

Energy Efficiency-Enhancing Investments in Experimental Oligopoly: Who Likes Them?

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Abstract

We present results from experimental price-setting oligopolies in which green firms undertake different levels of energy-saving investments motivated by public subsidies and demand-side advantages. We find that consumers reveal higher willingness to pay for greener sellers' products. This observation in conjunction to the fact that greener sellers set higher prices is compatible with the use and interpretation of energy-saving behaviour as a differentiation strategy. However, sellers do not exploit the resulting advantage through sufficiently high price-cost margins, because they seem trapped into "run to stay still" competition. Regarding the use of public subsidies to energy-saving sellers we uncover an undesirable crowding-out effect of consumers' intrinsic tendency to support green manufacturers. Namely, consumers may be less willing to support a green seller whose energy-saving strategy entails a direct financial benefit. Finally, we disentangle two alternative motivations for consumer's attractions to pro-social firms; first, the self-interested recognition of the firm's contribution to the public and private welfare and, second, the need to compensate a firm for the cost entailed in each pro-social action. Our results show the prevalence of the former over the latter.

Keywords: corporate social responsibility, energy savings, public good, experiments, vertical differentiation, altruism.

JEL Classification: C91, L11

Introduction

Apart from a purely altruistic motivation stemming from a managers' environmental concerns, most firms undertake energy-saving investments in order to gain specific economic benefits. There are at least three types of benefits a firm may obtain from the adoption of investments in energy-saving production processes. First, it will achieve to lower its variable costs, thus becoming more competitive in the short run. Second, it may benefit from public support in the form of subsidies designed to encourage the adoption of green supply chain policies. Third, it may gain a long run image-related demand-side advantage by

becoming more popular among socially-responsible consumers whose increased fidelity and support to firms with some kind of corporate social responsibility (CSR) might be reflected on a higher willingness to pay for these firms' products.

While the above has been noticed by different strands in the literature, the interplay between these effects has not been studied so far, mostly due to the difficulty in isolating them from a plethora of other co-existing factors and phenomena entailed in the firms' market and non-market strategies and the consumers' underlying motivations.

Previous experimental work by Barreda et al. (2011) has established that consumers tend to support sellers with some prosocial activity and that this motivates firms to make socially beneficial investments in an effort to differentiate themselves from other, less generous sellers. In fact, it had been shown there that firms may end up in a prisoners' dilemma leading them to lower profits than if they had not become prosocial. However, in that paper, the consumer was treated as a black box. No motivation was clearly identified as to why consumers are willing to pay more for products sold by socially responsible firms. For example, it was not clarified whether a consumer supports a prosocial seller because he appreciates the costs incurred during the prosocial activity, or because the activity itself has a direct utility-increasing effect for the consumer. Beyond that work, the question is relevant in modern economies because it could help us identify the right policy to follow, in order to better target the right source of prosocial consumer behavior. Should we stimulate the consumer's willingness to reward manufacturers for the cost undertaken or, alternatively, should we exploit the consumer's will to reward prosocial outcomes?

Another policy-relevant question that had been left unanswered was whether a favorable public attitude towards prosocial firm activities through, say, a green supply chain subsidy, could have a crowding-out effect, going against the consumer's appreciation of prosocial activities. In modern societies, many researchers believe that economic policy needs to be innovative as to the instruments that should be used in order to favor the emergence of the desired outcomes.

This study is the first to address the desirability of public subsidies to green sellers in the presence of socially responsible consumers. Beyond taxes and subsidies, governments increasingly use advertising techniques in order to educate citizens with principles leading the society and the economy along the desired path. It is commonly accepted as obvious that subsidizing green firms and increasing the consumers' awareness towards environmental issues are both monotonically beneficial for the society and profitable for green producers. For example, Endres (1997) proposes the use of state campaigns aimed at awakening people's ecological awareness. However, there are only a few studies focusing on the negative effects that such campaigns may have on the economic and environmental performance of product markets. For example García-Gallego & Georgantzis (2009, 2011) argue that the state cannot rely upon private campaigns aiming at increasing the consumer's ecological awareness, because firms would benefit from increasing consumer heterogeneity by funding campaigns targeting the most environmentally conscious of the consumers. On the contrary, state campaigns should aim at increasing the ecological awareness of the least environmentally conscious consumers. The effect

a subsidy may have on a socially responsible consumer's attitude towards green firms has never been addressed so far.

Thus, our question is very important nowadays, as consumer responsibility increases and could be sufficient to motivate firms' prosocial activity, rendering any further monetary extrinsic incentives inefficient or even counter-productive. We address both questions, revisiting the experimental data-set of Barreda et al. (2011).

Milton Friedman (1970) argued that "only people can have responsibilities. In a free-enterprise, private-property system, the responsibility of a corporate executive is to make as much money as possible, while conforming to the basic rules of the society, both those embodied in law and those embodied in ethical custom". This critical position towards corporate social responsibility is also apparent in neoclassical economists' recent statements¹. Other economists argue, in contrast, that within a context of globalization, nation states and their agencies are severely constrained in their ability to monitor and protect the rights of their citizens and to provide sufficient public goods². Consistent with economic theories of the firm, McWilliams and Siegel (2001) suggest that the economic case is not to reject CSR entirely, but to find an optimum level of CSR. Husted and Salazar (2006) extend these arguments to say that a strategic approach to CSR may help business firms to improve profitability and enhance social performance at the same time. They describe the context in which it may be possible to maximize social profit so that both society and business firms benefit. Distinguishing among strategic CSR, altruistic CSR, and even coerced CSR, McWilliams, Siegel, and Wright (2006) describe a variety of perspectives on CSR, which they use to develop a framework for consideration of the strategic implications of CSR. Baron's (2001) define strategic CSR as the use of CSR to attract socially responsible consumers, in the sense that firms provide a public good in conjunction with their marketing/business strategy. Attending to product differentiation, we can divide papers about strategic CSR into three different groups. The first group considers ethical consumption as a source of vertical³ product differentiation assuming that all the consumers prefer buying the product with a CSR characteristic than the product without such a characteristic. The vertical differentiation represents the CSR aspects of the production process that are perceived as a quality improvement of the final product by socially conscious consumers. The second group presumes horizontal⁴ product differentiation assuming that only some consumers prefer a particular product, but the preference is based on taste, rather than quality. The third group⁵ is a mix of the two former groups, assuming that consumers' population is split into two different exogenously given groups of consumers with different preferences: the group of convinced standard consumers and the group of potentially ethical consumers.

Our paper relates to the aforementioned first group where product variants differ in their quality and consumers differ in their

¹ See Henderson (2001), Jensen (2002) and Sundaram and Inkpen (2004).

² See Beck (2000), Kaul et al. (2003) and Scherer et al. (2007).

³ See Amacher et al. (2004), Uchida (2007), Calveras et al. (2007), Mitrokostas and Petrakis (2008), Baron (2009), Bottega and De Freitas (2009), Casadesus-Masanell et al (2009), Toolsema (2009) and García-Gallego and Georgantzis (2009).

⁴ See Becchetti and Solferino (2003) and Conrad (2005).

⁵ See Davies (2005) where the size of groups of consumers is exogenously given and Fanelli (2008) where is not.

willingness to pay for quality, following the pioneering work of Mussa and Rosen (1978), Gabszewicz and Thisse (1979), and Shaked and Sutton⁶ (1982, 1983). Unlike Crampes and Hollander (1995) we model the cost of quality as an increase in firm's fixed cost, constraining its subsequent actions, and hence the actions of its competitors. This insight applies to the regulatory arena as well as Lutz et al. (2000) show when they find that corporate leaders may strategically commit to modest environmental improvements that constrain regulators' ability to set tough standards.

The question of whether firms can use energy-saving improvements in their technology to achieve a sustainable competitive advantage is an important question. A paper by Reinhardt (1998) finds that a firm engaging in a CSR-based strategy can only generate an abnormal return if it can prevent competitors from imitating its strategy. In competitive markets this is unlikely, since CSR is highly transparent. Other theoretical studies (Dutta et al., 1995; Hoppe and Lehmann-Grube, 2001) show that any early mover advantages that might be gained by offering higher quality products are eroded when competitive strategies are observable.

Our work relates with research on CSR emerged from public economics' arena. In this field, Baron (2007) considers the formation of firms that can engage in costly CSR and shows that social entrepreneurs and not shareholders bear the cost, unless the corporate social responsibility is a surprise. A social entrepreneur is willing to bear the cost either because doing so expands the opportunity sets of citizens in consumption-social giving space or because there is an entrepreneurial warmglow from the firm's social responsibility. A social entrepreneur carries strategic CSR beyond profit and market value maximization. Baron (2008) presents a theory of CSR in the form of the private provision of public goods and private redistribution by a firm. In this paper the firm privately provides the public good in response to the preferences of its consumers, shareholders, and managers, and if shareholders had altruistic preferences for the beneficiaries of the social expenditures more would be provided subject to any crowding out by government expenditures. In a most recent paper Baron (2009) considers motivation underlying corporate social responsibility in a setting in which firms compete directly in a market.

While some oligopoly models predict that firms producing a higher quality product earn 'abnormal' returns, these findings hinge on the assumption that costs are constant and independent of quality. Furthermore, some economic models of CSR (Baron, 2001; Feddersen and Gilligan, 2001) identify an important countervailing force on the ability of companies to engage in strategic CSR in oligopolistic industries: activists who target leading firms. This countervailing force makes it difficult for oligopolistic firms to achieve a competitive advantage through the strategic use of CSR.

Bagnoli and Watts (2003) study the feasibility of CSR by private firms with "warm-glow" (in Andreoni's (1989, 1990) sense) preferences for

⁶ Arora and Gangopadhyay (1995) apply this model to voluntary overcompliance of firms with established government standards. In their model the market gets segmented by income levels and firms with different levels of environmental-friendliness are able to charge different prices and achieve a positive profit. Choi and Shin (1992) modify the vertical differentiation model by Shaked and Sutton (1982) allowing for an uncovered market based on "taste diversity".

public goods. They conclude that, when firms explicitly link provision of a public good to sales of the private good they offer, the provision of the public good is inversely related to the competitiveness of the market. Specifically related to our framework, they find that if provision of the public good is not explicitly linked⁷ to the sales of the private good and there is free entry, too little of the public good is privately provided. The reason is that even firms enter until profits are zero, they are only able to capture the participation benefits that accrue to consumers but not the common benefits of having a positive quantity of the public good available. Kotchen (2006) develops a general model of private provision of a public good that includes the option to consume an impure public good. This paper shows that, if a green market is not sufficiently large or environmental quality is not a gross complement for private consumption, introducing a green market may actually discourage private provision of an environmental public good and diminish social welfare. Besley and Ghatak (2007) find that firms that use CSR will produce public goods at exactly the same level as predicted by the standard voluntary contribution equilibrium for public goods, hence always leads to an excessive level of public goods.

García-Gallego and Georgantzis (2009, 2011) study a model of vertical product differentiation, focusing on what happens as consumer preferences shift toward more environmental friendly products. They identify important links between market structure and the distribution of consumer preferences. For example, as upscale consumer preferences become greener, firms may respond by "greening" their products and raising prices accordingly, thereby causing some consumers to shift their purchases to brown firms charging lower prices. Alternatively, a greening of preferences at the downscale end of the market may cause firms to make their products less green, in order to bring downscale consumers into the more profitable green market. The authors show that there can be very subtle welfare effects resulting from increased corporate greening, and that such greening does not necessarily create welfare gains.

Our paper relates with three experimental papers. First, taking eco-labelling as an example of CSR, Cason and Gangadharan L. (2002) study sellers' incentives to offer products of differing environmental quality. The authors conclude that the regulator can improve environmental performance by providing the option of certified green labeling in a posted offer market with 5 sellers and 6 buyers that lasts for 20 periods. When offered the possibility of selling products certified by a third party at a fixed cost, unknown to buyers, most sellers pay for the certification and endogenously decide to deliver environmentally friendly products, while cheap talk or reputation building are ineffective in increasing market efficiency significantly. In our setting the moral hazard problem of false labeling is directly solved because every certification is guaranteed. A key difference with our framework is that the environmentally superior product has a higher unit cost and benefits only the buyer of that product whereas we consider that every consumer, buying or not the ecological varieties, benefits from the cleaner production process followed by an ecological producer. Second, Rode et al (2008) study ethical differentiation of products in trioplistic experimental markets where producers set prices for the exogenously determined varieties they sell. The high quality producer's costs were higher

⁷ When firms implicitly link provision of the public good to sales of the private good they offer, they voluntarily increase their fixed costs of providing the private good.

than the others. In two treatments, the additional costs were attributed to compliance with ethical guidelines. In the third, no justification was provided. Many consumers reduced their experimental gains by purchasing the ethically differentiated products at higher prices. The extra cost of producing a superior unit was effectively donated to an NGO fighting child labor, having thus a potentially different valuation for every experiment participant, while in our framework the contribution to the social fund is equally shared among all consumers. Lastly we re-examine the experimental data-set of Barreda et al. (2011), who investigate whether firms' concerns for socially beneficial objectives is the result of strictly economic motivation or, alternatively, whether the non selfish hypothesis survives after strictly economic motivations have been accounted for. They find that, even when firms use altruistic donations as a profit oriented differentiation strategy, some of their investment is not recovered from their market activities maintaining at least a part of their pro-social behavior within the purely altruistic domain.

Experimental Design

In our design, nine sessions were conducted, with a total of 324 participants. Experimental subjects were students at the University Jaume I, Spain. Using standard procedures, subjects were recruited among voluntary undergraduate students from different economics and business-related courses. Before the session started, subjects were randomly distributed into two separate rooms, one for consumer-subjects and one for firm-subjects. Inside each room, an experimentalist gave to each subject an identification number, read the corresponding written instructions and answered any remaining questions⁸. This procedure ensured that consumers were not aware of the firms' costs and firms were unaware of the consumers' reservation price.

At the end of each session, subjects were privately paid in cash. A session lasted 150 minutes approximately⁹ and average earnings were 30€. Specific software, based on PHP programming, was created for this experiment. All sessions were carried out at our Laboratori d'Economia Experimental in Castellón, Spain (LEE, <http://www.lee.uji.es/>).

Five treatments were implemented, respectively denoted as T0, T1, T2, T3 and T4. The main characteristics of each treatment are described in Table 1. Each market consists of 9 firms and 9 consumers. Firms produce a homogeneous commodity at a constant unit cost equal to 100 ExCUs (Experimental Currency Units). The market lasts for 37 periods. Each period, the consumer must purchase a unit of the good and has to decide which company to buy from. To buy the product, each period the consumer starts with an initial endowment of 200 ExCUs. We use T0 as the baseline treatment.

In the baseline treatment T0, each period, firms simultaneously decide the selling price for the product. Once the 9 firms have taken their price decisions, this information appears at the same time in the computer screens of all consumers. Consumers then must decide from which company to buy the unit of product. After the consumers' decisions, a new period starts in which each firm receives previous period information concerning prices charged by all firms in the market, the demand for each firm, and the per period and cumulative profits. As the session goes on, this information is stored in a complete history, so that the subject can always make use of it in its decision-making process. Similarly, consumers have a complete history

⁸ See the instructions in the appendix.

⁹ Sessions in T0 lasted around 90 minutes.

on the purchase prices paid in each period by each consumer, to which firm they bought the good from, and per period as well as accumulated earnings. For consumers, per period earnings are calculated as the difference between the initial endowment and the price paid for the unit. The total profits of the experimental subjects are equal to their accumulated earnings in the 37 periods.

In treatments T1 to T4, in addition to price, the firms have to choose the level of investment which has a positive externality to the environment represented as contribution to a public good, shared equally among all the consumers in the market. This variable has 5 possible levels, numbered 0 through 4, so that level 0 means no contribution, and level 4 involves maximum contribution to the public good. The fact that a company invests to become green has implications not only for firms but also for consumers. For firms, a higher level of contribution involves, in the actual period, a higher fixed cost of being 'different' but also a lower variable cost. Before the session starts, subjects are told that the government is prepared to subsidize part of the firms' investment. Therefore, the total (fixed) cost for the firm that contributes is the difference between the investment and the amount of saving generated, plus the subsidy received from the government. In a market in which firms invest in contributing to a public good, a higher level of investment implies, for consumers, a higher part from the contribution from the Public Fund (PF), independently of whether the consumer purchased from that firm or not. The time structure of the experiment for treatments T1-T4 is as follows. Firms play a three stage game. In the first stage, firms contribute to the public good. In the second, they compete in prices and, in the third, consumers choose which firm to buy from a unit of the product. While firms decide the selling price each period, the level of investment is a strategy for companies in the medium term, so they decide on that level every only in periods 1, 7, 13, 19, 25, and 31. This feature in our design represents the fact that, in the real world, deciding on prices is more frequent than deciding on investment. Once all firms have taken their decisions, each consumer receives information on the price and the investment level chosen by each firm, as well as its share of the PF. With this information, consumers decide which firm to purchase the unit product from. Once consumers decide, a new period starts in which each firm receives information on price and investment levels set by all firms, the number of units sold by and the corresponding benefits for each firm.

In T1 and T2, each firm knows the information concerning the transactions made in the previous period. In T3, firms have a complete history on prices, demand and firm profits for each period in the past. In T4, the aforementioned complete history incorporates the investment level chosen by each company.

A comparison between T1 and T2 allows us to analyze how firms respond to quantitative changes associated with the structure of costs and social benefits. Moreover, comparing T2 and T3 allows us to analyze how firms respond to qualitative changes in the historical information on prices. Finally, the comparison between T3 and T4 makes possible to study how firms respond to qualitative changes in the historical information about the investment levels.

Additionally, it should be noted that treatments with certification and given the extremely competitive environment designed, firms had a fixed amount of money as participation fee, which add (or subtract if negative) profits made in the session. Moreover, the earnings of

consumers in each period were equal to the initial endowment minus the price paid plus the share of the common fund.

Firm behavior

Figure 1 shows that, in the baseline Bertrand markets, firms have posted prices which have remained relatively close to the competitive price 100, while, at the same time, a significant amount of heterogeneity is observed, both in the absence (markets 1 and 2) and in the presence of contribution strategies (markets 3-18). In fact, in several markets, there have been systematic efforts to maintain higher than competitive prices, especially in the presence of an energy-saving strategy available to the firms. On the contrary, some markets have remained almost perfectly competitive, including cases of markets with an energy-saving strategy available to the firms, like for example market 13. However, clearing prices (those at which consumers actually buy the product) have presented far less heterogeneous patterns, remaining much closer to the competitive level of 100 monetary units. This is more clearly reflected on average market clearing prices aggregated by treatment, presented in figure 3. Generally speaking, we observe tight convergence of clearing prices to the competitive level in all treatments implemented.

However, when we take all periods into account, we find that the aforementioned pictures of convergence to the perfectly competitive price should not be mistakenly interpreted to imply that the availability of energy saving to firms leaves posted and clearing prices unaffected. On the contrary, when comparing prices obtained from the baseline treatment, T0 with those obtained in the other treatments (T1-T4), we find that both posted (M-W test, $p=0.0014$) and clearing prices (M-W test, $p=0.0000$) are significantly higher in the presence of CSR strategies, rather than in the absence of them. Therefore we can formally state the first result of our experiments:

RESULT 1: *The adoption of energy-saving investments leads to higher posted and market clearing prices than the absence of such strategies.*

Next, we refer to figure 2. We observe the evolution of firms' energy-saving investments as the result of their "altruistic" behavior. Note a striking similarity to the usual temporal pattern of contributions obtained in standard public good experimental games. Specifically, contributions start relatively low and they rise during the early periods of the session, while they decrease over the remaining periods of the session. Like in the case of clearing prices, which have been lower than posted ones, "clearing" contributions have been systematically higher than posted ones. Therefore, consumers have systematically preferred cheaper sellers and sellers who have contributed more to the public fund. However, this result is formally established and further refined in the analysis of the demand side behaviour, presented in the next section.

In the remaining paragraphs of this session we focus on individual behavior as reflected on the estimates of an econometric model capturing demand and supply side behavior.

Figures 4 and 5 represent pricing (dots) and purchasing (marked with an "x") decisions on a bi-dimensional price-energy-saving space. Overall, we see that persistent dispersion exists in both sellers' and consumers' strategies. Firms tend to invest positive amounts to the greening of their production, posting at the same time higher than competitive prices. Towards the end of the experiment (especially, period 36), firms tend to set close to competitive prices, even when

they have invested maximal amounts to energy saving processes. Consumers also tend to become more homogeneous in their behavior, choosing sellers who are investing more. In few words, sellers seem to recognize their ability to sustain higher prices when becoming greener thus differentiating from other sellers and consumers tend to increasingly enjoy firms' altruism at lower and lower prices.

This pattern is now presented in a more formal way. First, we analyze firm i 's pricing decision (logarithm of p_i) in period t as a function of other firms' (j) logarithm of average price in the previous period, $t-1$, as well as own and rival average contributions (C_i , C_j , respectively) through the estimation of the following model:

$$(1) \quad (1) \quad lp_{it} = \alpha + \delta \cdot t + \beta_0 \cdot lp_{i,t-1} + \beta_1 \cdot lp_{j,t-1} + \sum_{k=1}^4 \gamma_k \cdot C_{it} \cdot Treat_k + \sum_{k=1}^4 \mu_k \cdot C_{jt} \cdot Treat_k + u_{it}$$

where $Treat_k$, $k \in \{1,2,3,4\}$, is a treatment specific dummy. The estimates are presented in Table 2.

The results of this estimation indicate the existence of several intuitively expected patterns. Specifically, a firm reacts by raising its price as a response to its rival's higher prices in the previous period. The firm sets a higher price the higher is its contribution to the public fund and the lower is its rival's contributions. Thus, a firm's price is higher, if it perceives its situation as advantageous in the "altruism" market, either through a higher own or a lower rival contribution. Furthermore, the firm is more likely to have a higher price, if the firm or its rivals had set a high price in the previous period. Finally, as expected, the only case in which rival contributions are insignificant in a firm's pricing decision is T3, in which there is no historic information on rival contributions.

RESULT 2: Firms adopting higher energy-saving investments tend to set higher prices, whereas they set lower prices when their rivals adopt higher energy-saving investments. Prices behave like in standard differentiated oligopoly models, exhibiting strategic complementarities.

Thus, adopting an energy-saving investment is like investing in higher product quality. It raises a firm's own price and decreases the rivals' prices, whereas prices exhibit the standard strategic complementarity pattern.

The most interesting pattern obtained on firm behavior is reflected on figure 3. While the baseline treatment has yielded the perfectly competitive outcome, driving firms' profits down to zero, markets with energy saving available to the firms have been clearly unprofitable. We have also formally compared profits in T0 to profits in treatments T1-T4 and found that, in the latter, firms have earned significantly lower profits (M-W test, $p=0.0000$). We formally state next this finding:

RESULT 3: When firms adopt energy-saving investments, their gains from relaxing price competition do not compensate their increased costs.

In the following section we focus on the main findings of this experiment on consumer behaviour.

Consumer behavior

We report the results on consumer behavior relying on regression techniques and taking advantage of the panel data structure of our sample. Our basic specification is as follows:

$$(2) \quad D_{it} = X_{it}\beta + \eta_i + e_{it} \quad (1)$$

The demand variable D_{it} is an ordered categorical variable taking the value from 1 to 9, therefore we employ a Random Effects Ordered Probit model where i is the individual, t is the periods of observations, η_i are the individual effects, e_{it} is the error term. X_{it} includes the following variables¹⁰: the firm's own price, the average of other's prices in the same period, the firm's own contribution, the other firms' average contribution, the subsidy when certificate from 1 to 4 is chosen by the firm (in model 1) or alternative the saving costs (in model 2).

We recognize the possibility that individual random effects, η_i , are likely to be correlated with some, if not all the explanatory variables. Suppose that the correlation takes place only through the long run components of the X_{it} variables and that these can be captured via the average, \bar{X}_{it} , of these variables over time¹¹. This specification is only applied to firm's own price (the average of other's price) and firm's own contribution (the other firms' average contribution).

Table 3, reports the results obtained from the estimation of the demand model. We compare two alternative motivations for consumer's attraction to pro-social firms. Model 1, presents the estimation results of the demand model after controlling for the effect of the consumer self-interested recognition of the firm's contribution to the public and private welfare. Model 2 shows the estimation results of the demand model which incorporate the firms' cost entailed in each pro-social action.

In line with the literature, our results confirm consumer's preferences for social responsible firms: a firm's investment in energy saving has a positive effect on its own demand and a negative effect on the demand of its rivals, whereas prices have, as would be expected exactly the opposite effects.

Result 4: Consumers react to energy-saving investments as if they were quality improvements in a firm's product. Prices have the expected effect on own and rival demand.

Comparing model 1 and 2, it is found that the main reason of consumers' willingness to support socially responsible firms, is that the activity itself has a direct utility-increasing effect, rather than the alternative of the consumer's willingness to compensate the firm's costs incurred during the pro-social activity.

¹⁰ The variables included in the model are defined in the Appendix, Table 4, whereas Table 5 reports the sample means.

¹¹ This specification is based on Mundlak (1978) methodology by specifying the correlation between the individual random effects and the time-varying observables as a linear function of those observables.

Result 5: Consumers prefer energy-saving manufacturers for the effect of energy saving on the environment, rather than as a way of compensating them for the extra costs incurred.

Finally, as stated earlier, the action of policy makers towards socially responsible firms and its impact on consumer and, finally, firms' strategies is important to be studied. The working hypothesis here is that institutional support towards energy saving may affect consumers' responses towards socially responsible firms and, eventually, the socially responsible strategies of the latter. The possibility of a "first-order" negative effect of extrinsic incentives on intrinsic ones has been studied under the term "crowding out". According to Bruno Frey's (1997) famous book "Not Just for the Money", such a subsidy may first, "crowd out" intrinsic genuinely altruistic motivations in firms' socially responsible action. This would correspond to the well-known first-order crowding out effect. In our first model, we uncover this undesirable crowding-out effect of public subsidies to pro-social firms especially in lower levels of social contribution. Our results indicate that probably the correct direction for measures supporting a corporation's socially responsible activities should be more educational efforts and advertising aimed at increasing the consumer's or, directly, the entrepreneur's social consciousness than direct subsidies.

Result 6: Subsidies to energy-saving producers may have a crowding-out effect, reducing the consumer's intrinsic willingness to support a firm's corporate social responsibility.

Conclusions

The true motivation of firms and consumers in the presence of energy-saving competition is difficult to study in isolation from other motivations and phenomena occurring in the real world. Thus, real world data have hardly given us reliable information on socially responsible consumers' motivations and on the role and weight of these motivations on firms' strategy saving decisions. Furthermore, public policies towards energy-efficient firms may interact with consumers' motivation and yield unexpected effects on the market outcome. We have used data from the lab to address these and other questions.

Our findings confirm that energy-saving investments have similar effects to those of vertical product differentiation. Firms adopting higher energy-saving investments behave as if they were selling a superior product, allowing them to set higher prices. However, they end up competing too much among them, lowering their prices close to competitive levels. Thus, they do not recover their energy-saving costs and incur losses. This, turns their ex ante profit-driven strategy into an ex post purely altruistic contribution to the public good.

Consequently, consumers deal with energy-saving firms' products as if they were the result of costly quality improvements. Regarding consumer behaviour, we are the first to show that consumers exhibit a higher willingness to pay for energy-saving firms' products due to the positive externality this has on the environment, rather than as a way of compensating them for the extra costs they incur. We are also the first to show that public subsidies to energy-saving firms may have an undesirable crowding-out effect, as they reduce the consumer's intrinsic willingness to support energy-saving manufacturers.

Both results have critical implications for economic policy in product markets with energy-intensive production processes, as they suggest that consumers may not appreciate firms' investment as a cost to the seller but as a benefit to the society as a whole. Finally, subsidies could overlap in an undesired way with intrinsic motivations, failing to achieve the pretended efficiency-inducing outcomes.

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Appendix I: Tables and Figures**Table 1: Main Characteristics of Treatments in the Market Experiment**

Treatment	Energy-saving Investment	Information	Contribution Costs	Sessions	Markets	N° of Subjects
T0	NO	PH	--	1	1-2	36
T1	YES	NH	Low	2	3-6	72
T2	YES	NH	High	2	7-10	72
T3	YES	PH	High	2	11-14	72
T4	YES	CH	High	2	15-18	72
TOTAL					18	324

CH: Complete History (selling prices and investment levels). NH: No History. PH: Selling Prices History only.

Table 2: Estimation of equation (1)

Variable	Coefficient	Std. Error	p> t
cons.	.0789	.0136	.000
T	.0007	.0003	.027
Ip _{it-1}	.3856	.0471	.000
Ip _{jt-1}	.0656	.0352	.065
C _{it} Treat ₁	.0071	.0024	.003
C _{it} Treat ₂	.0147	.0071	.041
C _{it} Treat ₃	.0146	.0071	.042
C _{it} Treat ₄	.0106	.0042	.013
C _{jt} Treat ₁	-.0089	.0046	.056
C _{jt} Treat ₂	-.0193	.0087	.028
C _{jt} Treat ₃	-.0029	.0051	.578
C _{jt} Treat ₄	-.0118	.0062	.058
R² = 0.3692		F(11,143) = 31.37	Prob > F=0.000

Table 3: Demand model, equation (2): ordered probit with individual random effects

	Model (1)		Model (2)	
	Estimate	t-value	Estimate	t-value
Firm price	-0.045	24.95***	-0.044	24.62***
Average price	0.024	8.83***	0.024	8.70***
Firm contribution	0.003	3.35***	0.008	28.11***
Average contribution	-0.010	16.44***	-0.010	16.26***
Subsidy when certificate 1	0.126	0.28	-	-
Subsidy when certificate 2	0.012	0.08	-	-
Subsidy when certificate 3	-0.079	1.89*	-	-
Subsidy when certificate 4	0.031	2.17**	-	-
Saving costs when certificate 1	-	-	-2.127	0.71
Saving costs when certificate 2	-	-	0.583	0.47
Saving costs when certificate 3	-	-	0.247	0.10
Saving costs when certificate 4	-	-	-0.053	0.04
Periods	-0.010	5.32***	-0.012	6.34***
Log likelihood	-5827.02		-5826.84	
N of individuals	5,305		5,305	

*, **, *** indicate significant improvement at 10, 5, 1 percent levels respectively

Table 4: Variable List

Amount of the selling product	Amount of the selling product measured on a 9 point scale of 0=not to sell to 9=sold out
Firm price	the firm's own selling price
Average price	the mean of others' firms selling prices per period
Firm contribution	the firm's own energy-saving investment
Average contribution	the mean of other firms' average energy-saving investment per period
Subsidy when energy-saving certificate is 1 to 4	This variable has 5 possible levels, numbered 0 through 4, so that level 0 means no contribution, and level 4 involves maximum contribution to the public good.
Saving costs when certificate is 1 to 4	This variable has 5 possible levels, numbered 0 through 4, so that level 0 means no saving costs, and level 4 involves maximum saving costs.
Periods	Periods/rounds of the experiment (1 -37 rounds)

Table 5: Sample descriptive statistics

Selling product from 0 to 9, mean (SD)	1 (1.8)
Firm price in ExCUs (Experimental Currency Units), mean(SD)	113 (19.6)
Average price of firms in ExCUs, mean(SD)	114 (8.6)
Firm contribution in ExCUs, mean(SD)	88 (80.5)
Average contribution of firms in ExCUs, mean (SD)	88 (42.4)
Subsidy when certificate 1 in ExCUs, mean (SD)	9.24 (8.82)
Subsidy when certificate 2 in ExCUs, mean(SD)	26.2 (24.5)
Subsidy when certificate 3 in ExCUs, mean(SD)	90.2 (80.6)
Subsidy when certificate 4 in ExCUs, mean(SD)	198.5 (175.6)
Saving costs when certificate 1 in ExCUs, mean (SD)	7.98 (3.36)
Saving costs when certificate 2 in ExCUs, mean (SD)	19.7 (8.12)
Saving costs when certificate 3 in ExCUs, mean (SD)	28.3 (13.02)
Saving costs when certificate 4 in ExCUs, mean (SD)	34.9 (16.8)
Valid Observations	5,305

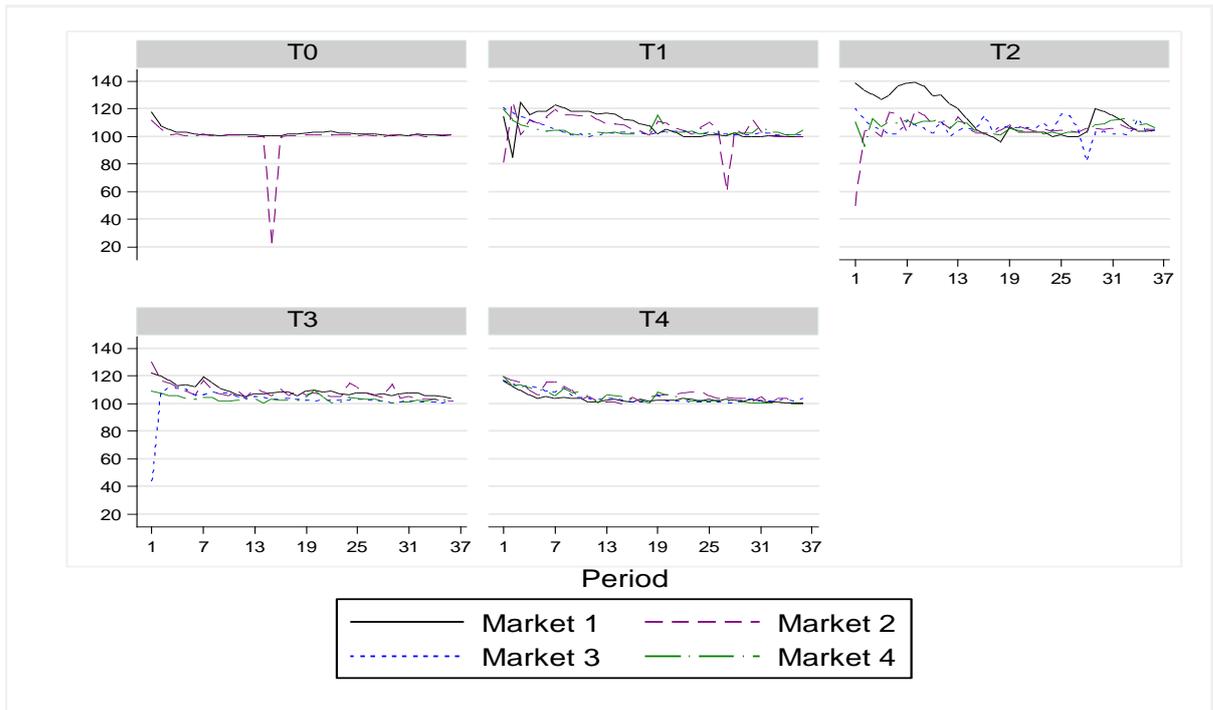


Figure 1: Evolution of average clearing prices over time: Treatment aggregates

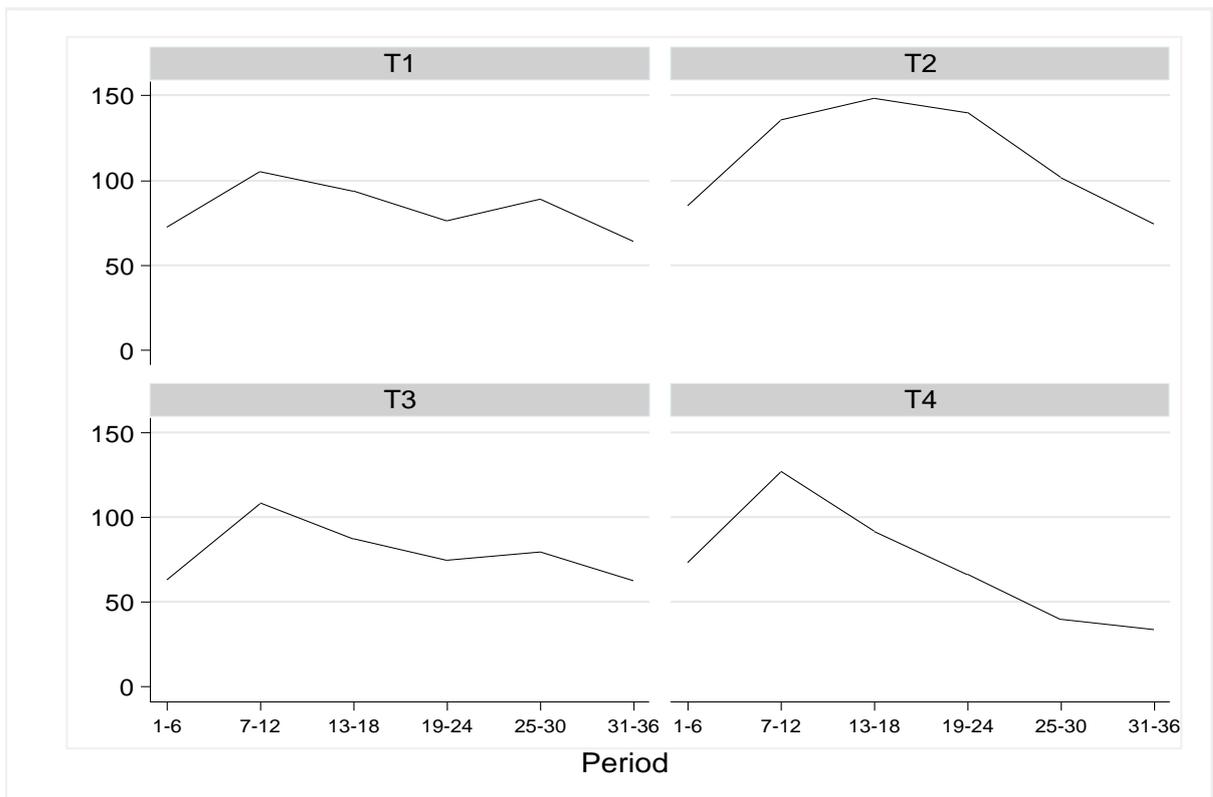


Figure 2: Evolution of green investments over time: Treatment aggregates

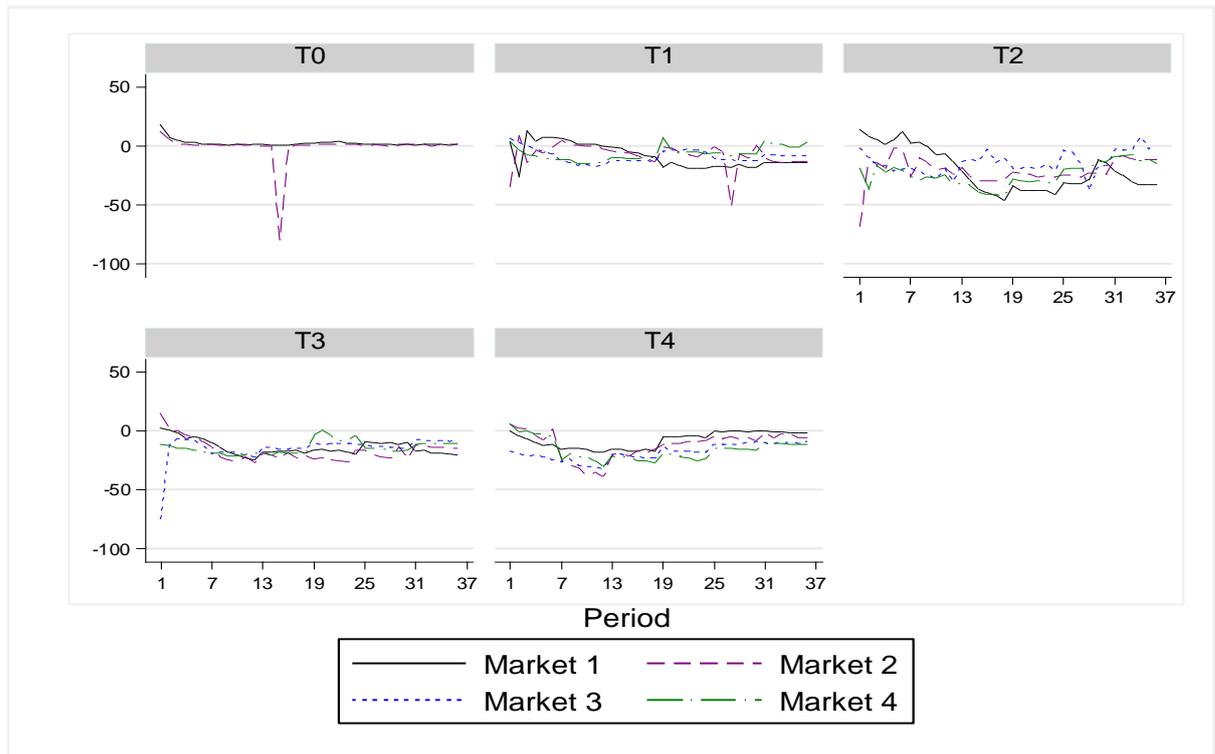


Figure 3: Evolution of average profit over time: Treatment aggregates

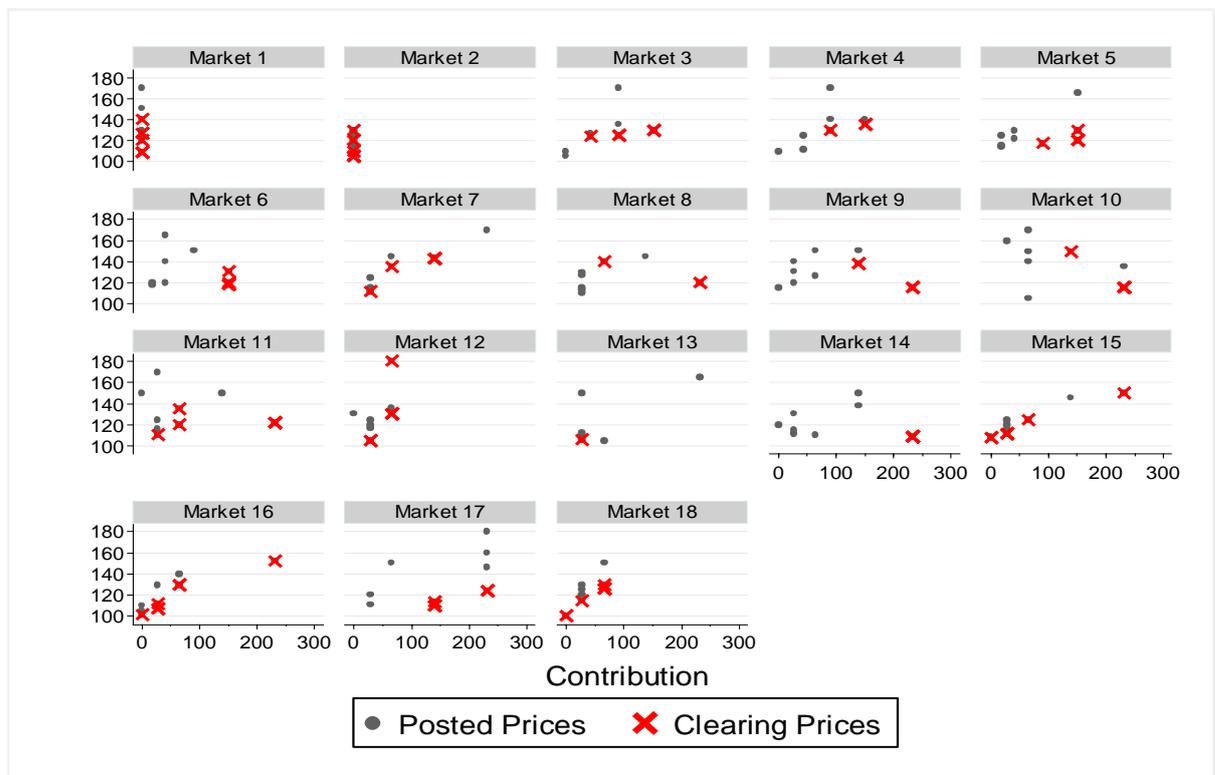


Figure 4: Initial (period 1) posted prices (dots) and purchasing decisions (marked with "x") per market

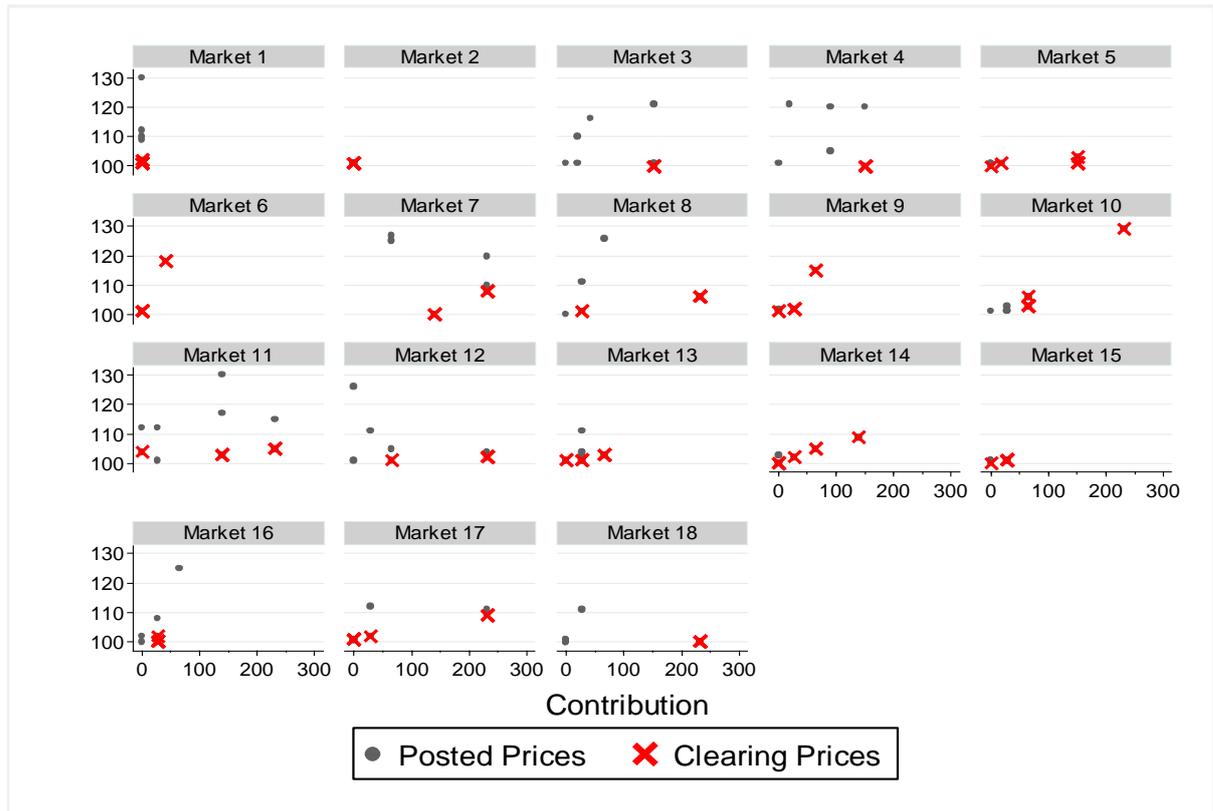


Figure 5: Period 36 posted prices (dots) and purchasing decisions (marked with "x") per market

Appendix II: Instructions (translated from Spanish)

1. Instructions to consumer-subjects

For all treatments:

The aim of this experiment is to study decision-making in economic environments. The rules are pretty simple. You will be privately paid in cash at the end of the experiment according to your accumulated earnings. Feel free to ask any questions regarding these instructions. Any communication among the participants is strictly forbidden. Below you will find some useful information:

1. This experiment lasts 37 rounds. In the first round, you will be randomly matched with other 8 subjects to create groups of 9 individuals. The matching is kept constant throughout the session, but you will never know the identity of the other members in your group.
2. You are a consumer interested in buying a certain product offered in the market. The market consists of 9 firms that are suppliers of this product. All firms produce the same good. Each period you are obliged to buy one unit of good. Therefore, your decision in the experiment consists of choosing which of the 9 firms buy from. At the beginning of a new period, you will receive an initial endowment of 200 ExCUs (Experimental Currency Units), to do your shopping. All consumers, all of them members of your group, have the same initial endowment.

Only for treatment T0:

3. The time schedule of subjects' decision making is, for each period, as follows: First, each firm must decide the product's selling price. Once all the firms have taken this decision, all consumers will

see each firm's selling price on the screen. Then you must decide from which firm you will buy the unit of product.

4. Once your decision is taken, before a new period begins you will receive information on the price you paid, the firm that you bought from (each firm is identified by a number) and your earnings for that specific period (which will be your initial endowment of 200 ExCUs minus the price paid for the unit of product). This information is accumulated for all periods in a complete history that you can consult before deciding.

5. At the end of the session, you will receive a monetary reward equal to your profits exchanged at a rate of 210 ExCUs = 1€.

Only for treatments T1, T2, T3 and T4:

3. In addition, you should know that firms can invest in a public good with the purpose of contributing to society. The implementation of this measure by a firm is embodied with a labeling system. Specifically, there are 4 levels of contribution, from the lowest (level 1) to the highest contribution (level 4). The no contribution at all is denoted by level 0.

4. The decision of firms of whether or not to contribute to the public good has a direct impact on the welfare of society. Therefore, in each period, the level of contribution implies that a certain amount of ExCUs is to be divided equally among all consumers. The higher the contribution level, the higher the contribution to the common fund.

5. In terms of decision making, firms distinguish two types of periods:

i) The periods 1, 7, 13, 19, 25, 31 and 37, where firms must decide both on the level of certification as the selling price of their product.

ii) The remaining periods in which firms decide only on the selling price. Therefore, the chosen level of certification will remain constant for six periods.

6. In order to be able to purchase the good, consumers have an each period initial endowment of 200 ExCUs plus 1/9 of the common fund created in this specific period. All consumers have the same initial endowment.

7. For each period, the time structure of decision making is as follows: every six periods, each firm must decide on its contribution level to the public good and on its selling price (all periods). Once the decisions are taken by all firms, you will learn about the contribution levels and the prices chosen, as well as the amount corresponding to the 1/9 of the common fund generated that belongs to you. At this moment you must decide which firm you choose to buy the product unit. Do not forget that all firms sell the same good.

8. Once made your decision, each period you will receive information on the price that you paid, the firm that you bought (each firm will be identified by a number), your earnings for the period (which will be your initial endowment of 200 ExCUs minus the price paid at purchase plus 1/9 of the common fund generated) and your accumulated earnings up to that period. Additionally, you will receive information on all firms in the market (price, certification and demand). This information is accumulated for all periods in a complete history that you can consult before deciding.

Only for T1:

9. At the end of the experiment, you will receive a monetary reward equal to your firm's profits exchanged at a rate of 420 ExCUs = 1€.

Only for T2, T3 and T4:

9. At the end of the experimental session, you will receive in cash a monetary reward equal to your profits exchanged at a rate of 580 ExCUs = 1€.

Thank you very much for your cooperation.

B1. Instructions to firms-subjects

For all treatments:

The aim of this experiment is to study decision-making in economic environments. The rules are pretty simple. You will be privately paid in cash at the end of the experiment according to your accumulated earnings. Feel free to ask any questions regarding these instructions. Any communication among the participants is strictly forbidden. Below you will find some useful information:

1. This experiment lasts 37 rounds. In the first round, you will be randomly matched with another eight subjects to create groups of nine subjects, kept constant throughout the session. You will never know the identity of the group members.

2. In the experiment you are a firm interested in selling a determined product that is offered in the market. This market consists of 9 individuals representing 9 firms, suppliers of this product. All firms produce the same good. At the beginning of each period, you will need to fix the selling of your product. You must make your decisions taking into account that:

- What it costs you to produce a product unit is a constant amount equal to 100 EXCUs (an Experimental Currency Units). This cost per unit is identical for all firms in this market.
- The selling price must be an integer number not exceeding 200 EXCUs.

Only for T0:

3. The demand of your market consists of a group of 9 subjects, selected at random at the beginning of the session to form a stable group throughout the experiment. Each consumer is forced to buy one unit of product in this market and the only decision is to choose which of the nine firms to buy.

4. For each period, the time structure of decision making is the following: once all firms have decided the selling price of the product, consumers will choose which firm to buy. After that, you will receive information on your screen on your price, your demand, your benefits as well as price, demand and profits for each of the firms of your market.

5. Your demand in each period depends on the decision taken by consumers. This decision will be made once known the price set by each of the firms operating in the market. Once consumers have decided which firm to buy, you will know the demand for your product and your profit at that period, and those of other firms in your market. This information is accumulated for all periods in a complete history that you can check in anytime you want.

6. At the end of the experiment, you will receive a monetary reward equal to affixed quantity of 10€ plus your firm's profits exchanged at a rate of 210 ExCUs = 1€.

Only for T1, T2, T3 and T4:

3. Additionally, you should know that you can invest to be more energy efficient in the production. The implementation of this measure it is embodied with a labeling system. Knowing that the government subsidizes a percentage of the investment, you must choose whether

certify or not your firm and, if so, the corresponding level. Specifically, there are 4 levels of certification, from lowest to highest efficiency, are denoted as 1, 2, 3 and 4. The non-certification is denoted with level 0.

4. In terms of decision making, you must distinguish two types of periods:

i) The periods 1, 7, 13, 19, 25, 31 and 37, where you must decide both on the level of certification as the selling price of their product. Additionally, you should know that periods 1 and 37 will be special. In these two periods you must decide on certification as price for five alternative scenarios of certification costs that you will observe on screen. These scenarios differ in the amount of the subsidy associated with each type of certification. For these two periods, once you have made your decision in each alternative scenario, one of them will be selected by computer at random, and you will be informed on screen to start the next period.

ii) The remaining periods in which firms decide only on the selling price. Therefore, the chosen level of certification will remain constant for six periods.

5. For each firm's decision involves a qualified investment and resulting energy savings. In this way, the cost of certification in each period will be equal to the investment chosen minus the subsidy by the government minus the resulting energy savings.

6. If you choose not certificate, your total cost per period is limited to your cost of production (100 ExCUs per unit of product). However, if you decide certificate in any category, your total costs per period is equal to your cost of production plus your cost of certification per period, depending on the category chosen.

7. The decision to certify by firms has a direct impact on the welfare of society. Therefore, in each period, each level of certification means that the firm will contribute a certain amount of ExCUs to a common fund to be divided equally among all consumers. The higher the certification, the higher the contribution to the common fund.

8. The demand of your market consists of a group of 9 subjects, selected at random at the beginning of the session to form a stable group throughout the experiment. Each consumer is forced to buy one unit of product in this market and the only decision is to choose which of the nine firms to buy.

9. For each period, the time structure of decision making is the following: once all firms have decided on certification and selling price of the product, consumers are informed and choose which firm to buy.

Only for T1 and T2:

10. Once decisions have been taken by both sides of the market, you will receive information on your screen on the previous period. Specifically, you'll see on your screen your certification, your price, your contribution to the common fund, demand and profits of the previous period, as well as certification, common fund contributions, price, demand and profits of each firm of your market in the actual period.

Only for T3 and T4:

10. Once decisions have been taken by both sides of the market, you will receive information on your screen on all past periods: in particular, you will be informed about the price, certification, contribution to the common fund (only for T4), demand and benefits to all firms in the market (you and your competitors) and this

information will build up for all past periods in a complete history that one can see during your decision-making

Only for T1:

11. At the end of the experiment, you will receive a monetary reward equal to affixed quantity of 15€ plus your firm's profits exchanged at a rate of 420 ExCUs = 1€.

Only for T2, T3 and T4:

11. At the end of the experiment, you will receive a monetary reward equal to affixed quantity of 15€ plus your firm's profits exchanged at a rate of 580 ExCUs = 1€.

Thanks for your cooperation.