Do Environment Protection Incentives Reduce Investment Uncertainty?

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Abstract. This paper uses a game theoretic approach to evaluate the effectiveness of different environment protection incentives with regard to the willingness of firms to engage in ecological production and related investment uncertainty. In case of eco-labels, asymmetric information between firms and consumers gives firms the opportunity to cheat and label their products without engaging in ecological production. Hence, there is no equilibrium where ecological goods are produced and labelled truthfully in a non-repeated game. Third party monitoring can improve the situation and allow for an eco-friendly equilibrium under certain conditions. Consumer awareness and credible signals play a crucial role in this setting. The importance of consumer awareness is even more evident when environment protection incentives are based on consumer commitment. Subsidies as another form of environment protection incentives are not likely to reduce investment uncertainty unless governments have strong incentives to gain a reputation of credibility.

1. Introduction

The results of an unprecedented growth of the western economies in the last century, together with an exponentially growing world population, today represent a substantial burden to the environment and natural resources that constitute the foundation of all essential and economic activities. Pollution of the environment and boundless exploitation of exhaustible resources in the wake of economic growth increasingly give rise to concerns about the convenience of common practices in production and consumption.

This raises the question of how economic incentive systems can be modified in order to motivate and foster investments in environmentally friendly and sustainable production. Since in recent years a growing number of environmentally conscious and more demanding consumers have led to an increase in the demand for environmentally friendly products, one possible way to deal with this problem is to focus on the potential of credible information in form of eco-labels to stimulate sustainable production and reduce associated investment uncertainties. Alternatively, an adequate system of government subsidies can compensate for additional costs and motivate producers to engage and invest in ecological production. This paper uses a game theoretic approach to analyse the decision processes of the parties involved and to evaluate the potential effectiveness of different measures.

The paper is organized as follows. Section 2 introduces the basic game theoretic model of eco-labelling with the necessary assumptions and presents a detailed solution analysis. In this kind of signalling game, firms decide whether to label their products or not, depending on their type, the quantity of additional costs and the consumers' ability to identify ecological products and the result-

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ing willingness to buy them. In section 3, third party monitoring is introduced to analyse how consumer search activities and the possibility to discover fraud prior to purchase can affect market uncertainty and the willingness of firms to invest in ecological production. The forth section highlights quantitative and qualitative consumer commitment as an incentive for environment protection and introduces the character of an information-supplying activist. Section 5 focuses on government policies and credibility and analyses the effects of subsidy announcements on the willingness of firms to engage in environmentally friendly production. Here the firms are faced with uncertainty and have to interpret the signals sent by the government in order to identify adequate investment decisions. Finally, section 6 concludes with a comprehensive discussion of the results.

2. Eco-labelling

The basic model considers an oligopolistic market with N > 1 competing firms. There are two potential types of products, ecological products (E) and non-ecological products (NE), and information about quality is private, i.e. only the firm itself knows about the quality of its products. Nature independently draws the quality of each firm, so ecological and non-ecological producers are distributed according to a commonly known probability distribution: a firm is a producer of ecological products with a probability of $p \in (0, 1)$ and of non-ecological products with a probability of $q = 1-p$. Production costs depend on the quality of the product, i.e. the unit costs of production for E are C_E and those for NE are C_{NE}, with $C_E > C_{NE} > 0$.
Hence, it is a Bayesian game with the following characteristics:

- The type τ of each firm i lies in the type set {E, NE}.
- The type of each firm i is drawn independently by nature (N) from a probability distribution that assigns probability $p \in (0,1)$ to the E-type and probability $q = 1-p$ to the NE-type.
- The move of nature, i.e. the type of a single firm is only observed by the firm itself.
- Firms produce at constant unit cost, that depend on the quality produced (C_E, C_{NE})
- With this hidden knowledge, firms (F) simultaneously choose whether to label their products (L) or not (NL). If they do so, they face additional costs in the amount of C_L per unit, which are reflected in a price premium for labelled products ($P_L > P_{NL}$).
- Consumers observe the prices and label characteristics of the products (P_L, P_{NL}) and decide whether to buy (B) or not (DB).
- In case of a purchase, the payoff to the consumer is the valuation of the product purchased (U_L/U_{NL}) net of the price paid. Otherwise, the payoff is zero.
- The payoff to each firm is its expected profit
- The model uses the solution concept of the Perfect Bayesian Equilibrium

This model allows for the investigation of different versions:

- Consumers are willing to pay a premium for labeled products ($U_L > U_{NL}$)
- Consumers are not willing to pay a premium for labeled products ($U_L = U_{NL}$)
- Ecological and non-ecological producers set different prices ($P_{LE} > P_{LNE}$; $P_{NLE} > P_{NLNE}$)
- When realized by the consumers, fraud (labeling of non-ecological products) reduces willingness to pay a price premium. However, this is only possible in repeated games when consumers are able to recognize quality differences (U_E/U_{NE} instead of U_L/U_{NL}, with $U_E > U_{NE}$).

In a basic setting, consumers cannot distinguish between the quality of ecological and non-ecological products, so the products are so called credence goods.
Previous academic research suggests that an "eco-friendly" outcome (equilibrium) with the adoption of ecological practices by the producers is only possible in repeated games, when consumers

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can observe quality and thus are able to reward fraud, or when quality is monitored by a third party [7].
To illustrate this, a version of the game introduced above is analyzed with the following assumptions:

- Consumers are willing to pay a premium for ecological products
- Ecological and non-ecological producers set the same prices P_L or P_{NL}
- Consumers are able to recognize quality differences after the purchase (Experience good, $U_E > U_{NE}$)

The extensive form of this game is shown in figure 2:

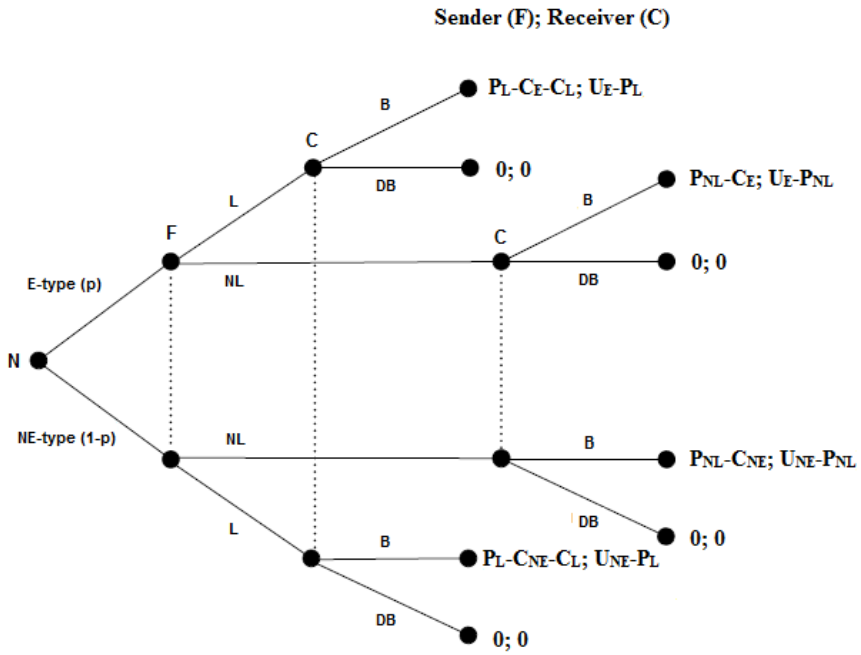

Figure 2: Eco-labeling Signaling Game

Here, the relationship between the parameters is assumed to follow:

$P_L-C_{NE}-C_L > P_L-C_E-C_L > P_{NL}-C_{NE} > P_{NL}-C_E > 0$ for the firm payoffs, and

$U_E-P_{NL} > U_E-P_L > U_{NE}-P_{NL} > 0 > U_{NE}-P_L$ for the consumer payoffs.

In this dynamic game of incomplete information timing is as follows:

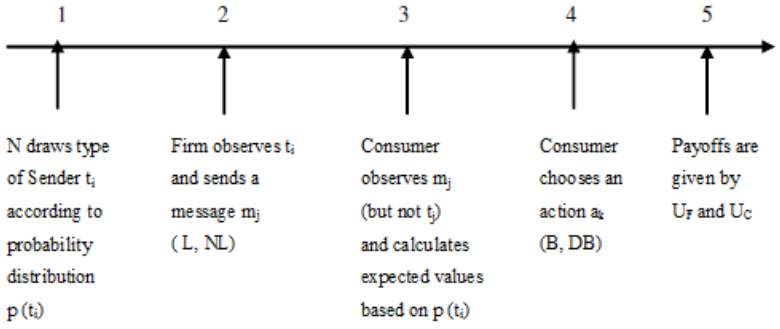

Figure 3: Timing of the Signaling Game. [6]

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The resulting equilibrium is called pooling or separating equilibrium, depending on whether the sender's (firm's) strategy is a pooling or separating strategy.
Since the game presented in Figure 1 involves two possible types of agents and two different signals, there are four possible equilibria with pure strategies, i.e. four possible pure-strategy perfect Bayesian equilibria:

- 1. Pooling equilibrium with both types of firms playing L
- 2. Pooling equilibrium with both types of firms playing NL
- 3. Separating equilibrium with the E-type playing L and the NE-type playing NL
- 4. Separating equilibrium with the E-type playing NL and the NE-type playing L

There is no separating equilibrium in this signaling game. Rather, there are two pooling equilibria, depending on the probability p that the sender is of type E and actually engaged in ecological production. If p is low, consumers decide to buy non-labeled goods and the e-type is not rewarded for his engagement. With a high share of ecological producers, consumers buy ecological products in the equilibrium, but non-ecological producers have the opportunity to cheat by labeling their products and earn an even higher payoff than the ecological producers. This outcome is consistent with the findings of previous academic research, that separating equilibria can hardly be achieved in non-repeated games [7, 8, 9]. A labeling system that reduces investment uncertainty, however, would require a separating equilibrium with truthfully labeled products which are priced accordingly.
One possible way to improve reliability of eco-labels is the utilization of costly signals which are hard to imitate by non-trustworthy types. According to Macho-Stadler/Perez-Castrillo, high quality producers "have to pay a signaling cost for the problem to be transformed from one of adverse selection to one of symmetric information" [6]. Ahn/Esarey (2004) explore the dynamics of social trustworthiness using a game theoretic model with costly signaling and find/receive the following results [1]:

- Trustworthy types get pushed aside if the costs of signaling are too high for them or too low for the untrustworthy types. In this case, activities in the society are driven by distrust.
- Even when signaling costs allow the separation of the trustworthy from the untrustworthy, there is no evolutionary stable equilibrium. Rather, there are cycles of pooling and separating equilibria and fluctuations of the proportion of trustworthy/untrustworthy types.
- It is possible, with a reasonable set of assumptions, to show that the trustworthy types can coordinate and cause equilibrium switching, shortening the length of the pooling cycle and maintaining trustworthy types as the majority in a society.

They conclude that the trustworthy must utilize signals that are not too costly for them but are hard for the untrustworthy to imitate.
Another possible way to improve trustworthiness of signals is third party monitoring. This aspect is analyzed in the following section.

3. Monitoring

The investigation of monitoring by a third party in connection with consumer search cost can be based on a model similar to that of Amato et al. (2012). In this case, the firm makes a production and labeling decision while being aware that it will be monitored by a third party with a commonly known probability p. The consumer in turn can search for information on the legitimacy of a label. If he does, he faces search costs $S > 0$ regardless of whether the firm in question is monitored or not. In the first case, he is able to determine the legitimacy of the label, in the latter case the search

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is in vain. Hence, the consumer has two options: to search and determine the legitimacy of a certain label if the firm in question is monitored, or not to search and accept uncertainty.
The game consists of four stages where firms or consumers make decisions:

- The firm decides whether (EP) or not (NEP) to engage in ecological production
- The firm decides whether (L) or not (NL) to label the products
- The consumer decides whether to search (S) and bear search costs or not (NS)
- The consumer decides to make a purchase (B) or not (DB), depending on whether he has searched or not and whether the firm in question is monitored or not.

The extensive form of this game is presented in Figure 4:

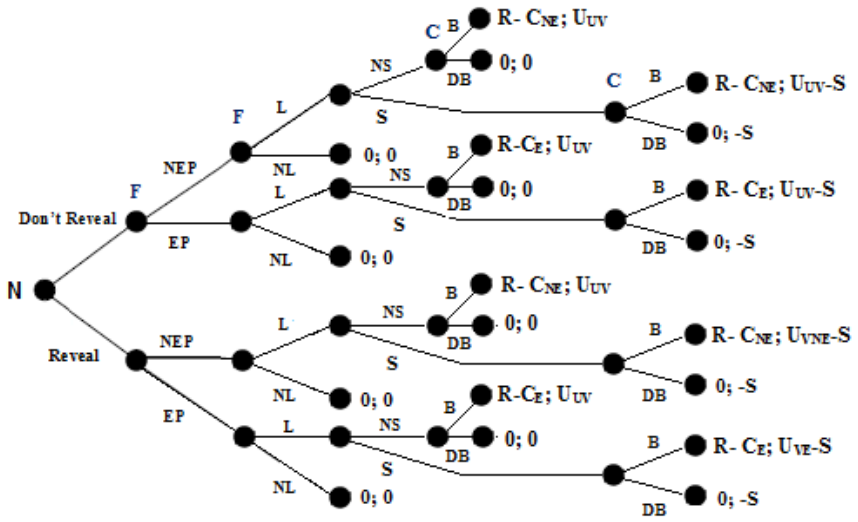

Figure 4: Third Party Monitoring of Eco-labels. (Source: Adapted from Amato et al. (2012).

It is assumed that the consumer has a higher utility when buying if he knows whether a label is legitimate or not. If a firm is not monitored and/or the consumer does not search, the legitimacy of the label cannot be verified and the consumer receives the utility U_{UV}. However, if the consumer does search and the firm in question is monitored, the consumer receives a utility of U_{VE} in case of a verification and U_{VNE} in case of fraud ($U_{VE} > U_{UV} > U_{VNE}$).
Again, the production costs are C_E or C_{NE}, respectively. However, the producers receive a uniform revenue R in case of a purchase, regardless of whether their label is legitimate or not. For simplicity, labeling costs are neglected and it is assumed that the consumer is only interested in labeled goods and is unwilling to buy non-labeled products.
Under certain conditions, this setting allows for a Nash-equilibrium in which a firm chooses to produce ecological products and label them accordingly even without repeated action [2]. To reduce investment uncertainty for ecological producers, it is necessary to identify a separating equilibrium with truthfully labeled products purchased by the consumers. To test this, a potential equilibrium is proposed where the firm engages in ecological production and the consumer searches and finally purchases the good unless it is revealed that the firm has been untruthful. An equilibrium of this kind requires reasonable parameter restrictions to prevent both, the firms and consumers to deviate from the proposed set of strategies.
First of all, the consumer will purchase if the firm's claim is unverified and $U_{UV} > 0$, regardless of whether he searches or not. In case of a search and the determination of the veracity of the firm's claim, the consumer will purchase if $U_{VE} > 0$ (correct label) and will not purchase if $U_{VNE} < 0$.

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Generally, the consumer's search decision is as follows: if the firm engages in ecological production and the consumer searches, he will be able to discover the truthfulness of the claim with probability p and in this case earns a payoff of $U_{VE} - S$. However, with a probability of 1-p he will not be able to determine the claim's truthfulness and receives a reduced payoff of $U_{UV} - S$. Without a search, the consumer will always buy and receive a utility of U_{UV}. Hence, a search is advantageous if $p (U_{VE} - S) + (1-p) (U_{UV} - S) > U_{UV}$, i.e. as long as $p > S/(U_{VE} - U_{UV})$. As a consequence, with $S > 0$, $U_{VE} > U_{UV}$, and $U_{VE}-U_{UV} > S$, a p* between 0 and 1 exists such that the consumer searches for all $p \geq p^*$. The last condition, $U_{VE}-U_{UV} > S$, is a prerequisite for the consumer to search, since otherwise, search costs exceed the possible gain from searching and the consumer has no incentive to search at all, irrespective of the probability to be successful. If, however, the condition holds, there are some probabilities p for which searching is the best response for the consumer to the firm engaging in ecological production and the consumer's decision whether to buy or not [2].
It remains to analyze whether the firm is willing to engage in ecological production given the consumer's strategy as described above. Basically, the adoption of ecological production yields a profit of $R-C_E$, irrespective of whether the firm is monitored or not and independent from the consumers search decision: if it is monitored, the consumer knows that the ecological claim is true and will buy the product; if the firm remains unmonitored, the consumer is not able to verify his beliefs about the truthfulness of the firm`s claim, but will believe it to be true and buy the product anyway as long as his payoff (utility) $U_{UV} > 0$, which is assumed to be the true.
A firm that decides not to engage in ecological production will be discovered and earn a payoff of zero with probability p. On the other hand, the firm will successfully mislead the consumer with probability (1-p) and earn a payoff of $R-C_{NE}$. Hence, the following condition must hold if the firm is to engage in ecological production:

$$R-C_E > p (0) + (1-p) (R-C_{NE}), \text{ or} \quad (1)$$

$$p \geq \frac{C_E - C_{NE}}{R - C_{NE}} \quad (2)$$

As a result, the probability for the firm to engage in ecological production depends on the difference between C_E and C_{NE} as well as on the absolute value of C_{NE} and the relation to R. The closer C_E is to C_{NE}, i.e. the smaller the additional cost of producing ecologically, the lower is – ceteris paribus - the probability p required for the firm to engage in ecological production. In addition, the smaller the difference between C_E and R, i.e. the less profit ecological production yields, the higher is the probability required in order for the firm to actually engage in this kind of production.
Hence, as long as a firm gains profit from engaging in ecological production ($R > C_E$), a firm will engage in ecological production if probability p exceeds a critical value p*, though this is more costly than the production of non-ecological goods ($C_E<C_{NE}$) [2]. Hence, there is an equilibrium in this the game in which the firm engages in ecological production and labels its products accordingly, because in case of fraud, it runs the risk of being discovered. Crucial prerequisites for this equilibrium are reliable monitoring activities in combination with attentive consumers valuing the engagement in green production and trying to verify environmental claims.
According to Amato et al. (2012), this model extends previous works on this subject [7] in two important respects [2]:

- The monitoring model reveals that an equilibrium, in which a firm engages in ecological production and eco-labeling, is possible even in non-repeated games, if consumers derive utility from knowing that a product is ecological prior to purchase.

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- Consumers wish to purchase green products and are willing to search for truly ecological products even though this involves additional costs. With the resulting information they build expectations regarding the probability p that the firms claim is justified.

The Authors note that the premise concerning consumer utility is highly plausible and supported by empirical research. The main feature of this single period equilibrium is the firm's incentive to produce ecologically even if there's a low likelihood of repeated transactions. This is because the consumer is able – at least with a certain probability - to reward fraud prior to the purchase, while in repeated games this is only possible in future periods. According to Amato et al., the fact that an equilibrium does not depend upon future patronage to induce ecological production is especially important in an environment of expanding "green choices", where a frequent change in the products purchased is rather likely and a reward scheme therefore might not work anyway [2].
However, there are some limitations to this approach. First of all, the assumption that the consumers are only willing to buy labeled goods seems somehow unrealistic in practice. In addition, the above mentioned development with an ever rising number of eco-labeled products complicates monitoring as well as searching for truly ecological products, and, as a consequence, the realization of a probability p required for an equilibrium in which firms produce ecologically.

4. Consumer Commitment

An alternative approach to the one presented above is that of consumer commitment. Here, it is assumed that there are some "information-supplying activists" [3] who – for example with support by the government - are willing and able to reveal the true practices of firms (maybe through internet platforms providing information on goods and firms) and by this give other consumers the opportunity to verify environmental claims at comparatively low cost. Apart from these activists, consumers in this game are divided in two groups, the engaged, committed consumers and the non-committed, who do not care for environmental matters. Then the timing of the game is as follows:

- Nature independently draws a type of consumer (committed / non-committed) from a commonly known probability distribution that assigns probability p to the committed type and probability q = (1-p) to the non-committed type
- Not knowing what type of consumer it actually faces, the firm decides to engage in ecological production (EP) or not (NEP).
- The firm decides whether (L) or not (NL) to claim ecofriendly production
- The consumer decides whether to search or not (committed consumer) and, finally, to purchase or not

It is assumed that the costs of production are higher for ecological products, and, as a result, these products are sold at a higher price (P^H instead of P^L). This is also true for labeled products of non-ecofriendly firms trying to mislead consumers. Consequently, labeled products are always more expensive than non-labeled, and non-committed consumers refuse to buy them since their decisions are led by mere price considerations. Committed consumers, on the contrary, do not buy non-labeled products and either engage in a search to verify the claim or believe the firms' claims to be true.

This game is depicted in Figure 5 in its extensive form:

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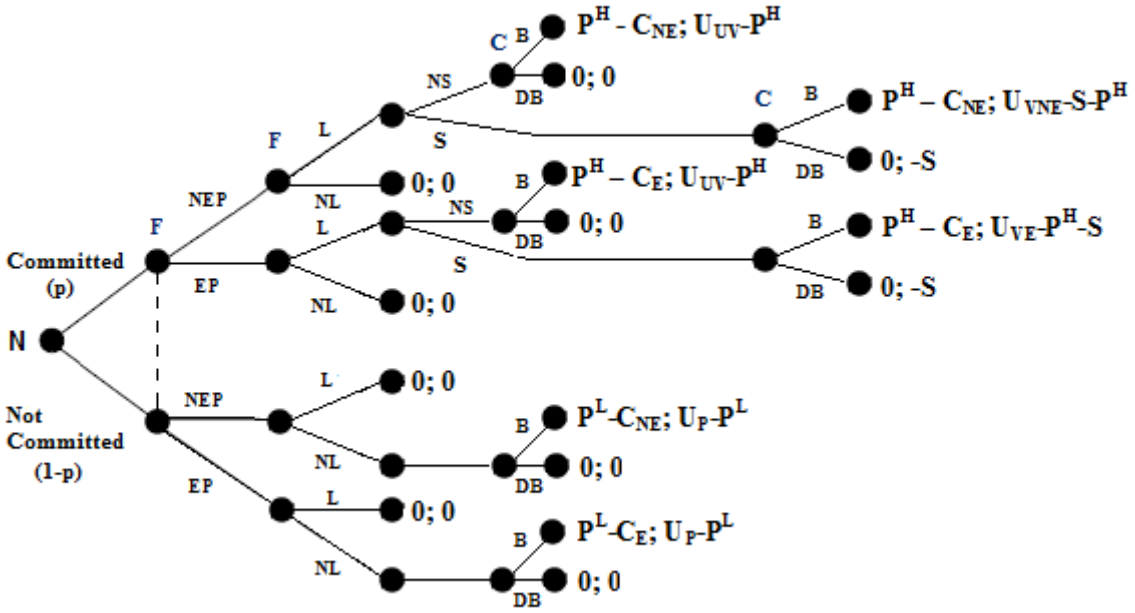

Figure 5: Consumer Commitment Game.

Again, to test for a separating equilibrium with truthful claims, a potential equilibrium is proposed where firms label their products truthfully and committed consumers are able to identify and choose their products.

To begin with, the non-committed consumer will only buy products without ecological claim (as long as $U_P > P^L$), since he does not value engagement in ecological production and his decision is led by the lower price of the ordinary product ($U_P - P^L > U_P - P^H$).

However, the consumer shows commitment with probability p and then chooses to search or not, depending on the values of U_{UV}, U_{VE}, and S. As already mentioned, the committed consumer is not willing to buy non-labeled or verified non-ecological goods ($U_{VNE}-P^H < 0$), and decides whether or not to verify the environmental claim prior to the purchase, i.e. to transform the credence attribute of the good into a search attribute by using information or not. Actually, the committed consumer searches if $U_{VE} - P^H - S > U_{UV} - P^H$, or $U_{VE} - S > U_{UV}$, so the additional utility derived from a verification must exceed search cost. Under these conditions, searching is the best response of the committed consumer to a firm claiming ecological production. Note that the searching committed consumer is not the eco-activist with high investment costs but part of the target group profiting from the engagement of a few activists presenting their findings. However, there are still some, if comparatively low, search costs to the committed consumer.

It remains to show that the firm will actually engage in ecological production and will label truthfully given the consumers' strategies. The possible strategies of the firm are as follows:

- 1: Engage in ecological production and label
- 2: No engagement in ecological production and label anyway
- 3: Engage in ecological production and do not label
- 4. No engagement in ecological production and no labeling

If the firm engages in ecological production and labels, and the committed consumer searches, the truthfulness of a claim is verified with probability p. Without a search, the committed consumer will always buy labeled products (as long as $U_{UV} > p^H$). As a consequence, the firm will be able to sell its ecologically produced and labeled products (and earn P^H-C_E) with probability p, while with

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probability (1-p) the consumer is not committed and will refuse to buy the higher priced product. As a result, the expected payoff from an "engagement/label"-strategy is as follows:

$$E(U) = p(P^H - C_E) + (1-p)\,0 = p(P^H - C_E) \quad (3)$$

In case the firm does not engage in ecological production and does not label, only the non-committed consumer will buy and the firm's expected payoff is:

$$E(U) = p(0) + (1-p)(P^L - C_{NE}) = (1-p)(P^L - C_{NE}) \quad (4)$$

If the firm does not engage in ecological production but labels anyway, the payoffs are $p(p^H - C_{NE})$ if the (committed) consumer does not search and 0 if the consumer searches.
The option of an engagement without a label is never advantageous, irrespective of the consumer commitment, since committed consumers refuse to buy non-labeled goods and non-committed consumers, unconcerned regarding production technology, can be served at lower production cost.
As a result, there is an equilibrium where the firm engages in ecological production and labels its products accordingly if the committed consumer searches and the expected payoff to the firms exceeds that from the "no ecological production/no label"– option:

$$p(P^H - C_E) > (1-p)(P^L - C_{NE}) \text{ ; or } \quad p > \frac{(P^L - C_{NE})}{(P^L - C_{NE}) + (P^H - C_E)}, \quad (5, 6)$$

That is, for a given proportion of committed consumers the profit from ecological production must be sufficiently high, or, in other words, the proportion of committed consumers must be higher the less ecological production yields compared to the production of ordinary goods.
However, this is only true if the committed consumer actually searches, since otherwise, the firm has an incentive to deviate from the equilibrium path and play "no ecological production / label", since this yields a higher profit ($P^H - C_{NE} > P^H - C_E$)
According to this model, consumer commitment and consumer search is a crucial prerequisite for the advantageousness of an investment in ecological production. This is a rather plausible conclusion in a market driven environment characterized by the matching of supply and demand. However, it also became clear that the quality of consumer commitment plays an important role as well, since confidence in the firms' claims is not sufficient and may seduce some firms to cheat and misinform committed consumers. Since consumer commitment cannot be influenced directly by political measures, the options are limited to raising ecological awareness and providing transparency, another important prerequisite for the proper functioning of competitive markets. In this model, this may be realized through informational support to the eco-activists, the most committed consumers, who as engaged guiding forces give other committed consumers the opportunity to detect truthfully produced goods at relatively low costs.
Summing up, it seems to be appropriate to divide consumers into more and less committed ones, and even the character of the information-supplying eco-activist may well find its counterpart in real world settings. Furthermore, though the presumption that all goods can be assessed correctly in case of a search is certainly somewhat unrealistic, limiting the range of products or producing firms to the most popular and widespread may provide a practicable approach to the solution of the labeling problem.

5. Subsidy announcements

Contrary to eco-labels, subsidies or other financial government support do not rely on consumer concessions to reduce investment uncertainty. Rather, reliability and policy predictability are important factors/the crucial elements that determine profitability of an engagement in ecological pro-

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duction. Hence, in this setting it is not up to the firms to signal quality and reliability, but the responsibility of the government to choose its/adequate politics and send truthful signals.
In order to analyze the possible effects of subsidies on investment decisions and uncertainty, a game theoretic model is introduced where a firm considers to engage and invest in ecologic production in expectation of subsidies while facing two possible future government types. The specifications of the model are as follows:

- The type τ of government i lies in the type set {S, NS}.
- The government of Type S will support ecological production with adequate policy measures to foster environment protection and compensate for additional investment, while the government of Type NS will refuse to do so. As a matter of fact, the S-type government will grant a subsidy of S to compensate for additional costs of ecological production.
- The type of government i is drawn independently by nature (N) from a probability distribution that assigns probability $p \in (0,1)$ to the S-type and probability $q = 1-p$ to the NS-type. It is assumed that both types of government want the firms to engage in green production but only one type is willing to give support.
- The move of nature remains private knowledge to the government, while the probability distribution is common knowledge.
- With its hidden knowledge, the government chooses whether to signal support (i.e. make a support announcement, SA) or not (NSA).
- The firms observe the announcements of the government and decide whether to invest (E) or not (NE) in ecological production.
- The government derives utility from environment protection and sustainability (U_P) on the one hand and from a reputation of reliability (U_R) on the other.
- The payoff to the firm is its expected profit, i.e. a fixed revenue $R > 0$ net of additional investment F plus a subsidy payment S, conditional on whether it decides to engage in ecological production or not and on whether the government is of type S or NS.
- Again, the model uses the solution concept of the Perfect Bayesian Equilibrium.

The firm will be able to sell a fixed quantity and receives a fixed revenue of $R > 0$ if it does not engage in ecological production, irrespective of the type of government it faces. Consequently, if there is no ecological production, the utility of the firm is R and government´s payoff is zero, unless it signals support and turns out to be unreliable. In this case, the payoff to the government is $-U_R$.
It is assumed that the firm will not be willing to invest unless the government signals support. However, in case of an engagement in ecological production, the firm and government types earn the following payoffs:

- If the government is of the type S, it derives utility out of environment protection and reputation of reliability, but, since it keeps its promise, has to pay a subsidy S. Hence, its payoff amounts to $U_P + U_R - S$. The firm on the other hand receives a revenue of R and the subsidy payment S, but faces investment costs of $F < S$. Consequently, it earns a payoff of $R-F+S > 0$.
- In case of a non-supportive government, the firm is misled and engages in ecological production under the (wrong) assumption that a subsidy will be paid. Though the government derives utility from environment protection without a subsidy payment, it has to pay for its fraud and earns a negative utility from a reputation of non-reliability. As a consequence, its payoff amounts to U_P-U_R. The firm suffers from the fraud and has to bear the investment costs without receiving any compensation. Hence, compared to the non-ecological production, it earns a reduced payoff in the amount of R-F.

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Like the consumer in the model described in Section 1.1, under asymmetric information the firm does not have perfect knowledge concerning the (future) support by the government while the government has private information about its type. Rather, the firm has a belief about the possible types of the government determined by the signal received and by probability p. Based on this belief, the firm will make its decision by comparing the expected utilities of the alternative actions
Here, it seems convenient to specify the elements of government utility in further detail. As already mentioned, the notion U_P depicts the utility the government derives from environment protection if firms switch to ecological production. This may be due to a decline in negative externalities and related government expenditures, an image of sustainability, or general benefits emerging from sustainable production techniques and the resulting products. The notion U_R, on the other hand, represents the utility the government derives from a reputation of reliability, or in case of $-U_R$, from a reputation of not being reliable. These different reputations are the consequences of a broken or fulfilled support promise.

There is a pooling equilibrium with support announcements by both types of governments and investments in green technology if $p < F/S$ and $U_P > U_R$ and $U_P+U_R > S$. The latter conditions are quite plausible, since it makes sense that a government will only be willing to give support if the net utility is positive and the utility derived from reaching political goals exceeds the perhaps rather momentary utility derived from a reputation of credibility. Assuming that support expenditures will not exceed additional firm costs by far, it becomes clear that the probability p must be quite close to one if investment should occur.
Again, however, turning to the reduction of investment uncertainty, there is no separating equilibrium in which a supportive type government gives a support signal and the non-supportive type signals no support unless the government attaches more importance to the reputation of credibility than to the (impure) reaching of political goals.

6. Discussion

The results show, that in the basic setting it does not pay for the firms to engage in ecological production and label their products accordingly unless there is a reward scheme with repeated actions that enables consumers to discover fraud and adapt their decisions in subsequent purchase situations. This is because of the credence good property of the products purchased and a lack of liability of eco-labels, which give untruthful producers the opportunity to cheat and gain an additional profit. Especially in an environment of expanding “green” choices with a plethora of different products and labels, however, it seems unlikely that even a reward scheme would work effectively. For eco-labels to reduce investment uncertainty, it is therefore indispensable to improve overall credibility of eco-labels. The results of the monitoring game indicate that an adequate monitoring of the labels in combination with environmentally conscious, attentive consumers ready to examine the truthfulness of the signals can establish an equilibrium with payable investments in ecological production. The consumer commitment game shows that the role of the monitoring institution may also be taken by highly motivated activists providing information to other committed consumers.
The effects of government subsidies, on the other hand, depend on the credibility of the governments involved, which in turn is determined by the importance attached to different goals. Since there is the temptation to announce support and cheat afterwards, the significance of a reputation of credibility plays a crucial role for the effectiveness of subsidy policies concerning investment decisions of firms.

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