The Role of Public Information in Corporate Social Responsibility*

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Abstract

Corporate social responsibility (CSR) often relates to the firms' supply of credence attributes as a response to a "conscious" demand by consumers that value such attributes. An example of such a credence attribute can be the conditions under which the product is produced, including child labor or any externalities associated with production. Since consumers cannot learn about such attributes either through search or experience, the phenomenon of CSR thus relies on the existence of a noisy informational channel (such as certifications, clubs, activists, media, advertisement) through which firms communicate consumers the credence attributes of their goods. In this paper we model such informational channel and show the positive relationship between the accuracy of the information transmitted to and obtained by consumers and the social responsibility of businesses. We also show that, in our setup, firms may be tempted to adding noise to the information channel (for example, through advertisement or lobbying of the media). Such manipulation of information has a negative effect over the supply of the credence attributes and, in some cases, it may even harm firms themselves. We show that, as a consequence, firms might find profitable to commit to not manipulate the information provided to consumers and, a way to do so would be the sometimes observed partnerships between firms and NGOs.

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1 Introduction

In this paper we study the role that information plays in the promotion of corporate social responsibility. This includes the analysis of both the role of played by information in the incentives of firms to adopt socially responsible business practices, as well as the incentives that different agents (firms, activists, the media) have in the provision of such information. Our analysis thus focuses on the workings and the accuracy of the informational channels that transmit information to consumers about businesses' practices, and their impact on the social responsibility of firms.

By corporate social responsibility we denote those "voluntary actions that firms take over and above compliance with minimum legal requirements, to address both its own competitive interests and the interests of the wider society".[1] More specifically, corporate social responsibility often relates to the supply by firms of credence attributes in the goods and services they sell (Nelson, 1970; Tirole, 1988, pp. 106-129; Baron, 2009). In addition to their physical and performance characteristics products have (unobservable) characteristics that consumers cannot learn through search or experience: these are the so-called credence attributes of the good. Examples of such credence attributes are numerous: the conditions under which the product is produced, including any externalities associated with production (e.g. pollution), how workers are treated and how well they are paid, hidden hazards associated with consumption of the product, etc.

To our view, firms provide socially responsible goods (or practices), namely some of these (or other) credence attributes, as a response to a demand by the market. Namely, it is because some consumers value the credence attributes supplied by the firm and may be willing to pay a premium (a higher price), that firms have an incentive to supply these credence attributes as a way to differentiate from other firms in the market. As an example, consider firms that produce goods that may generate environmental (negative or positive) externalities (e.g., pollution) as a by-product of the consumers purchasing decision. Then, a profit maximizing firm may go beyond the regulatory requirements by choosing more expensive production technologies that reduce its

[1] As defined by the UKs Department of Trade and Industry.

externalities so as to satisfy the demand of some "conscious" consumers that take into account the external effects of their purchase.

Thus, a key factor behind CSR is the "consciousness" of consumers. By "consciousness" (or "altruism"), we denote the extent to which an agent values a given credence attribute and is willing to pay a higher price for a good that includes such attribute (that is socially responsible). There exist indeed empirical studies indicating that some consumers are willing to pay a premium for goods that have a credence attribute attached to them. Such credence attributes can be related to the labor conditions of a firm (Hiscox and Smyth, 2009), to charity linked products (Elfenbein and McManus, 2007), or the environmental goodness of a product (Casadesus-Masanell et al., 2009). Thus, evidence indicates that for some consumers there exists a willingness to pay a higher price for products of firms that adopt some practices labeled as socially responsible or, alternatively, to penalize those firms that are perceived to be socially irresponsible (see also, for instance, Mohr et al., 2001, and Murray and Volgel, 1997). Thus, such consumers might be willing to pay a premium for goods that are produced without harming the environment, that are produced by firms that employ handicapped workers, or that do not involve child labor. Intuitively, the amount of conscious consumers, and the degree to which such consumers value the credence attributes and are willing to pay for them, should have a positive impact on the behavior of firms; namely, lead them to adopt the socially responsible practices (attach the credence attributes demanded when selling their products).

An important issue (which is the focus of this paper), however, arises because of the asymmetry of information between the firm and the consumers regarding firms' practices. Consumers cannot learn either through search or experience the unobservable credence attributes that are attached to the good or service that the firm sells. This happens when, for instance, the extent of the externality depends on the technology used by the firm, not readily observable by the consumer (e.g., the pollution generated in the production of the good, or the use of child labor in the facilities of the firm in a third world country). In either case, such firm behavior is not directly observable by the consumer and thus, even if willing to pay a higher price for a socially responsible (clean,

ethical) product, the consumer has the problem of not being able to ascertain the true nature of the good offered by the firm. It is clear then that, absence enough information, the market (firms) might fail to provide the credence attributes valued by consumers (Akerloff, 1974).

Informational issues are thus key in the development of CSR. The level of information accuracy (or lack of it), how it is produced in the market and the incentives of agents to provide it, are the focus of this paper. There exist in the market several institutions designed to cope with the asymmetry of information, with the lack of information by consumers on the credence attributes supplied by firms (i.e., the social responsibility of firms' practices). These institutions include certifications, whether provided by a single firm (Bottega and de Freitas, 2008) or a group (club) of them (Baron, 2009); the information provided by activists such as NGOs (Feddersen and Gilligan, 2001) in the context of private politics (Baron, 2003); direct (advertisment) or indirect communication by firms; and information provided to consumers/citizens by the media (Dyck and Zingales, 2002). As we see, the number of agents and institutional arrangements that (may) play a role in the transmission of information to consumers on businesses' practices are wide.

Our analysis starts in a simple framework in which consumers/citizens obtain a noisy signal regarding the technology used by a firm: either a clean (and more expensive to the firm) technology that produces a unit of a public good for each unit of the good sold, or a dirty and cheaper technology which does not produce any unit of the public good. Even though each consumer is small (negligible) in relation to the market and might thus free-ride in its purchasing decision, we assume that consumers are, to a varying degree, altruists/conscious (or, alternatively derive a warm-glow from purchasing the good produced with the clean technology). As a consequence, a firm might have an incentive to invest in the clean technology if, afterwards, is able to charge a higher price to consumers. There is, however, asymmetric information between the firm and consumers with regards to the technology effectively used (the technology used by the firm is its own private information). Consumers, however, receive a noisy signal on the choice, on which technology the firm is actually using.

Our framework thus allows us to discuss in which way the accuracy of the information that

consumers receive influences the incentives of firms to be socially responsible. We show that, intuitively, the higher the accuracy of the information provided to consumers on the true technology used by the firm, the more likely there will be an equilibrium with socially responsible business practice (this is result stated in proposition 1 of the paper.). Additionally, we also show that the more altruism (consciousness of consumers) there is in the market, the more likely there will be an equilibrium in which the firm chooses the clean technology. (Proposition 2 in the paper.)

Next, we take a step backwards in the analysis of the informational channel between firms and consumers (and possibly other agents) on the choice of the technology by the firm. More specifically, we analyze the incentives of firms to provide information and show that, if possible, firms would manipulate (e.g., through advertisement) the information provided to consumers, hence increasing the probability of a dirty technology to go undetected.

Such manipulation, however, would also decrease the accuracy of the information provided to consumers (increase the noise of the signal they receive), and might thus eliminate the possibility of an equilibrium with the clean technology, which might even harm the firm herself. As a consequence, and in some cases, the firms would like to be able, whenever possible, to commit ex ante not to manipulate the information provided to consumers, or in other words, to increase the accuracy of the information provided to the public. For the firm, a way to accomplish this commitment would be the involvement of a third party (such as a NGO) whose independent reputation would assure in a credible way that the firm does not manipulate the information provided to consumers and, thus, increase the accuracy of the signal received by consumers. This result might show the one of the rationales behind many partnerships we see in real life between firms and NGOs; e.g., the firm GAP with the NGOs Social Accountability International and Verite; Starbucks with the environmental NGO Conservation International, and the multinational fruit company Chiquita with Rainforest Alliance. We discuss such partnership in in length and detail below.

1.1 Related Literature

Like Besley and Ghatak (2007) and Bagnoli and Watts (2003), and without loss of generality, we model CSR as the provision of a public good. This is analogous to the supply of a credence attribute in a joint manner with the good the firm is selling (as in Baron, 2009). Our paper focuses on the informational issues between firms and consumers, and also other actors in the economy (e.g., NGOs). Several papers with different approaches have analyzed this. One of such perspectives is the literature on certification and eco-labels. Bottega and de Freitas (2009), for instance, analyze certification by a third party (either a private firm or an NGOs) and the effect it may have on the scope for public regulation. An important difference with our analysis is that, in their framework, the certifier credibly informs (with certitude) about the credence attribute that the firm is supplying. Thus, in their framework, informational accuracy and manipulation is not an issue. The same, for instance, can be said about Baron (2009) which analyzes the supply of credence attributes by firm members of a club (a voluntary organization) that is in charge of verifying that the established standard is met.

The media and other actors (interest groups, firms themselves) do also play a role (in addition to third party certifiers) in the transmission of information to consumers about businesses practices. Generally, governments, interest groups (such as NGOs), and firms themselves generate and aggregate information that the media then process and selectively communicate to consumers/citizens. Dyck and Zingales (2002) provides both anecdotal and systematic evidence that media affect companies' policy towards the environment. They look at the effects of the press on the private sector's responsiveness to environmental concerns. They show (in accordance to our result in proposition 1) that the press (using as a proxy the circulation of daily newspapers normalized by population) has a positive effect on firm's responsiveness to environmental concerns. Baron (2003, 2005) discuss the private politics involved in such a process of aggregating, selecting and transmitting information in which a myriad of agents interact (firms, NGOs, etc.). Feddersen and Gilligan (2001) analyze in an incomplete information theory the role of an activist in the

provision of information to consumers regarding the credence attributes of products (businesses' practices).

Our paper is, to our knowledge, the first one to discuss the role of public information in the promotion of CSR while allowing for the manipulation by the firm of the information provided to consumers regarding business practices. There are many papers dealing with the manipulation of information by agents: in the cheap talk literaure, where informed agents may lie (Crawford and Sobel, 1982; Farrell and Rabin (1996), etc.), and in persuasive games, where informed agents only may hide information (Dye, 1985; Glazer and Rubinstein, 2006; Grossman, 1981; Jovanovic, 1982; Shin, 1994; etc).

In section 2 we present the benchmark model which allows to obtain and discuss proposition 1 and 2, namely, the role of the accuracy of information and the altruism of consumers in the promotion of CSR. Next, in section 3, we analyze the provision of information by the firm and its incentives to manipulate such information. Also in section 3 we analyze the incentives of a firm to commit no to manipulate with the help of a NGO, while also discussing some examples of such partnerships between a firm and an NGO. We then conclude in section 4.

2 The Benchmark Model

The model consists of a perfect competitive market in which firms sell an homogeneous good. One firm among all may differentiate from the others by attaching a credence attribute to this good. We consider that this firm may choose to produce with a cleaner (and more expensive) technology than the rest.[2] In the economy there is a continuum of consumers who by consuming the good produced with the clean technology exert a positive externality of value G on each consumer in the market. The technology used is private information of the firm, while all consumers receive a noisy signal regarding the type of technology used by the firm.

[2]Other analogous examples might be better working conditions in the factories such as excluding child labor, or paying a wage above the market wage.

2.1 Firms and Technologies

There is a perfect competitive market in which firms produce an homogenous good. Firms do not make profits, and the market price and the marginal cost are normalized to 0. One and only one firm (henceforth, the firm) may differentiate in the market by attaching a credence attribute to the good it sells. We model this by allowing the firm to choose a clean technology rather than the dirty technology with which the rest of the firms produce. The firm, thus, may choose with which technology T to produce, whether to produce the good with a clean technology (C) or with the dirty and standard technology (D), i.e. $T \in \{C, D\}$. The clean technology entails a fixed cost $F \geq 0$, whereas the dirty technology entails no fixed cost. In either case, the marginal cost of production is 0.

If the firm uses the clean technology, it generates for each unit produced a positive externality of value G to all potential consumers of the market (producing with the dirty technology generates no positive externality). Thus, G is a public good and consumption of a unit produced with the clean technology can be seen as either equivalent to the private contribution to a public good (as in Besley and Ghatak, 2007), or to the consumption of a good with a credence attribute attached to it (as in Baron, 2009).

The firm that can differentiate may be one of three different types, depending on the size of the fixed cost in which it incurs in case it uses the clean technology. With ex ante probability $\frac{1-s}{2}$ the firm has a fixed cost of $F = \infty$ of choosing the clean technology . As a consequence, indepently of market conditions, this type of firm will never choose the clean technology. With probability $\frac{1-s}{2}$, for the firm choosing the clean technology has a fixed cost of $F = 0$. This type of firm will always choose the clean technology. Finally, with a probability s the firm can use the clean technology with a fixed cost of F, with $0 < F < \infty$. This firm, as we analyze below, will be 'strategic' regarding its decision on which technology to use. The firm learns its type before the choice of the technology, and consumers do not observe the type of the firms.

2.2 Consumers

There is a mass of unit 1 of consumers with utility

$$u = v + \alpha\phi - p,$$

where v is the valuation of the standard good, and ϕ is the magnitude of the positive externality, with $\phi \in \{0, G\}$. More specifically, $\phi = G$ in case the the firm uses the clean technology, and 0 if the good consumed is produced by the firm using the dirty technology. We focus on the relevant cases, in which the positive externality G is larger than the fixed cost of the strategic type, i.e., it is always efficient that the strategic type uses the clean technology. Finally, p is the price paid by the consumer.

α represents the type of the consumer with regard to his/her degree of altruism. Thus, for instance, α denotes the consumer's valuation of a clean environment or of consuming a good not produced with child labour. More specifically, we assume that α is distributed over the interval $[0, 1]$ with a distribution function $F(\cdot)$. We also assume that the reliability function of the distribution, *i.e* $\overline{F(\cdot)} = 1 - F(\cdot)$, is logconcave.

3 Signals and Information

The technology effectively used by the firm is not observable by the consumers. Consumers, however, receive one of two signals concerning the technology used by the firm. The signal is s, where $s \in \{s_C, s_D\}$. The probability that consumers receive one or other signal does of course depend on the technology that the firm is using. Thus, the probability that the signal is s given that the technology chosen is T is $\Pr(s \mid T)$. More specifically,

$$\begin{aligned}
\Pr(s_C \mid C) &= 1, \\
\Pr(s_D \mid C) &= 0, \\
\Pr(s_C \mid D) &= 1 - \gamma \\
\Pr(s_D \mid D) &= \gamma,
\end{aligned}$$

where $\gamma \in [0, 1]$. That is, if the firm uses the clean technology, the signal will be s_C with certainty. However, if the firm uses the dirty technology there is some noise and thus consumers may receive either signal. Notice that γ represents the accuracy of the signal, with a higher γ implying a more informative signal. More specifically, notice that with $\gamma = 0$ the signal is non-informative whatsoever since consumers never receive signal s_D.

3.1 The Market Game

The timing of the game is as follows.

1. Nature chooses the type of firm, namely, the level of the fixed cost F of the dirty technology.
2. The firm chooses the technology with which it is going to produce. The rest of the firms produce and sell the standard good (at zero price and cost).
3. Nature chooses the signal $s \in \{s_C, s_D\}$ on the technology used by the firm according to the previous probabilities. All consumers receive the same signal.
4. The firm sets its price p.
5. Each consumer decides whether to buy or not from the firm. The alternative is to buy the standard good from the competitive fringe (at zero price).
6. Profits are realized.

4 Solving the game

4.1 Demand

As usual, we solve the game backwards and, thus, start determining demand which depends on the marginal consumer α^* that is indifferent between buying the good to the firm or buying the standard good from the competitive fringe (at zero price). Namely:

$$v + \alpha^* \cdot \Pr(C \mid s)\, G - p = v. \tag{1}$$

Then,

$$\alpha^* = \frac{p}{\Pr(C \mid s)\, G}. \tag{2}$$

Thus, those consumers with $\alpha \geq \alpha^*$ will buy the "differentiated" good from the firm, while those with $\alpha < \alpha^*$ will buy the standard good. As a consequence, and given the distribution function of α over $[0, 1]$, the demand faced by the firm is $1 - F(\frac{p}{\Pr(C|s)G})$. We see that demand depends on the signal received by the consumer and the posterior probability that the technology chosen by the firm is the clean one. We analyze this further below.

4.2 Firm's Profits

The profit of the firm (gross of fixed cost, if any) is demand times price, namely,

$$\pi(p, s) = \left[1 - F\left(\frac{p}{\Pr(C \mid s)\, G}\right)\right] \cdot p. \tag{3}$$

Given this profit function, and given the signal received by all consumers, which is the price set by the firm, and its posterior profits? We answer this question in Lemma 1 next, where we see that the price (and profits) of the firm depends on the signal received by consumers.

LEMMA 1 *The price set by the firm is* $p^*(s) = \Pr(C \mid s)\, Gr^*$*, whereas firm's profits (gross of fixed costs, if any) are then* $\pi^*(s) = [1 - F(r^*)] \Pr(C \mid s)\, Gr^*$*, with* $r^* = \frac{[1-F(r^*)]}{f(r^*)}$.

On the one hand, if consumers receive signal s_D, the posterior probability that the technology chosen by the firm is the clean one is zero. As a consequence, and since all consumers are then homogeneous, the price then set by the firm is 0, i.e., the willingness that the consumer has to pay for the product when it believes that it is produced using the dirty technology (in which case consumption entails no public good, no positive externality). In such a case, the firm's profits are 0.

If consumers receive signal s_C, then they have a positive willingness to pay for the product and the price will no be longer 0. The optimal price characterized in Lemma 1, is linear in the conditional probability of that the clean technology has been used. As we will show in the next

section, this conditional probability will be increasing in the accuracy of the signal. Given this optimal price, the more activist consumers will buy from the firm, and the other consumers will buy from the market. It turns out that the marginal consumer (and consequently the demand) is independent of the information structure, and only depend on the distribution of the consumer altruism parameter, $\alpha^* = r^*$. Firm's profit (gross of the fixed cost) are linear both in the equilibrium price and in the conditional probability that the clean technology has been used, $\pi^*(s) = \Pi \Pr(C \mid s)$, where $\Pi = [1 - F(r^*)] Gr^*$.

4.3 The Market Equilibrium

Given this above, which will be the technology chosen by the firm in equilibrium? Since such a choice is private information of the firm, consumers are going to have beliefs on such choice based on the signal received, hence solving the game requires solving for the perfect Bayesian equilibrium. As defined in Fudenberg and Tirole (1991), a perfect Bayesian equilibrium (PBE) is a set of strategies and beliefs such that, at any stage of the game, strategies are optimal given the beliefs, and the beliefs are obtained from equilibrium strategies and observed actions using Bayes rule. Note the link between strategies and beliefs: the beliefs are consistent with the strategies, which are optimal given the beliefs.

Clearly, the choice will depend on which is the type of the firm. In any case, the type with $F = \infty$ will always choose the dirty technology while the type with $F = 0$ will always choose the clean technology. We then have left to discuss what the type with $0 < F < \infty$ is going to do. Call this the 'strategic' type. We focus on pure strategies equilibrium, and we (need to) study when the 'strategic' type is going to choose the clean technology (the socially responsible equilibrium) and when it is going to choose the dirty technology (the not socially responsible equilibrium).

4.4 The Socially Responsible Equilibrium

We denote as socially responsible the equilibrium in which the "strategic" type firm chooses the clean technology. In equilibrium it must be that priors and beliefs are consistent with strategies. Then, in such a case, (and since the $F = 0$ type by assumption also chooses the clean technology), priors (beliefs of consumers) are that the clean technology is chosen with probability $\Pr(C) = \frac{1-s}{2} + s = \frac{1+s}{2}$, and the dirty technology is chosen with probability $\Pr(D) = \frac{1-s}{2}$.

For the firm to be optimal to choose the clean technology over the dirty one, it must be that the expected profits (before the realization of the public signal) when choosing the clean technology are larger than the profits using the dirty technology, i.e.

$$\pi(T = C) \geq \pi(T = D). \tag{4}$$

Let $\pi_C^*(s) \equiv \Pi \Pr_C(C \mid s)$ be the firm profits in this case in which the "strategic" type firm has chosen the clean technology (whereas as π_D^* will stand for the case in which the "strategic" type will choose the dirty technology) and the realization of the public signal on the technology chosen by the firm is s. (Recall from above that $\Pi = [1 - F(r^*)] Gr^*$).

Using bayes rule, we obtain $\pi_C^*(s_D) = 0$ and $\pi_C^*(s_C) = \frac{\Pi(1+s)}{2-\gamma(1-s)}$. This profit function reflects the willingness to pay for good of consumers. This willingness to pay is 0 if the realization of the signal is s_D since in this case the consumers learn that the technology was the dirty with certainty. When the realization of the signal is s_C then, the williness to pay is increasing on the accuracy of the signal γ.

The expected profits are

$$\begin{aligned} \pi(T = C) &= \Pr(s_C \mid C)\, \pi_C^*(s_C) + \Pr(s_D \mid C)\, \pi_C^*(s_D) - F \\ &= \pi_C^*(s_C) - F, \end{aligned}$$

since $\Pr(s_C \mid C) = 1$ and $\Pr(s_D \mid C) = 0$. On the other hand,

$$\begin{aligned} \pi(T = D) &= \Pr(s_C \mid D)\, \pi_C^*(s_C) + \Pr(s_D \mid D)\, \pi_C^*(s_D) \\ &= (1 - \gamma)\pi_C^*(s_C) \end{aligned}$$

Then, the condition over expected profits becomes

$$\begin{aligned} \pi_C^*(s_C) - F &\geq (1-\gamma)\pi_C^*(s_C), \\ \gamma\pi_C^*(s_C) &\geq F. \end{aligned}$$

Plugging in the expression of the profits, we obtain the necessary condition for the socially responsible equilibrium

$$\frac{\gamma(1+s)\Pi}{2-\gamma(1-s)} \geq F,$$

where recall that $\gamma \in [0,1]$.

4.5 The Not Socially Responsible Equilibrium

The analysis is analogous to the previous one. Suppose now that the "strategic" type firm chooses the dirty technology. Then, in such a case, priors (beliefs by consumers) that a firm chooses the clean technology are $\Pr(C) = \frac{1-s}{2}$, whereas that a firm chooses the dirty technology are $\Pr(D) = \frac{1-s}{2} + s = \frac{1+s}{2}$. As we specified above, for notational purposes, let $\pi_D^*(s_C) = \Pi \Pr(C \mid s)$ be the profit of the firm (gross of fixed costs) when the signal is good (s_C) and the 'strategic' type firm has chosen the dirty technology. Using the bayes rule, we obtain $\pi_D^*(s_C) = \frac{(1-s)\Pi}{2-\gamma(1+s)}$. These profits are linked to the positive williness to pay of consumers that is increasing in the accuracy of the signal. As in the previous case, when the realization of the public signal is bad the profits are zero, i.e $\pi_D^*(s_C) = 0$. Finally, the necessary condition for the "strategic" type to choose the dirty technology is that

$$\pi(T = D) \geq \pi(T = C). \tag{5}$$

For the same arguments than above, this is equivalent to

$$\begin{aligned} (1-\gamma)\pi_D^*(s_C) &\geq \pi_D^*(s_C) - F, \\ \gamma\pi_D^*(s_C) &\leq F. \end{aligned}$$

Plugging in the expression of the profits, we obtain the necessary condition for the not socially responsible equilibrium

$$\gamma\pi_D^*(s_C) = \frac{\gamma(1-s)\Pi}{2-\gamma(1+s)} \leq F.$$

5 Main Results

Once we have characterized the equilibrium of the game, we can analyze the impact of the accuracy of the consumers' information in the payoff of the strategic firms and in the likelihood that the necessary conditions specified above are satisfied.

Lemma 2 *The expected profits of the strategic firm in the socially responsible equilibrium (non socially responsible equilibrium) are increasing (decreasing) in the accuracy of the signal γ.*

Lemma 2 shows that the accuracy has a positive (negative) effect when the strategic firm chooses the clean (dirty) tecnology. Then, the necessary condition for the socially responsible equilibrium (non socially responsible equilibrium) is more (less) likely to be met when the accuracy of the signal is large. The proposition states this result.

Proposition 1 *When the level of accuracy γ is small, the only equilibrium is that the firm is not socially responsible (chooses the dirty technology), whereas when the level of accuracy is large enough, the only equilibrium is that the firm is socially responsible (chooses the clean technology). For intermediate levels of accuracy, both strategies are part of an equilibrium.*

The intuition is straightforward. Only when there is enough information regarding the action followed by the firm consumers will be willing to pay a higher price for a good labeled as socially responsible. Given that consumers' behavior depends on the information they hold, the firms incentives to undertaking socially responsible actions also does. Mathematically, we can see this analysing the effect of γ on the probability that the technology used is the clean one when the signal is s_C. We see that this probability increases with γ, and accordingly does the willingness to pay of the consumer. As a consequence, the incentives of the firm to be socially responsible

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(to choose the clean technology) are higher. As a consequence, we can state that the better information there is regarding the firm's practices, the more incentives the firm has to behave in a socially responsible manner.

We can also analyse the impact of the level or degree of altruism (of activism) in society on the strategic choice of the firm regarding technology. This we do in the following proposition, measuring the degree of activism in society according to the first-order stochastic domiance. Let $F'(\cdot)$ be an alternative distribution of α such that F' that first-order stochastically dominates F, $F'(\cdot) \geq F(\cdot)$ for all $\alpha \in [0,1]$.

Proposition 1 *In a more altruist (activist) society, the firm is more likely to be socially responsible.*

Propositions 1 and 1 have two important implications over the total welfare in the economy.

Corollary 1 *Total surplus (welfare) is increasing in the likehood of the adopting the clean technology. Namely, (i) for a given level of information accuracy γ, the total surplus is increasing in the level of altruism (activism) of society; and (ii) for a given distribution of activism F, the total surplus is increasing in γ.*

All consumers derive utility from the firm adopting the clean technology, even though only a part of them are willing to pay for it (knowing that their individual decision would not have an effect over the firm's decision). We, however, do not consider that activist consumers may obtain additional utility for their prosocial behavior.

6 Endogenous Information Structures

In this section we consider that the accuracy of the public signal will depend on the behavior of the firm and other actors such as NGOs, the media, the public administration, etc. In particular,

we consider in a reduced form model that the ratio between good and bad news about the firm determines the probability of signal realization: the probability of receiving a good realization s_C (a bad realization s_D) is $P(s_C) = \frac{N_G}{N_B+N_G}$, $(P(s_D) = \frac{N_B}{N_B+N_G})$ where N_G (N_B) are good (bad) news.

News are produced by the firm and other private actors. It is natural to assume that the firm will only provide good news. The other actors, on the other hand, may either be biased in favor of the firm (for example, due to advertisement or lobbying), or will convey truthful information (such as NGOs). We can explain our initial information structure using this simple reduced form. On the one hand, when the firm chooses the clean technology, then $\Pr(s_C \mid C) = 1$, since all agents will provide good news since there is not conflict of interest between the biased (the firm) and the unbiased (NGOs) actors. On the other hand, when the firm chooses the dirty technology, then $\Pr(s_C \mid D) = 1-\gamma$, because there is a conflict between neutral and biased actors, and hence there will be good and bad news.

In this section, we study what are the incentives of the firm to manipulate the information, and the impact that such manipulation has on the equilibruim and on welfare, including on the own profits of the firm.

6.1 Manipulation

Consider the case in which the firm can increase the amount of good news when the technology used is the dirty one. We assume that this manipulation is costless.[3] This means in our model that the firm can increase $\Pr(s_C \mid D)$, namely, it decreases the accuracy of the information available to consumers, decreasing γ to γ'. Then, the timing of the game goes as follows:

1. Nature chooses the type of firm, F.

2. The firm chooses the technology with which it is going to produce.

3. The firm either manipulates or not. In the case of manipulation, the firm increases $\Pr(s_C \mid D)$,

[3]Introducing a cost of manipulation would not change the main features of the equilibrium.

from $1-\gamma$ to $1-\gamma'$, where $\gamma' < \gamma$.

4. Nature chooses the signal $s \in \{s_C, s_D\}$ on the technology used by the firm according to the information structure determined by $\Pr(s_C \mid D)$. All consumers receive the same signal.

5. The firm sets its price p.

6. Each consumer decides whether to buy or not.

7. Profits are realized.

6.1.1 Equilibrium with manipulation Lemma 2 shows that the expected profits of the strategic firm decreases with accuracy when it is using a dirty technology, and increases when it is using the clean technology. For the same token, manipulation is going to be used only by firms using a dirty technology. If the firm uses the clean technology, it is not interested in manipulation because, by assumption, the signal will be the clean one. If the firm uses the dirty technology manipulating is good for the firm's profits because taking (in equilibrium) the value of the signals as given, manipulation increases the probability that the signal is good, s_C. In short, manipulation makes relatively more atractive the dirty technology, and this implies that it is more difficult to find an equilibrium in which the strategic firm chooses the clean technology. The next Lemma states this result.

LEMMA 3 *The possibility of manipulation reduces the likelihood of a socially responsible equilibrium. The new necessary condition is* $\frac{\gamma'(1+s)\Pi}{2-\gamma'(1-s)} \geq F$.

In particular, if the fixed cost of the strategic types lies over the interval $[\frac{\gamma'(1+s)\Pi}{2-\gamma'(1-s)}, \frac{\gamma(1+s)\Pi}{2-\gamma(1-s)}]$ the possibility of manipulation makes not feasible the socially responsible equilibrium. The intuition of the proposition is as follows. When manipulation is costless, the non strategic type with $F = +\infty$ will always manipulate. This worsens the value of the good signal and consequently makes less atractive the clean technology. Moreover, as we said above, makes more profitable deviating from the socially responsible equilibrium since it increases the probability that the signal is s_C without

incurring in the fixed cost. Both effects leads to make more difficult that the necessary conditions for the socially responsible equilibrium are met.

It is interesting to know who benefits from the possibility of manipulation. Consumers are clearly worst since it is less likely than the good equilibrium arises. The non strategic type with $F = 0$ and the strategic type with F such that it chooses a clean tecnology independently of manipulation, decrease their profits due to manipulation since it reduces the value of the good signal. The non strategic type with $F = +\infty$ and the strategic type with F such that it chooses a dirty tecnology independently of manipulation, increase their profits due to manipulation since increasing the probability a good signal overcomes that the good signal is less valuable.

It is specially interesting the case in which the possibility of manipulation makes unfeasible the socially responsible equilibrium when it was possible without it. In such a situation, there are strategic types that choose a clean technology when manipulation is not possible, but when this possibility exists, they choose a dirty technology and reduce the accuracy to γ' afterwards. This, however, does not mean that these types are better off with manipulation; in fact, next Lemma states that some of these strategic types are worst off when manipulation is a possibility.

LEMMA 4 *The possibility of manipulation may lead a strategic firm (that, absent such possibility, would choose the clean technology) to choose the dirty technology and then manipulate. Furthermore, some of these firms (may) show a reduction in their profits due to such manipulation possibility.*

6.2 Commitment through External Agents

The previous result implies that (some) firms might favor an increase in the transparency regarding thier business practicies (the choice of technology in our model). Such higher transparency would have the effect of, on the one hand, increase the incentives of firms to adopt repsonsible busnies spracties and, on the other hand, might also increase the own profits of the firm. A higher transparency might be achieved through different institutional settings, for instance, through reg-

ulatory policies. In this section, however, we focus on the incentives that some firms might have to commit unilaterally to a higher transparency; namely, to commit not to manipulate the information that will be available to consumers regarding the techonology chocie of the firm. As we discuss in the following subsection, an example of such a business strategy can be found in the many partnerships between firms and NGOs whose logic lies in the role of the NGO as a an indpeendet and reputable certifier of some of the firm's business practices.

To undertake such an analysis, consider the previous model with an additional period in which firms may choose whether or not to commit to not manipulate. Moreover, it is natural to assume that this commitment is visible by consumers and that they update their valuation of the product using the commitment decision as well as the realization of the signal. Then, the timing of this new signaling game goes as follows:

1. Nature chooses the type of firm, F.

2. The firm decides whether or not to commit to not manipulate, $d \in \{C, NC\}$. This commitment decision is visible.

3. The firm chooses the technology with which it is going to produce.

4. If the firm has not commited in period 2, it decides whetherto manipulate or not. In case of manipulation, the firm increases $\Pr(s_C \mid D)$, from $1-\gamma$ to $1-\gamma'$, where $\gamma' < \gamma$.

5. Nature chooses the signal $s \in \{s_C, s_D\}$ on the technology used by the firm according to the information structure determined by $\Pr(s_C \mid D)$. All consumers receive the same signal and they update their beliefs using the signal realization and the (visible to all) commitment decision.

6. The firm sets its price p.

7. Each consumer decides whether to buy or not.

8. Profits are realized.

6.2.1 Equilibrium with commitment and manipulation Then, we have to characterize the perfect bayesian equilibrium of the game

$$\{(d^*_{F=0}, \sigma^*_{F=0}), (d^*_S, \sigma^*_S), (d^*_{F=\infty}, \sigma^*_{F=\infty}), \lambda_{F=0}(d,s), \lambda_{F=S}(d,s), \lambda_{F=\infty}(d,s)\},$$

where (d^*_T, s^*_T) is the equilibrium strategies of type T, and $\lambda_T(d,s)$ is the posterior the belief of type T when a decision d and a signal realization s have been observed by consumers. Notice that in the previous sections we have focused on the posterior probability, $P(C|s)$, now using the equilibrium strategies and the beliefs, we can construct $P(C|s,\lambda)$ which is key in the analysis. We can have a conflict between the realization of the signal and extreme values of the believes, we will assume that independently of the beliefs, a bad signal realization always reveals the type of technology, $P(C|s_D,\lambda) = 0$.

LEMMA 5 *The perfect bayesian equilibria in pure strategies must be a pooling equilibria in which all the types follow the same strategy regarding the commitment decision.*

The intuition is as follows. There does not exist a separating equilibrium in which the type $F = \infty$ chooses a different strategy than the other two types, since independently of the realization of the signal, it would not get any profits and mimicking the type $F = 0$ generates positive profits. In summary, $F = \infty$, has incentives to be with the other two types. For the opposite argument, there does not exist a separating equilibrium in which the type $F = 0$ chooses a different strategy than the other two types, since the other two types have incentives to mimic $F = 0$. Finally, there not exist a separating equilibrium in which the strategic type chooses a different strategy than the other two types: the strategic type, depending on the parameters, has the same preferences than $F = 0$ or $F = \infty$, which implies that the previous arguments apply.

We can construct two pooling equilibria in which the two types choose either to commit or not to commit, believes on the equilibrium path are the priors and consumers have a belief outside of the equilibrium path $\lambda_{F=\infty} = 1$. However, it seems less natural an equilibrium in which "good" firms loose this oportunity to differentiate. In fact, this equilibrium may not pass the intuitive criterium of Cho-Kreps.

PROPOSITION 2 *The pooling equilibrium in which all types of firms follow a commitment strategy is the only perfect bayesian equilibrium that satisfies the intuitive criterium of Cho-Kreps for all parameter values.*

The pooling equilibria requires beliefs out of the equilibrium path that give more weight to the types that will produce with a dirty technology. When the pooling equilibrium is on NC, these types are in their first best, then these out of equilibrium believes are more difficult to sustain.

6.2.2 Partnerships between firms and NGOs The previous analysis shows that, under some circumstances, firms may have incentives to commit not to be able to manipulate the information available to consumers on regards to the choice by the firm of the technology used in production. In other words, to increase the transparency on regards to the chocie of its technology. It is our opinion that such result lies behind the rationale for many of the partnerships between a firm (or a group of firms) and an NGO (or a group of them) that we observe in many industries. Even if this is true, however, it should also be clear that the rationales behind such partnerships may vary and are not confined to the rationale presented in this paper. For instance, Brugman and Prahalad (2007) discuss such alliances between a firm and an NGO for the purpose of developing some entrepreneurship and business model in the developing world. Such a partnership allows firms and NGOs to share some knowledge and capabilities that are specific to each one.

More closely linked to the analysis and result in our paper is one of the strengths that, according to Yaziji (2004), NGOs have (as apposed to corporations). Such a strength is 'legitimacy'[4]. As Yaziji (2004) explains, and according to a poll conducted by the Edelman public relations firm, both Americans and Europeans said they found NGO spokespeople more credible than either a company's CEO or Public Relations representative. Some fraction of the public, specially in Europe, sees NGOs as dedicated first and foremost to serving an aspect of the general social welfare. This is what gives credibility to their positions regarding social issues as, e.g., are the environmental ones. Such 'legitimacy' is precisely the reason why in our framework NGOs can

[4]The other three are awareness of social forces, distinct networks and specialized technical expertise.

be used by firms as a way to commit to the public (consumers) to a certain course of action and can increase the transparency of their actions. Furthermore, Yaziji (200$) also stresses that partnering with NGOs, and advertising it, can draw stricter scrutiny form the public, the press, the regulators, and so on than your company formerly received. Notice that such effect of partnering with an NGO is analogous to increasing transparency in our framework, making it more difficult to manipulate the information (reducing the accuracy of the information).

Examples of such partnerships between a firm and an NGO abound. In the garment industry, for instance, the firm GAP, in its aim to try to ensure a proper treatment of workers in the factories that are part of its supply chain, provides two independent evaluations of GAP's factory inspection program by the NGOs Social Accountability International and Verite. In another example, the multinational firm Starbucks has developed a partnership with an NGO, environmental group Conservation International, with the aim of increasing transparency in their operations and assuring that the operations were done under sound conditions. Next we discuss with more details yet another example of such partnerships between a firm and an NGO.

Chiquita partnership with Rainforest Alliance One such collaboration that exemplifies well the rationale of a partnership between a firm and an NGO stressed in this paper is that of Chiquita with Rainforest Alliance. In such partnership we can observe both the aim of the firm to differentiate through a socially responsible (green) startegy, as well as the role of the NGO in the provision of credibility in the transmission by the firm of information to consumers.

Chiquita is a US-based fruit producer, one of the largest agricultural firms in the world and in 1999 was Costa Rica's third largest banana exporter, accounting for more than 18% of the total $623 million worth of exports, while Rainforest Alliance is an NGO dedicated to 'the conservation of tropical forests for the benefit of the global community'. In the late 1980s there was an expansion of banana production in Costa Rica whereby the area of land area under cultivation increased from 20,000 hectares to 50,000 hectares in just five years. A consequence of such expansion of banana production was the heightening of concerns about the environmental and social impacts of banana plantations. Already Chiquita had faced legal action in the US by Central American employees

who claimed that handling certain pesticides had caused them long-term health problems.

Thus, at a point in time, Chiquita recognized that the market was changing and becoming more sensitive to environmental issues and, as a consequence, it sought to position itself in the market as 'environmentally friendly'. It is then, in pursuit of such a differentiation strategy, that Chiquita recognizes that it needs to consult outside the company as a way to gain credibility with its initiative. Building an alliance with one (or more) NGOs was seen as a way to do so.

In 1992, two NGOs - the Rainforest Alliance and the local Fundacion Ambio (in Costa Rica) agreed to work together with the banana producer, Chiquita. The result of this collaboration was the 'Better Banana' project (BBP). Eight years later this certification scheme, now run by a network of NGOs coordinated by the Alliance, had become one of the largest eco-labeling initiatives in the world, certifying coffee, citrus fruits and bananas. More than 160 banana farms were certified by the Better Banana scheme, covering 120,000 acres in Ecuador, Colombia, Panama, Guatemala, Honduras and Costa Rica.

As a resut of their cooperation, Rainforest Alliance and Chiquita contend that since 1993 they have begun changing the face of tropical agriculture. The Better Banana project is now operated by the Conservation Agriculture Network - a group of Latin American NGOs - with Rainforest Alliance acting as the secretariat. The CAN is intended to expand the role of southern NGOs, and pluralise the NGO relationship with Chiquita.

7 Concluding remarks

The rise in the importance of the phenomena of Corporate Social Responsibility that has taken place in the last 15 or 20 years is inextricably linked to an increase in the transparency of the market and non-market behaviour of firms. This is not to say, of course, that there are no other important aspects that have also played a role in the expansion of CSR (e.g., an increase in the consciousness of the public in regards to environmental and other social issues), but informational issues are at the core of CSR. Accordingly, thus, our focus in this paper is the analysis of the role that informational transparency on the behaviour of the firm has in the incentives of firms to be

socially responsible.

We focus on the effect that a consciousness demand has in the incentives of firms to adopt 'green' technologies in their production activities. The adequate framework for our analysis is one with a demand by consumers of a good with credence attributes (that it is produced with a green technology). Since such an attribute is not directly observable by consumers, demand and willingness to pay must depend on some indirect information: in our set-up a signal that all consumers receive on regards to the technology used by the firm. This signal is a reduced form modelling of the information that consumers receive about firms. The first result in our paper is quite intuitive: the better the information available to consumers, the more consumers are willing to pay for a good labeled as 'green', and, accordingly, the more incentives firms have to adopt a 'green' mode of production. In addition to numerous anecdotal evidence, there is some empirical evidence in support of this intuitive result. In Dyck and Zingales (2002) it is shown that a higher diffusion of the press in a country (a construct of better available information to consumers on firms' practices) implies a higher responsiveness of firms towards environmental issues, that is, firms are more likely to be 'green'.[5]

In spite of our use of a reduced form modeling of the information available to consumers, we acknowledge that the availability of information to consumers on the firm's practices is endogenous, namely, it is dependent on many actors' behaviour. Such information is depedent not only on media behaviour (the press, TV), but also other parties interested behaviour, such as NGOs, activist shareholders and institutional shareholders, financial analysts, and the information provided by the firm itself. Acknowledging this, the second part of our analysis has endogenized the information available to consumers by allowing the firm to manipulate such information in a way that decreases the accuracy of the signal received. We show that, as a result of such manipulation capability, an equilibrium with socially responsible business practices becomes less likely. Since consumers know that the information they have is likely to have been manipulated, they are less willing to pay a premium for the supposedly 'green' product. Accordingly, a firm then has less

[5]See also Xia et al. (2008) for empirical evidence on the impact of media freedom in the adoption by firms (and the correpsonding global diffusion) if the environmental ISO 14001 certification.

incentives to adopt the (more costly) green mode of production.

More surprising, though, is the result that some of these firms end-up worse-off because of their possibility to manipulate the information provided to consumers. This is so because such manipulation possibility destroys a socially respsonsible equilibrium in which the firm provided the good with the credence attribute (green mode of production), and the consumer paid a premium price. As a consequence of the decrease in profits due to the manipulation possibilities, these firms would favor any measure that ties their hands and impedes them to manipulate the information; in other words, a measure that increases the transparency in the market regarding the firm's mode of production. A regulatory example of such a measure is the European Union Directive 1999/94/EC which requires car makers to inform consumers on fuel economy and CO2 emissions of each car. Such a Directive has the explicit aim both of increasing the consciusness of consumers and of allowing already conscious consumers to take their buying decisions in accordance to their preference, thus giving incentives to firms to sell less polluting cars.[6]

We, however, focus our analysis on a decentralized solution such as the observed partnerships between firms and NGOs. While acknowledging that such partnerships may serve several purposes, we provide a rationale behind such alliances in the way that an indpeendent adn reputable NGOs i capable of credibly certifying consumers that the information, eventhoguh maybe still noisy,has not been manipualetd by the firm. We show that when such partnerships become available to firms, the only intuitive (à la Cho-Kreps) perfect bayesian equilibrum in pure strategies is that in which such partnerships are formed with the purpose of firms to credibly and visibly commit in the eyes of consumers not to manipulate the information they receive. In such a way, transparency in the market is increased, and a socially responsible equilibrium becomes more likely. Examples of such partnerships abound in many industries, e.g., GAP and Verité, the multinaitonal fruit company Chiquita and Rainforest Aliance, Starbucks and Conservation International, etc.

[6]More specifically, the labelling Directive requires the display of a label on fuel consumption and CO2 emissions on all new cars, the publication of national guides on the fuel efficiency of new cars, the display of posters at the dealerships and the inclusion of fuel efficiency information in printed promotional literature.

A Appendix

Proof of lemma 1: As $\overline{F(\cdot)} = 1 - F(\cdot)$ is logconcave, $\pi(p, s)$ is quasiconcave on p (see Bagnoli and Bergstrom (2005)) and the optimal price is given by the first order condition

$$-f\left(\frac{p^*}{\Pr(C \mid s)\, G}\right) \cdot \frac{p^*}{\Pr(C \mid s)\, G} + 1 - F\left(\frac{p^*}{\Pr(C \mid s)\, G}\right) = 0$$

Taking $r = \frac{p}{\Pr(C|s)G}$, the solution is characterized by $r^* = \frac{[1-F(r^*)]}{f(r^*)}$. As r^* is a feature of the distribution F and it is independent of $\Pr(C \mid s)$ and p, we can characterize the optimal price and firm's posterior profits as functions of r^*.

$$p^*(s) = \Pr(C \mid s)\, G r^* \text{ and } \pi^*(s) = [1 - F(r^*)] \Pr(C \mid s)\, G r^*$$

■

Proof of lemma 2:

i) The expected profits of the strategic firm in the socially responsible equilibrium are:

$$\pi(T = C) = \pi_C^*(s_C) - F = \frac{(1+s)\Pi}{2 - \gamma(1-s)} - F$$

if we take the derivate over the accuracy of the signal γ, we obtain:

$$\frac{d\pi(T = C)}{d\gamma} = \frac{-(1-s)(1+s)\Pi}{(2 - \gamma(1+s))^2} > 0$$

- ii) The expected profits of the strategic firm in the not socially responsible equilibrium are:

$$\pi(T = D) = (1-\gamma)\pi_D^*(s_C) = \frac{(1-\gamma)(1-s)\Pi}{2 - \gamma(1+s)}$$

if we take the derivate over the accuracy of the signal γ, we obtain:

$$\frac{d\pi(T = D)}{d\gamma} = \frac{-(1-s)(1-s)\Pi}{(2 - \gamma(1+s))^2} < 0$$

■

Proof of Proposition 1: The characterization of the equilibrium depends on the both condition stated in the main text.

$$\begin{aligned} \gamma\pi_C^*(s_C) &= \frac{\gamma(1+s)\Pi}{2 - \gamma(1-s)} \geq F, \\ \gamma\pi_D^*(s_C) &= \frac{\gamma(1-s)\Pi}{2 - \gamma(1+s)} < F. \end{aligned}$$

Notice that as $\gamma \in [0,1]$, $\pi_C^*(s_C) - \pi_D^*(s_C) = \frac{4s(1-\gamma)\Pi}{(2-\gamma(1-s))(2-\gamma(1+s))} \geq 0$. In particular, $\pi_C^*(s_C) > \pi_D^*(s_C)$ if $\gamma < 1$, and the profits' difference converges to 0 when $\gamma = 1$. Moreover, $\pi_C^*(s_C)$ and $\pi_D^*(s_C)$ are increasing on γ. These results implies that if $\Pi > F$, there exist two values of γ, $\gamma^* < \gamma^{**}$ such that, for $\gamma < \gamma^*$ only the condition $\gamma\pi_D^*(s_C) < F$ holds, whereas for $\gamma > \gamma^{**}$ only the condition $\gamma\pi_C^*(s_C) < F$ is satisfied. For intermediated values of γ, both conditions hold. ■

Proof of Proposition 1: $\Pi' = [1 - F'(r^{**})] Gr^{**}$ where $r^{**} \in \arg\max\{[1 - F'(r)] Gr\}$. Notice that

$$\Pi' = [1 - F'(r^{**})] Gr^{**} \geq [1 - F'(r^*)] Gr^* \geq [1 - F(r^*)] Gr^* = \Pi.$$

This implies that, $\pi_C'^*(s_C) = \frac{(1+s)\Pi'}{2-\gamma(1-s)} \geq \pi_C^*(s_C) = \frac{(1+s)\Pi}{2-\gamma(1-s)}$. For the same token, $\pi_D'^*(s_C) \geq \pi_D^*(s_C)$. The proposition follows for the previous results and the equilibrium conditions. ■

Proof of Corollary 1: Given that the size of the market of the clean firm is fixed $r^* = \frac{[1-F(r^*)]}{f(r^*)}$. Surplus only depends of the likehood of implementing the clean tegnology. Hence the results are just an application of Propositions 1 and 1. ■

Proof of lemma 3: As the non strategic type with $F = \infty$ will manipulate, the value of a good signal, $\pi_C^*(s_C)$, decreases from $\frac{(1+s)\Pi}{2-\gamma(1-s)}$ to $\frac{(1+s)\Pi}{2-\gamma'(1-s)}$. Moreover, manipulation make more attractive to deviate since the good signal is more likely, then the condition of the equilibrium becomes:

$$\pi_C^*(s_C) - F \geq \Pr(s_C \mid D)\, \pi_C^*(s_C) = (1 - \gamma')\pi_C^*(s_C)$$

then

$$\gamma'\pi_C^*(s_C) = \frac{\gamma'(1+s)\Pi}{2 - \gamma'(1-s)} \geq F$$

This condition is more dificult to safisfied that $\frac{\gamma(1+s)\Pi}{2-\gamma(1-s)} \geq F$, because $\frac{\gamma(1+s)\Pi}{2-\gamma(1-s)} \geq \frac{\gamma'(1+s)\Pi}{2-\gamma'(1-s)}$

Proof of lemma 1:Take for example the limit firm with fixed cost equal to $\frac{\gamma'(1+s)\Pi}{2-\gamma'(1-s)} + \varepsilon$. the payoff of this firm in the clean equilibria is $\frac{(1+s)\Pi}{2-\gamma(1-s)} - \frac{\gamma'(1+s)\Pi}{2-\gamma'(1-s)}$which is higher than its payoff in the dirty equilibrium $\frac{(1-\gamma')(1-s)\Pi}{2-\gamma'(1+s)}$

$$\frac{(1+s)\Pi}{2-\gamma(1-s)} - \frac{\gamma'(1+s)\Pi}{2-\gamma'(1-s)} > \frac{(1-\gamma')(1+s)\Pi}{2-\gamma(1-s)} > \frac{(1-\gamma')(1-s)\Pi}{2-\gamma'(1+s)}$$

The last inequality, follows from

$$\frac{(1-\gamma')(1+s)\Pi(2-\gamma'(1+s))}{(2-\gamma(1-s))(2-\gamma'(1+s))} > \frac{(1-\gamma')(1-s)\Pi(2-\gamma(1-s))}{(2-\gamma'(1+s))(2-\gamma(1-s))}$$

Then

$$(1+s)(2-\gamma'(1+s)) > (1-s)(2-\gamma(1-s))$$

which simplifies to

$$2(1+s)-\gamma'(1+2s+s^2) > 2(1-s)-\gamma(1-2s+s^2)$$

and finally

$$(\gamma-\gamma')(1+s^2)+2s(2-\gamma'-\gamma) > 0$$

This is true given that $1 \geq \gamma > \gamma'$. ■

Proof of lemma **??**: In order to rule out the partially separating equilibrium (given that we have two possible strategies and three types) we have to consider six cases. Consider that $F=0$ chooses C and the other two types choose NC. This cannot be an equilibrium since if the strategic type in equilibrium chooses a dirty technology, then $P(C|s_C, NC)=0$ and both types are willing to mimic $F=0$, if the strategic type chooses a clean technology, then it would increases its profits by choosing C. Trivially, if $F=0$ chooses NC and $P(C|s_C, NC)=1$ and the other two types C, the other two types are better by deviating. If $F=\infty$ chooses a different type of the other two, the posterior belief and its profits will be 0, and then, $F=\infty$ would be better by deviating. Finally, if the strategic type choose a different strategy than the other two, there are two possibilities. First, the strategic type chooses a clean technology, then $P(C|s_C, d_T)=1$ and $F=0$ would prefer to mimic the strategic type. Second, the strategic type chooses a dirty technology but then, the posterior belief and its profits will be 0, and then the strategic type would be better by deviating.

Finally, the pooling equilibrium on any strategy C and NC is always an equilibrium because we can have arbitrary believes out of the equilibrium path, in particular $\lambda_{F=\infty}(., s_C)=1$. ■

Proof of lemma **??**:f022 The pooling equilibrium in which all the types choose C, posterior believes on equilibrium path are equal to priors believes and the belief out of the equilibrium

path is $\lambda_{F=\infty}(NC,.) = 1$, is a perfect Bayesian equilibrium and satisfies the intuitive criterion of Cho-Kreps. The first part, is direct because independently of the realization of the signal, the profits of the firm when choosing NC are 0. Then, all the types prefer C to NC. Moreover, this equilibrium satisfies the Cho-Kreps criterion since the maximum payoff of type $F = \infty$ are achieved with NC and $\lambda_{F=0}(NC,.) = 1$, then we cannot rule out the belief $\lambda_{F=\infty}(NC,.) = 1$.

The pooling equilibrium in which all the types choose NC, posterior believes on equilibrium path are equal to priors believes and the belief out of the equilibrium path is $\lambda_{F=\infty}(C,.) = 1$, is a perfect Bayesian equilibrium but for some parameters does not satisfy the intuitive criterion of Cho-Kreps. In particular, consider that parameters are such that the strategic type chooses clean technology and does not have incentives to manipulate. Then, the equilibrium payoff of the $F = \infty$ type on the equilibrium path is $\frac{(1-\gamma')(1+s)\Pi}{2-\gamma'(1-s)}$. Then, if $\frac{(1-\gamma')(1+s)\Pi}{2-\gamma'(1-s)} > (1-\gamma)\Pi$, type $F = \infty$ will be better in the equilibrium path than choosing C with the most favorable belief $\lambda_{F=0}(C,.) = 1$. This rule out $\lambda_{F=\infty}(C,.) = 1$ and consequently the previous pooling equilibrium. ■

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