk have an impact on consumer behavior. These results show the potential impacts of eco-labeling.

Environmental attributes of goods relate to process attributes. Because of the informational asymmetry between sellers and consumers, markets for eco-friendly goods are subject to the lemon's problem (Akerlof, 1970). Thus, formally, eco-labels are modeled as tools that enable to mitigate informational asymmetry on product environmental quality (see for example, Cason and Gangadharan, 2002; Caswell and Modjuszka, 1996; Kirchhoff, 2000; Teisl and Roe, 1998). *We depart from this theoretical framework and argue that, even in the presence of an eco-label, markets for eco-friendly products may still be inefficient.* We model eco-friendly goods as goods with environmental quality information costs. The originality of the paper is twofold. (i) We show that only a careful design of the eco-labels can increase market efficiency. We model environmental attributes of goods as attributes that are costly to verify. In the absence of a label, consumers rely on several proxies to get information on product environmental quality. Moreover, even in the presence of an eco-label, consumers still search for information on the meaning and credibility of the information provided. Modeling the market for eco-friendly goods as a market with information costs on environmental quality of goods allows us to take account of the information search behavior of consumers. We also test for the effect of reputation and self-declared labels on market efficiency and consumer information demand. (ii) We provide an empirical test of the effect of quality information costs on market efficiency. Such markets have been modeled theoretically (Bester and Ritzberger, 2001; Kilstrom, 1974) but to our knowledge, there is no empirical test of the theoretical propositions. It is difficult in surveys to control for the level of information cost on quality because this cost may vary among individuals. Experiments in the lab enable to test our hypotheses. The environment is controlled and variables accurately known.

[1] Global Ecolabelling Network website : http://www.gen.gr.jp/USA.html

We find that a low cost (10% of consumers willingness to pay for high quality products) introduces a friction not high enough to lead to adverse selection whereas a high information cost environment (around 66% of consumers willingness to pay for high quality products) drives out high quality products. We find that allowing for reputation in an asymmetric information market does not enhance market efficiency as a whole. We find self-declared labels have a positive effect on market efficiency and on the probability of sellers' proposing high quality products but it also has distributional effects (only sellers benefit from self-declared labels). According to Kihlstrom (1974), demand for information on product quality is a derived demand for products. We find that demand for information follows the classic law of demand and that it is a non linear function of product price as theoretically expected (Bester and Ritzberger, 2001). We also find that the probability of purchasing information on quality when its costs are high deceases when sellers use self-declared labels: either buyers use self-declared labels as an information-revelation device or reputational affects feedbacks are a substitute for information demand.

Our paper is organized in the following way. In section 2, we examine the theoretical and experimental literature on markets with information asymmetry and on markets with quality information costs, and discuss in detail the relevant experimental evidence. In section 3, we detail the experimental setting and the theoretical predictions. In Section 4, we present our results and discuss them. Section 5 summarizes our results and concludes.

2. Eco-labeling, quality information costs and related literature

In this section, we present the different types of eco-labels and their implications on information quality costs and market efficiency. We first analyze the different sources of information costs on quality for eco-friendly products. Then, we review the economics literature on informational asymmetry, information costs on quality and self-declaration.

2.1. Eco-labeling types and quality information costs

ISO14000 defines three types of eco-labels. Type II eco-labels are self-declared labels whereas types I and II eco-labels are certified by a third party. Type I eco-labels are binary informational tools. In type I eco-labels, the information is relative (good for the environment or not as compared to the other similar products) and the scoring is already done whereas type III eco-labels give absolute, more or less detailed information about the impact of the product itself on the environment. The scoring is left to the consumer. It follows that the type of label will have an effect on buyers' information costs on quality as described hereafter.

In the absence of an eco-label, consumers decide to invest a certain amount of their resources in information search for product environmental quality. The amount invested depends on individual parameters like the prior level of knowledge, the access to information, the ability to analyze information. The introduction of eco-labels is new information that may or may not lower the cost of information search. The information eco-labels convey has still to be analyzed, understood and believed. We identify three potential sources of quality information costs in the presence of an eco-label (Bougherara and Grolleau, 2004; Karl and Orwat, 1999). (i) First, consumers may incur definition costs. Environmental criteria are not set by the market demand side contrary to other attributes of goods. The consumer does not define what is good for the environment. Rather eco-labels' promoters are quality-makers. Environmental criteria are set by the seller (type II eco-labels) or are the outcome of a negotiation between several interested parties (like firms, government, NGOs, consumer organizations…) (most type I and III eco-labels). The endogeneity of environmental quality to the eco-labeling process is due to the lack of consumers' ability to define what an environmentally-friendly product is. The issue addressed here has nothing to do with verification (Plott and Wilde, 1982). A buyer may verify that a farmer has maintained hedgerows but she may lack expert abilities to know if it is good for the environment. (ii) The second type of quality costs are the most commonly referred to. They are the verifying costs; that is, the resources invested by buyers to check that the seller has done what he claims. Because of credence properties, buyers can seldom verify claims. Even if there are certifying devices (type I and III eco-labels), these may seem more or less credible to the buyer that may or not invest in a costly search for more information on product quality. (ii) The third category of quality information costs pertains to signaling (Wynne, 1994). Suppose there are no definition costs and no verifying costs. Buyers still have to analyze the label they are provided with. If we assume consumers have limited cognitive abilities, label format may entail costs for buyers. Some labels convey simple yes-or-no information (type I eco-labels) whereas others are detailed life cycle analyses indicating the environmental impacts of the product at each step of the life cycle and for each environmental field (some type III eco-labels). The former are less costly to analyze for buyers than the latter.

Modeling eco-labeled products as products with quality information costs gives a different perspective to the analysis of eco-labeling as a policy tool. It is already apparent that label design will have an important role in shaping quality information costs that in turn have an impact on market efficiency.

2.2. Literature on information asymmetry about product quality

2.2.1. Theoretical literature on information asymmetry

Information economics classifies good into three categories – search, experience and credence goods. Nelson (1970) drew on Stigler (1961) to define a *search good* as a good for which consumers can inspect the several alternatives before purchasing (for example, the try of a dress before purchase). The author introduces a category of goods called *experience goods* for which consumers had better evaluate the good through purchase than through search. Consuming the good reveals information on product quality. The cost of searching for information on quality is higher than the price of the good (for example, evaluation of the taste of several brands of tuna cans). To choose among several products, consumers prefer to buy information on products by way of experience – that is to say purchasing the product – until the marginal cost of the information becomes superior to its marginal return. Darby and Karni (1973) widened this classification. They added a third type of goods – credence goods which quality is costly to judge even after purchase so that information about product quality is costly for consumers.

This classification of goods or characteristics into these three types has been furthered by several authors (Ford et al., 1988; Krouse, 1990, p. 510; Andersen and Philipsen, 1998; Cho and Hooker, 2002) especially focusing on the cost of getting information on product quality rather than on the time when consumers become informed (before or after purchase or neither). Then goods can be considered as distributed according to the level of information costs about quality. At one extreme, the perfect search goods (information costs are nil) and at the other, credence goods (information costs are prohibitive). As analyzed in the previous section, eco-labeled products usually fall into the category of credence goods and quality information costs on environmental attributes are barely low for consumers[2].

2.2.2. Experimental literature on information asymmetry

Experimental literature has focused early on information asymmetries on markets[3]. The literature focuses on several questions. Plott and Wilde (1982) deal with market efficiency when buyers must rely upon sellers' recommendation for the purchase of a service. Buyers then shop for competing sellers' diagnosis at no cost before choosing the seller they will buy the service from. The hypothesis of a no cost diagnosis is strong. The authors show than competition among sellers reduces incentives for sellers to shirk and increases market efficiency. Miller et Plott (1985) study the effect of sellers' costly signaling on market equilibrium. The sellers' type is exogenously determined and sellers can engage in costly signaling where signaling is costlier for low quality sellers than for high quality sellers. The market leads to a separating equilibrium only if the signal cost difference between high and low quality sellers is high enough. In markets with adverse selection, Lynch et al. (1991; 1986)

[2] Some environmental attributes may be easy to verify. Think for example of products claiming to use less packaging. Consumers may check at a glance if toothpaste is sold with or without outside packaging.

[3] Given our study, we focus on experimental literature dealing with adverse selection. For moral hazard, see Keser et Willinger (2002 ; 2000), DeJong et al. (1985).

deal with information revealing mechanisms after purchase about seller type. Information revelation to all participants (public) is more efficient that information revelation to each buyer (private). Sellers' reputation building has no effect on the adverse selection outcome. Binding sellers' commitments mitigate adverse selection whereas self-declared commitments do not. In one treatment, the authors revealed information about sellers' type only after several trading periods (close to a credence good) instead of revealing information right after the exchange (experience good). But, this did not yield significant differences. Finally, Cason and Gangadharan (2002) study the effect of reputation, self-declaration and certification on market efficiency. Reputation and self-declaration increase market efficiency but not as much as certification.

Most experimental articles we reviewed deal with experience goods. Only two papers deal with credence goods. Plott and Wilde (1982) study the definition problem and Lynch et al. (1991) study the verification issue. In this article, we deal with markets with quality information costs; that includes definition, verification and signaling issues.

2.3. Literature on consumer information costs about product quality

The theoretical literature on consumer quality information costs is surprisingly scarce. The seminal paper of Kihlström (1974) offers a general theory of consumer demand for information on quality. Demand for information is a derived demand. Information on quality is purchased only because there is a demand for another good (the product on which information is demanded). Second, information demand occurs only when product quality is uncertain. Drawing on the model of Grossman and Stiglitz (1980), Bester and Ritzberger (2001) model quality information demand as a dynamic game with complete information. Sellers are of two types: high quality q_H and low quality q_L. Buyers know the probability of seller being of a high quality type $l \in [0,1]$ and the probability of seller being of a low quality $(1-l)$. Buyers observe the product price and then decide whether to buy information or not on product quality at a cost $k > 0$. The market equilibrium is a function of buyers' beliefs and under certain hypotheses, the lower the quality information cost, the lower the probability agents will invest in quality information purchase. The experimental literature deals with markets with information costs on prices (Brannon and Gorman, 2002) but to our knowledge, no experimental article studied markets with information on product quality.

2.4. Literature on self-declared labeling

Theoretically, self-declared labels (Type II) are sometimes referred to as "cheap talk" because of the absence of certification mechanisms. Cheap talk is defined as a message send by a sender to a receiver that has no direct effect on payoffs. Cheap talk is expected to to have no effect on market efficiency when the interests of the sender and the receiver of the "cheap talk" message diverge enough (Crawford and Sobel, 1982; Farrell and Rabin, 1996). Environmental self-declared messages by the sender (the seller) cannot reveal truthful information to the receiver (the buyer) because, for a given price, the seller's payoff decreases with the product quality whereas the buyers' payoff increases with the product quality. Given the divergence of interests between sellers and buyers, cheap talk cannot reveal truthful information in the case of eco-labels. However, self-declared eco-labels are often different from cheap talk in that they may have a direct effect on payoffs when reputational effects are allowed; Messages contained in self-declared eco-labels may then reveal truthful information because of the threat of reputational effects (being found lying). In the presence of quality information costs and reputational effects, we expect self-declared eco-labels to have a positive effect on market efficiency.

The experimental literature on cheap-talk and reputation has been reviewed in the previous section on informational asymmetry and shows that the experimental effect of reputation and self-declaration is not clear-cut. We test for these effects in this paper in the case of information costs on quality.

As a conclusion to section 2, we may say that there is a gap in the experimental literature for testing the effect of quality information costs on market efficiency and consumer demand for information, and that "counteracting institutions" as Akerlof (1970) names them, such as reputation and self-declaration, have not been tested in such a context. This is precisely the aim of our study.

3. Experimental protocol and theoretical predictions

The aim of this section is to present the experimental setting and the theoretical predictions for each treatment in the experimental before turning to the results.

3.1. Experimental setting[4]

Experimental subjects were 132 students from ENESAD (Dijon, France) and Université de Rennes I (Rennes, France). Eleven subjects participated in each session, randomly assigned as 5 sellers and 6 buyers. We report 12 sessions. All sessions except one have 32 trading periods. Subjects traded using experimental currency units (ECU), which were converted to Euros at the end of the experiment using a known but private conversion rate. All sellers had the same conversion rate (1 point = 0.004 Euros) and all buyers had the same conversion rate (1 point = 0.013 Euros). Average earnings were 30 Euros.

During each market period sellers can sell a maximum of two units of grade Regular or two units of grade Super. It is public information that Supers are more expensive to produce than Regulars, but only sellers know the exact cost. Each Super costs the seller 120 ECU and each Regular costs the seller 20 ECU. Buyers' resale values for Supers are more than for Regulars and this is also public

[4] We use an experimental protocol similar to Cason and Gangadharan's (2002) and Lynch et al.'s (1991). The reader can refer to these papers for a detailed description. This section borrows from the wording of Cason and Gangadharan (2002) for the presentation of the experimental setting. The protocol was designed during a stay at Purdue University. We are grateful to Tim Cason for his help.

information, but only buyers know the exact values. The marginal value of the Supers is always greater than for Regulars. The value of the first unit of Super is 330 ECU, the second unit is 300 ECU, and the third is 270 ECU. For Regulars the values are 180, 165, and 150 respectively. Buyers therefore prefer to buy Supers unless they are priced 120-150 ECU more than Regulars. All buyers and sellers have identical value and cost schedules, resulting in the market demand and supply schedules shown in Figure 1. In the efficient equilibrium with Supers delivered, the equilibrium price is 300 ECU with 10 units exchanged, resulting in a total maximum exchange surplus of 1980 ECU. In the inefficient equilibrium with all Regulars delivered, the equilibrium price is 165 ECU with 10 units exchanged, resulting in a total exchange surplus of 1540 ECU. Trading efficiency in the inefficient Regulars equilibrium is therefore 1540/1980=0.778. In addition to the profits earned from the units bought, buyers receive a bonus of 50 ECU each period and a starting balance of 200 ECU at the beginning of the experiment. This was stated explicitly in the experiment instructions. The reason for these bonus payments is that in this market design buyers could incur significant losses in the early part of the session if they naively buy Regulars at high Super prices. The bonus plus the starting balance helped them absorb early losses and therefore maintained control over monetary incentives. Buyers could choose not to purchase from any seller and still earn 10 ECU.

[Insert Figure 1]

3.2 Treatments

We design 5 treatments where the baseline treatment is *Ref* where there is a complete information asymmetry between the seller and the buyer (Table 1). To test for the impact of varying information costs on market efficiency and demand for information, we design treatment *Ref* (information asymmetry), *High* (high information cost) and *Low* (low information cost). To test for the impact of reputation, we compare treatment *Rep* where buyers can identify sellers from one period to the other with the baseline treatment. To test for the effect of self-declaration, we compare treatment *Self* where seller can self-declare their units' type (Regular or Super) and where buyers can identify sellers from one period to the other with the *High* treatment. In the experimental sessions, a credence good was traded. As such, information about quality could not be revealed after each trading period. A perfect credence good experimental market would require information on quality to be revealed either though information purchase when possible (as in the *High*, *Low* and *Self* treatments) or at the end of the experiment only. However, experimental participants had to be trained and their incentives to play maintained. We could not keep the information asymmetry during 32 periods. We organized the sessions in four blocks. In the first block (period 1 et 4), information on quality was revealed after each trading period to train the participants. In the second block (period 5 to 8), information was revealed at period 8 only. In the third block (period 9 to 16), information was revealed at period 16 only. In the last block (period 17 to 32), information was revealed at period 32 only).

[Insert table 1]

3.2 Theoretical predictions

The literature review enables us to draw theoretical predictions as to the effect of information costs, reputation and self-declaration on market efficiency and on demand for information on quality.

3.2.1. Market efficiency and probability of offering type S units

Two predictions can be formulated as regards market efficiency and probability of offering type S units. First, we expect treatment *Low* to be similar to a perfect information model where the equilibrium for S units occurs for a price equal to 300 and the equilibrium for R units occurs at a price equal to 165. Thus, only S units are traded because sellers' profits and buyer's profits are higher than for R units. "As the information cost becomes negligible, the equilibrium approaches the full information outcome and prices become perfectly informative" (Bester et Ritzberger, 2001, p.1360). Second, we expect the *Ref* treatment and the *High* treatment to lead to adverse selection where only R units are traded at a price equal to 165. This is the lemons problem (Akerlof, 1970). We expect that allowing for reputation effects in the *Rep* treatment and for self-declaration in the *Self* treatment will increase market efficiency because these are counteracting institutions.

3.2.2. Information demand on quality

The predictions on information demand on product's quality is a function of information costs but also of product's price (derived demand). The effect of information costs is expected to be in line with the law of demand whereby demand for information decreases with its cost. The effect of product price on information demand is less straightforward. We use the model of Bester et Ritzberger (2001). Let u be the buyer's outside option payoff, $\mu(p)$ the buyer conditional probability of seller type S given the price p, V the buyer redemption value (V_R if R unit and V_S if S unit). The buyer's expected payoff from not testing for the quality is: $Max \quad [\mu(p).V_S + (1-\mu(p)).V_R - p \, , u]$.

The informed buyer purchases the good if $V - p \geq u$. Therefore, the expected payoff from becoming informed is $\mu(p).Max[V_S - p, u] + (1-\mu(p)).Max[V_R - p, u] - k$ with k, the information cost.

Two cases appear:

- If $u > V_S - p$, it is always optimal not to buy the unit. Buyers will not invest in information. In our experiment, $u = 10$ then there is no information purchase if $p > V_S - u$ with three possible values for V_S (320 for the first unit, 290 for the second unit, and 260 for the third unit in the period).

- If $u < V_R - p$, it is always optimal to buy the unit and thus not to purchase information. In our experiment, $u = 10$ then there is no information purchase if $p < V_R - u$ with three possible values for V_R (170 for the first unit, 155 for the second unit, and 140 for the third unit in the period).

We can then formulate the following hypotheses. There is no information purchase if price is in the interval $]-\infty,170] \cup [320,+\infty[$ if the buyer has not already bought any unit in the period, in the interval $]-\infty,155] \cup [290,+\infty[$ if the buyer has already bought one unit in the period, and in the interval $]-\infty,140] \cup [260,+\infty[$ if the buyer has already bought two units in the period.

The optimal information purchase behavior is not so clear if $V_R - u < p < V_S - u$. Buyers purchase information if the expected payoff from becoming informed is higher than the expected payoff from not testing for the quality:

$$\mu(p).Max[V_S - p, u] + (1-\mu(p)).Max[V_R - p, u] - k \geq Max[\mu(p).V_S + (1-\mu(p)).V_R - p\ , u]$$

We know that $V_I - u < p < V_S - u$. Thus, the preceding expression can be written:

$$\mu(p).(V_S - p) + (1-\mu(p)).u - k \geq Max[\mu(p).V_S + (1-\mu(p)).V_R - p\ , u]$$

Two cases appear:

- If $Max[\mu(p).V_S + (1-\mu(p)).V_R - p\ , u] = u$, then, $\mu(p).(V_S - p) + (1-\mu(p)).u - k \geq u$ and $p \leq V_S - u - \frac{k}{\mu(p)}$
- If $Max[\mu(p).V_S + (1-\mu(p)).V_R - p\ , u] = \mu(p).V_S + (1-\mu(p)).V_R - p$, then, $\mu(p).(V_S - p) + (1-\mu(p)).u - k \geq \mu(p).V_S + (1-\mu(p)).V_R - p$ and $V_R - u + \frac{k}{1-\mu(p)} \leq p$

We formulate the following hypothesis: When $V_R - u < p < V_S - u$, after observing p, buyers optimally purchase information if and only if :

$$V_R - u + \frac{k}{1-\mu(p)} \leq p \leq V_S - u - \frac{k}{\mu(p)} \qquad (1)$$

It is not possible to test this hypothesis with our data because we don’t know buyers' beliefs $\mu(p)$. However, we can test for a less detailed hypothesis. Figure 2 shows the preceding predictions depending on the price of the product and on the order of purchase of the unit in the trading period. Four price thresholds can be determined from this figure: 140, 170, 260 and 320.

[Insert figure 2]

If the price is lower than 140 or higher than 320, there is no information purchase. If the price is in the interval [170,260], the probability of purchasing information is higher than if the price is in the interval [260,320]. But if the price is in the interval [260,320], the probability of purchasing information is higher than if the price is in the interval [140,170]. We are thus able to predict the magnitude of the probability of information purchase as a function of product price.

How will allowing for self-declaration impact on buyers' demand for information? The *Self* treatment allows for sellers to declare the type of their units. As such, the information provided in this treatment will have a direct effect and an indirect effect on information demand. First, as a direct effect, self-declaration will act as a substitute for information purchase and will probably have a negative impact on consumer demand for information. Second, as an indirect effect, self-declaration provides buyers with information that impacts on buyers' beliefs $\mu(p)$. Consequently, in the *Self* treatment, the decision rule (1) will be shifted according to the impact on $\mu(p)$. Our predictions on information demand as a function of the prices intervals will not be modified.

4. Results

We first present the descriptive statistics on the number of traded R and S units and on the level of market efficiency in each treatment. Then, the econometric results on market efficiency and information demand are presented and discussed.

4.1. Descriptive statistics [A compléter]

[Insert table 2]

4.2. Econometric analysis

Table 3 defines the variables used in the econometric analysis. The independent variables are dummy variables for the various experimental treatments, each interacted with two variables that capture the dynamic tendencies in the data. Following Noussair et al. (1995), the variables 1/t and (t-1)/t allow the estimates to reflect respectively the early period effects (small t) and the long run effects (high t). We are mainly interested in the long run effects since behaviors in early periods often correspond to learning effects. Following Cason and Gangadharan (2002), we define the variable *Ratio* equal to

$\frac{E(\pi_S^N)}{E(\pi_R^N)}$ as the ratio of expected earnings from offering Supers to the expected earnings from offering Regulars. The expected earnings are computed as follows. Consider R units. If a seller has offered R units in the (N-1) first periods and offers R units in period N, the seller revises his beliefs on expected profits according to the following formula: $E(\pi_R^N) = \frac{(N-1)\times E(\pi_R^{N-1}) + \pi_R^N}{N}$.

[Insert table 3]

Table 4 presents the econometrics results for the following four dependent variables: market efficiency, sellers' surplus, buyers' surplus and the probability of offering type S units (reference treatment in the model: *Ref* treatment). Table 5 presents the econometric results for the probability of purchasing information (reference treatment in the model: *Low* treatment).

[Insert tables 4 and 5]

We present the results on the effect of information costs first and then, on the effect of reputation and self-declaration. We will comment only the long run effects.

4.2.1. Testing for the effect of information cost

Table 4 shows the market efficiency decreases with information costs on quality. Market efficiency is significantly (1%) higher in treatment *Low* as compared to treatments *Ref* and *High*. Market efficiency in treatment *High* is not significantly different from treatment *Ref*. It seems there is a threshold information costs above which markets behave as if there was informational asymmetry. We do not reject our theoretical predictions about the low information costs treatment behaving as a close-to-perfect information market and the high information cost treatment behaving as a lemons market. But, the regression on sellers' surplus and buyers' surplus show that results are differentiated. Sellers benefit from the introduction of information cost –even in the high cost treatment– as compared to the baseline treatment whereas buyers do not benefit at all even when the information cost is small. The probability of offering type S units is higher in the *Low* treatment than in the *High* and *Ref* treatments. It shows that sellers have more expectations on their high quality units being traded when information costs are low.

Table 5 shows that the demand for information decreases with information costs (law of demand) and that there is no linearity between demand for information and product price. The predictions on prices intervals are verified.

4.2.2. Testing for the effect of reputation and self-declared labels

We find that reputation has no overall effect on market efficiency (see table 4) like Cason and Gangadharan (2002). It has a differing effect on sellers and buyers. Sellers benefit from allowing for reputation whereas buyers experience a loss. It seems buyers, by considering price as a quality signal, wrongly trusted sellers, and that sellers cheated since the probability of offering S units is not significantly different in the Rep treatment as compared to the baseline treatment.

Self-declaration has a positive effect on market efficiency (table 4). When information costs on quality are high, self-declaration seems to be able to mitigate market inefficiencies (higher efficiency in the *Self* treatment as compared to the *High* treatment). Two comments are in order. First, market efficiency is not as high as in treatment Low where the information cost is low. Second, self-declaration has increased sellers' surplus but not buyers' surplus. There are distributional issues. If we look at the last column of table 4, we see that the probability of offering type S units is higher in the *Self* treatment as compared to the *High* treatment. Sellers have increased their S unit offers but they were not traded on the market. Finally, we find that self-declaration has a negative effect on information demand (table 5) as compared to the treatment *Low*. The negative impact of self-declaration is higher in absolute value than the effect of the high information cost treatment. It means that either buyers use self-declared labels as an information-revelation device or reputational affects feedbacks are a substitute for information demand. In any case, buyers wrongly substituted information demand (costly device for buyers) for self-declared labels (no-cost device for buyers).

5. Discussion and conclusion

The aim of our paper was to investigate the impact of eco-labels design on market efficiency and on consumer quality information demand. We modeled labels as information mechanisms that could entail more or less quality information costs for buyers. We also provide an empirical test on the model of Bester and Ritzberger (2001) in an experimental setting that allows for controlling information costs. Our main results are: (i) market efficiency decreases with information costs on quality, but sellers are the sole winners and even a small information cost does not enhance buyers' surplus; (ii) allowing for reputation in an asymmetric information market does not enhance market efficiency as a whole but only for sellers whereas buyers loose for allowing for reputation effects; (iii) self-declaration increases market efficiency but only sellers are better off while buyers are indifferent; (iv) information demand is a decreasing function of its cost and a non linear function of product price; (v) self-declaration is a substitute for information purchase.

What implications can we draw from such results? First, let us consider the results concerning the effect of information costs. As mentioned earlier, the type of label (type I, II or III) and its being more or less detailed will determine the level of quality information cost. As shown by our results, even when information cost is low, buyers are no better than if there were no label if the cost is theirs to bear. Information costs on quality are a crucial determinant of eco-label success. An eco-label promoter should consider minimizing these costs. An eco-label designed to minimize quality information costs may increase market efficiency. Targeting may considerably lower information costs on quality. Two variables may impact on information costs on quality. First, when designing the label, promoters should have the consumer target in mind. The label may target consumers whose cognitive abilities are high or whose opportunity cost of time is low to minimize information costs. Second, labels can be targeted to certain products. For example, type III labels (no a priori scoring) may be better fit for low frequency purchases for which consumers take time to trade-off product attributes. Second, let us consider counteracting institutions to adverse selection such as reputation and self-declaration. As in other experimental studies, reputation did not increase market efficiency in asymmetric markets. This is in line with the credence goods properties. Environmental attributes cannot be provided through reputation building only. As for self-declaration in markets with information costs, although the probability of offering high quality units was higher, only sellers were better off. The market was able to have high quality units traded but buyers did not benefit. Buyers wrongly substituted information demand (costly device for buyers) for self-declared labels (no-cost device for buyers). Type II labels do not provide the consumer with guarantees as to the real environmental quality improvement if definition, verification and signaling costs are high.

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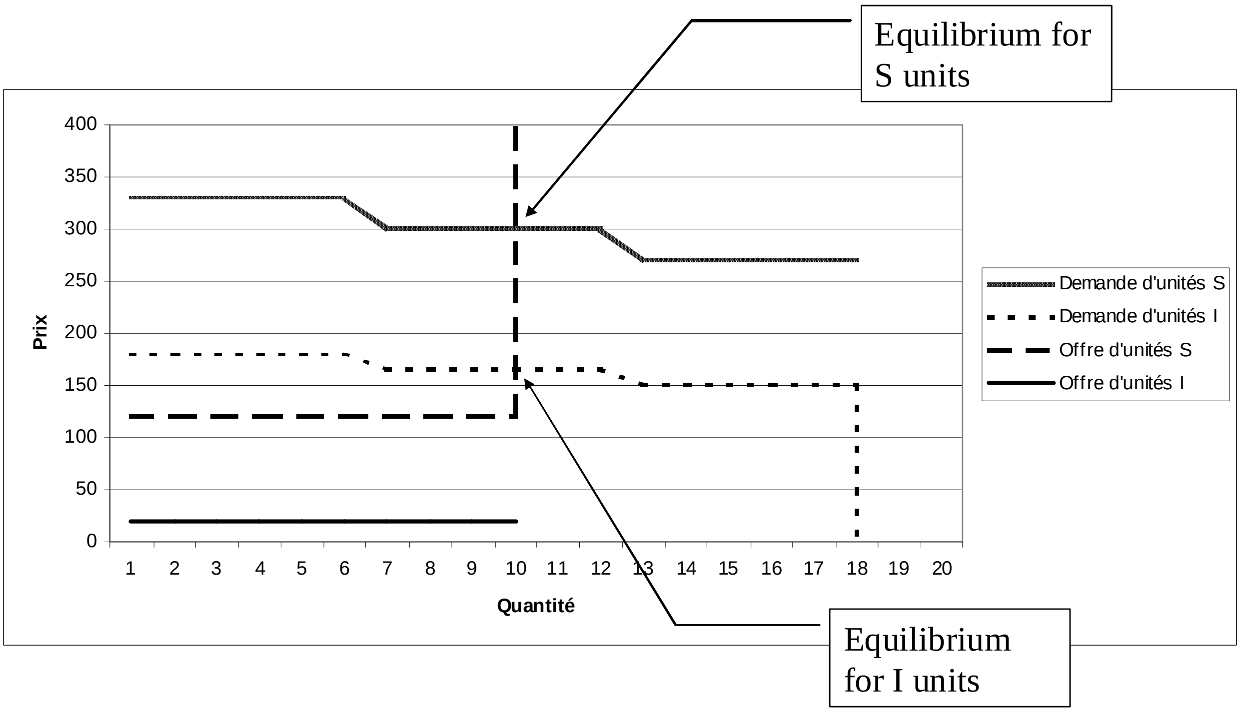

Figure 1: Theoretical perfect information market equilibrium

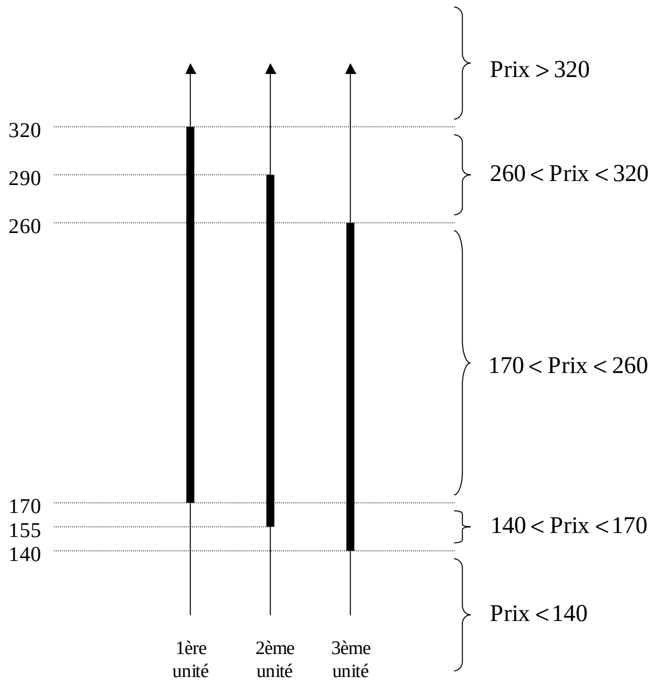

Figure 2: Probability of information purchase as a function of product's price and the order of purchase of the unit in the trading period (when line is thin, the probability is zero; when line is bold, the probability is a function of buyers' beliefs $\mu(p)$)

Treatment	**#Sessions**	**Description**	**Information cost**	**Information cost as a share of buyers' maximum willingness to pay for an S unit as compared to an R unit**
Ref	*3*	-Informational asymmetry between sellers and buyers	"∞"	-
High	*2*	-Buyers can get information on quality at a high cost	100	About 66%
Low	*3*	-Buyers can get information on quality at a low cost	15	10%
Rep	*2*	-Informational asymmetry between sellers and buyers -Buyers can identify sellers from one period to another (allows for reputation effects)	"∞"	-
Self	*2*	-Buyers can get information on quality at a high cost -Buyers can identify sellers from one period to another (allows for reputation effects) -Sellers can self-declare their type (S or R)	100	About 66%

Table 1: Treatments

	Number of I and S units sold										**Efficiency**				
	Ref		*High*		*Low*		*Rep*		*Self*		*Ref*	*High*	*Low*	*Rep*	*Self*
	I	S	I	S	I	S	I	S	I	S					
Treatment average (period 5-32)	6.2 (76)	0.2 (76)	7.7 (56)	0.6 (56)	6.5 (84)	1.4 (84)	7.0 (56)	0.4 (56)	7.2 (56)	1.4 (56)	0.502 (76)	0.626 (56)	0.620 (84)	0.584 (56)	0.667 (56)
Treatment average (final 10 periods)	7.8 (22)	0 (22)	7.9 (20)	0.7 (20)	7.1 (30)	1.5 (30)	7.3 (20)	0.2 (20)	8.1 (20)	0.7 (20)	0.597 (22)	0.634 (20)	0.687 (30)	0.576 (20)	0.642 (20)
Treatment average (final 5 periods)	8 (10)	0 (10)	8.9 (10)	0.4 (10)	7.1 (15)	1.6 (15)	6.6 (10)	0.3 (10)	8.4 (10)	0.5 (10)	0.615 (10)	0.692 (10)	0.699 (15)	0.538 (10)	0.657 (10)

The number of periods used to compute the mean is given in brackets. For example, the *Ref* treatment has three sessions (one session with 24 trading periods and two sessions with 32 trading periods), the mean for the first row is computed with [20+28+28] trading periods which gives 76, the mean for the second row is computed with [2+10+10] which gives 22. For the last row, the mean is computed with [0+5+5] trading periods which gives 10.

Table 2: Statistics

Variable	**Value**	**Description**
High	-	Dummy for treatment *High*
Low	-	Dummy for treatment *Low*
Rep	-	Dummy for treatment *Rep*
Self	-	Dummy for treatment *Self*
Ref_init	$\frac{1}{t}$	Allows to measure the effect of treatment *Ref* in early periods as compared to treatment *Ref* in the long run
High_init	$High \times \frac{1}{t}$	Allows to measure the effect of treatment *High* in early periods as compared to treatment *Ref* in the long run
High_fin	$High \times \frac{(t-1)}{t}$	Allows to measure the effect of treatment *High* in the long run as compared to treatment *Ref* in the long run
Low_init	$Low \times \frac{1}{t}$	Allows to measure the effect of treatment *Low* in early periods as compared to treatment *Ref* in the long run
Low_fin	$Low \times \frac{(t-1)}{t}$	Allows to measure the effect of treatment *Low* in the long run as compared to treatment *Ref* in the long run
Rep_init	$Rep \times \frac{1}{t}$	Allows to measure the effect of treatment *Rep* in early periods as compared to treatment *Ref* in the long run
Rep_fin	$Rep \times \frac{(t-1)}{t}$	Allows to measure the effect of treatment *Rep* in the long run as compared to treatment *Ref* in the long run
Self_init	$Self \times \frac{1}{t}$	Allows to measure the effect of treatment *Self* in early periods as compared to treatment *Ref* in the long run
Self_fin	$Self \times \frac{(t-1)}{t}$	Allows to measure the effect of treatment *Self* in the long run as compared to treatment *Ref* in the long run
Ratio	$\frac{E(\pi_S^N)}{E(\pi_I^N)}$	Ratio of expected earnings from offering Supers to the expected earnings from offering Regulars.

Table 3: Independent variables

Dependent variables	Market efficiency	Sellers' surplus	Buyers' surplus	Pr(offering S units)
Econometric model	OLS	OLS	OLS	Random-effect Logit
Intercept	0.574[a]	0.571[a]	0.605[b]	-4.366[a]
	(0.033)	(0.037)	(0.272)	(0.589)
Ref_init	-0.962[b]	1.522[a]	-25.806[a]	16.950[a]
	(0.389)	(0.435)	(3.168)	(3.583)
Low_init	-0.994[b]	-3.207[a]	21.139[a]	-11.097[b]
	(0.501)	(0.561)	(4.085)	(4.482)
Low_fin	0.199[a]	0.184[a]	0.345	1.466[b]
	(0.046)	(0.051)	(0.371)	(0.722)
High_init	0.709	-1.970[a]	27.501[a]	-7.137
	(0.559)	(0.625)	(4.552)	(5.372)
High_fin	0.075	0.136[b]	-0.531	0.395
	(0.051)	(0.056)	(0.411)	(0.857)
Rep_init	0.381	-2.146[a]	25.648[a]	-5.293
	(0.559)	(0.625)	(4.552)	(5.091)
Rep_fin	0.055	0.150[a]	-0.890[b]	0.753
	(0.051)	(0.056)	(0.411)	(0.830)
Self_init	0.449	-2.752[a]	32.460[a]	-7.153
	(0.559)	(0.625)	(4.552)	(4.708)
Self_fin	0.139[a]	0.197[a]	-0.445	1.403[c]
	(0.051)	(0.056)	(0.411)	(0.785)
Ratio	–	–	–	0.505[c]
	–	–	–	(0.253)
Sigma *(Test for seller individual random effects)*	–	–	–	1.371[a]
	–	–	–	(0.208)
Adj R-Sq	0.2035	0.1103	0.3761	–
#Observations				

Table 4: Econometric results on market efficiency, sellers' surplus, buyers' surplus and the probability of offering type S units (a, b and c respectively mean a 1%, 5% and 10% significance level)

Dependent variable	Probability of purchasing information on a given unit
Intercept	-4.337[a]
	(0.886)
High	-2.549[a]
	(0.295)
Self	-2.947[a]
	(0.297)
Unit price<140 or >320	0.003
	(0.002)
Unit price in [140,170]	0.013[b]
	(0.006)
Unit price in [170,260]	0.027[a]
	(0.004)
Unit price in [260,320]	0.020[a]
	(0.004)
Period	0.021
	(0.014)
-2LogL	
#Observations	
#Observations where information is purchased	

Table 5: Econometric results on the probability of purchasing information on quality (a, b and c respectively mean a 1%, 5% and 10% significance level)