ON FIRM INVESTMENT IN INNOVATION AND CSR
IN THE PRESENCE OF ACTIVISTS*

by

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Abstract

Defining firm investment in reduction of damages generated in the process of innovation as a form of corporate social responsibility (CSR), the paper identifies the determinants of such CSR investment, the emergence of an activist group and welfare consequences. It demonstrates that the presence of an activist group motivates CSR. The higher the innovation profit, the lower the CSR. An activist group emerges only if the innovation profit is high but the social costs of innovation and the fixed costs of activist group formation are not too high. Finally, CSR investment may not always improve welfare in the innovation context.

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1. INTRODUCTION

Since the last three decades, the systematic investment of firms in the creation of product innovations has dramatically increased, especially in knowledge intensive sectors like biotechnology, microelectronics, telecommunications and new materials. Even while such innovations have increased societal welfare and firm profit, in many cases they have also generated social damages in the process. For instance, firm investment in new product creation has provoked social costs in the form of trials and experiments with uncertain effects[1], risked changing age-old practices[2], caused civic strife because of relocation[3], destroyed natural environments[4] etc. In response, the State may or may not be able to take rectifying actions because of imperfect information about the damage[5], a lack of adequate infrastructure to enforce regulations that preempts the damage[6], or political compulsion from vested interests to overlook the damage[7]. In the above context, two empirical puzzles beg for more study and understanding. First, why do some innovating firms spend more on CSR than others? For instance, why is a relatively innocuous innovating firm like Yves Rocher spending so systematically on CSR in relation to innovation, while other similar firms do not? Second, why do activists go after some innovators and not others? In this case, we may again ask, why are activists so intensely pursuing Monsanto but not other major biotech innovators like Genentech? The present paper hopes to develop some answers and give insight on such questions by examining the rationale for firms to invest in CSR, in the presence of activists who may or may not confront the firm.

Consumers who are concerned by the socio-economic or environmental damages that could be caused by the innovation strategy of firms often turn to activists to press for their compensation, as they may not be sufficiently organized to enforce a Coasian bargaining. In such contexts, while striving to innovate, firms may undertake voluntary investment, beyond compliance to existing regulations, in order to reduce any damage engendered. Defining such investment as a form of corporate social responsibility (CSR)[8], the present paper examines its rationale and determinants, while providing some insight on the strategies of activists as well, as a function of the innovation strategy of firms.

To address the above issues, a two-player game, with a firm and an activist is developed. Two contrasting cases are considered to measure the rationale and impact of CSR: one in which the firm does not practice CSR; and another in which the firm practices CSR. Indeed, since the incorporation of CSR into firm strategy is a relatively recent phenomenon, we examine both the traditional firm, which chooses its innovation effort to maximize its expected profit, and the modern firm, which is aware of the potential of CSR investment. In both cases, the firm faces a self-less activist group that is aware of the magnitude of the potential damage and fights on behalf of consumers for compensation. However, the activist group may or may not be able to prove that damages have been incurred. If the damages are proved, either the firm compensates the victims the full amount of the damage in an out of court settlement, or the activist group takes the firm to the court, which directs the firm to pay the same amount of compensation to the victims.

In the second scenario, the rationale for CSR investment is examined assuming that the firm can reduce the social damages provoked by its innovation strategy through investment in CSR. Such CSR has a positive opportunity cost, because in its absence, this effort would have been diverted to innovation creation, to increase the expected profit. Moreover, the CSR investment also has a direct impact on the efforts of the activist group, because then the firm shares the responsibility of looking after the welfare of consumers with them.

In economics, there are two strands in the existing literature on CSR. The first starts from the premise that the CSR motivation of the firm is grounded in a sense of reciprocity to society or is a form of pure philanthropy (e.g. Baron, 2007; Besley and Ghatak, 2007). The second treats CSR as a strategic investment of the firm either to pre-empt the actions of competitors (Bagnoli and Watts, 2003; Arora and Gangopadhyay, 1995) or regulators (Maxwell, Lyon and Hackett, 2000) or activists (Baron and Diermeier, 2007) or hostile share-holders (Cespa and Cestone, 2007). This paper clearly aims to make a contribution to this second strand, examining a case where the firm invests in CSR in order to reduce the demand for compensation from activists.

In the strategic CSR literature, there is a distinction between 'private politics' and 'public politics' games. The former only involves confrontation between the activist group and the firm (e.g. Baron, 2003; Baron and Diermeier, 2007), while the latter includes public institutions as well. For instance, Maxwell, Lyon and Hackett (2000) illustrate an example of 'public politics', where a firm practices CSR by reducing pollution emission to a low enough level such that the regulator is forced to opt for a milder pollution standard than that recommended by the activists[9]. Our paper can be

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considered as a bridge between these two sub-varieties of games. It involves a public institution, namely the court, but the court is relegated to being a non-strategic player. The role of the court is limited to upholding and enforcing the demand for compensation of the activist group, provided that the activist group produces sufficient, verifiable evidence, as proof of the damage caused. Therefore, there is no scope for lobbying, making our game one of 'private politics', but including a non-strategic public player.

The contribution of the present paper to the literature on CSR as a strategic investment in the context of innovation can be summarized as follows in terms of its main results, some of which are counter-intuitive.

First, the paper demonstrates that when the innovation profit is either very high or very low, the firms are not likely to engage in CSR. However, if the potential social damage is very high, whatever the innovation profit, firms will not invest in innovation either. Even in the presence of activists, when innovation value is high, the trade-off for the firm, between innovation investment and CSR, may favour the former. When innovation profit is low, there is no threat from the activist group, and hence, there is little or no CSR investment in this case too.

Second, the paper throws some light on the oft-asked question: why do so many innovations creating social damage go unnoticed by the activists, while others invite strong protests from international networks of activists? According to this paper, it is rational for activists to focus on innovations that have the potential to generate a high consumer surplus for end-users as well high profit for firms. The social damage caused by innovations plays a double role. If it is very high, it might deter the creation of the activist group itself, as it increases the loss from risk of failure to claim compensation. On

the other hand, if the damage by the innovation is very small, it lowers the incentive of activists to press for compensation. Thus, radical innovations are more likely to attract activists than incremental ones.

Third, the paper questions some empirical truisms on CSR investment and social welfare, in the context of innovation. For instance, it is usually assumed that high investment in CSR by innovating firms is beneficial to society, while low CSR is to be chastised. However, in contrast, we show that there are contexts, where a firm's CSR investment reduces the welfare of society, while under other circumstances, lowering CSR is indeed better. Thus, the paper advocates a public policy that does not uniformly press innovating firms to invest in CSR; it might be worthwhile to consider some sectoral distinctions.

Fourth, the model indicates that the inclusion of CSR investment as part of the innovation strategy of firms is deeply motivated by the presence of activists and the risk of compensation payment for any negative externalities generated. Thus, the model calls for the promotion of public policies that seek to protect 'whistle blowers' such that dialogue with activists may be promoted.

The above results thus offer a number of hypotheses that can be tested on real case studies. For instance, the factors that increase innovation profit such as lower product market competition, stronger IPR, high market entry barriers etc. are likely to lower the strategic CSR practised by the firm. From the demand side, the longer is the previous history of confrontation with activists, the greater are the incentives for CSR investment.

The originality of the paper therefore lies not only in its theoretical results on CSR investment in the context of technological innovation, but also in the testable hypotheses yielded by the model, and the insight provided on the innovation strategies of firms in knowledge intensive sectors.

The paper is organized as follows. Section 2 presents the theoretical model. Section 2.1 examines the strategy of the innovating firm without CSR investment, followed by section 2.2, which looks at the CSR practicing firm. Then section 2.3 compares the welfare level of the CSR equilibrium with that of the no-CSR equilibrium. Section 3 presents the testable hypotheses yielded by the model, some brief supporting case studies and inferences for policy. Section 4 concludes.

2. THE MODEL

Consider a firm that is contemplating investment in the creation of an innovation that can produce consumer surplus, but can also generate some negative externalities in the form of social damages. For instance, in the case of genetically modified (or GM) seeds, even before their commercialization, protests were initiated by activists on account of the potential damage that could be caused to the environment through contamination. Field trials of GM crops are still not permitted in all crops in many countries because of such contentions. Similarly, in nanotechnology there is a fear that the process of innovation creation could capture important natural resources like water to the detriment of consumers and the environment. Another example that is widely debated is that of outsourcing of clinical trials for the development of new drugs to developing countries, where the poverty pressure could lead to the poor being used as guinea pigs. In such

cases, activists protest from the start because of the potential damage that could be caused by the process of innovation creation as well as its possible commercialization, should the R&D efforts of the firm bear fruit. However, the firm can attempt to reduce the negative externalities caused by investing in CSR as part of its innovation strategy.

To model these two contexts, we develop two simple sequential games. In the first game, the firm starts by deciding its innovation effort and then the activist group chooses its effort level to press for compensation and the game ends. There is no consideration of CSR. In the second game, the firm again moves first, dividing its effort between R&D investment and CSR investment to reduce potential damage; and as before, the activist group follows with its effort level and the game ends.

2.1 INNOVATION STRATEGY WITHOUT CSR

Consider a firm that has to choose an innovation effort level $e_i \in [0, 1]$, say in the form of R&D investment in a particular range in order to create an innovation. The higher is the innovation effort, e_i, the higher is the probability of success $\alpha(e_i) \in [0,1]$. For simplicity let us assume $\alpha(e_i) = e_i$. However, effort does not come without a cost. We make the standard assumption that the R&D costs function $g(e_i)$ is convex, i.e. $g(0) = 0$, $g'(e_i) > 0$, $g''(e_i) > 0$ and as $e_i \to 0$, $g'(e_i) \to 0$, as $e_i \to 1$, $g'(e_i) \to \infty$.

The innovation if successfully created generates a profit of $V > 0$ for the firm and a consumer surplus of $C > 0$ for the consumers. At the same time, the innovation process engenders a social cost $D > 0$, independent of whether or not the firm is ultimately successful in bringing the innovation to the final market. The firm is aware of this, as well as a few knowledgeable consumers. We assume D is independent of e_i[10].

Let us suppose that the government either does not have information about the damage or even if it knows about the damage, cannot preempt it due to lack of adequate regulatory infrastructure, lack of enforcement capabilities or pressure from lobbying by vested interests. Therefore, there is a selfless activist group or NGO in this midst to protect the interests of consumers. Furthermore, let us assume that the activist group comes to know about the social cost D costlessly, due to complaints made by the conscious consumers[11]. With this information, it mobilizes the consumers and represents them in their demand for compensation. If the damages are proved, either the firm compensates the victims to the full amount of the damage D in an out of court settlement, or the activist group takes the firm to the court, which directs the firm to pay the same amount of compensation to the victims.

With the objective of maximizing the expected surplus of the consumers, the self-less activist group chooses an effort level $e_d \in [0,1]$ to prove damages. Let the probability of success β be such that $\beta(e_d) = e_d$. Furthermore, let the costs of supplying the effort e_d be given by $\phi(e_d) = A + h(e_d)$, where $A > 0$ denotes the fixed cost of operation for the activist group that is collected from the society itself. The value of A depends on the factors like the start-up costs in the legal system, the cost of communicating to the consumers etc. We also assume the function $h(e_d)$ is convex, i.e. $h(0) = 0$, $h'(e_d) > 0$, $h''(e_d) > 0$ and as $e_d \to 0$, $h'(e_d) \to 0$, as $e_d \to 1$, $h'(e_d) \to \infty$. Moreover, all the higher order derivatives of $h(e_d)$ are assumed to be zero. If the activist group succeeds, the firm is forced to compensate D to the consumers, irrespective of whether or not the firm succeeds in commercializing the innovation.

The game proceeds as follows. First the firm decides its effort e_i , then the activist group decides its effort e_d [12]. Then four outcomes are possible: (i) with probability $e_i(1-e_d)$, the firm successfully innovates and escapes the payment of the compensation; (ii) with probability $e_i e_d$, the firm successfully innovates, but is forced to pay the compensation; (iii) with probability $(1-e_i)(1-e_d)$, the firm fails to innovate but manages to escape compensation payment; and finally (iv), with probability $(1-e_i)e_d$ the firm fails to innovate and on top of this failure, is forced to pay for the potential damage as well. The parameters *V*, *C*, and *D* and the functional forms of $\alpha(.) \; \beta(.) \; g(.) \; h(.)$ are assumed to be common knowledge.

The expected payoff functions of the two players of the game can now be described.

The expected payoff of the firm, $\pi_f(e_i, e_d)$ assuming that it is risk neutral, is the expected net profit from innovation effort. In other words:

$$\pi_f(e_i, e_d) = e_i(1-e_d)V + e_i e_d(V-D) + (1-e_i)e_d(-D) - g(e_i). \tag{1}$$

On simplification, the above expression of π_f yields:

$$\pi_f = e_i V - e_d D - g(e_i). \tag{2}$$

Given our assumption that the NGO is self-less, the expected payoff of the activist group is simply the expected returns to the consumer net of the effort cost. Again, assuming risk neutrality, the activist group's expected payoff, π_a , can be expressed as:

$$\pi_a(e_i, e_d) = e_i(1-e_d)(C-D) + e_i e_d C + (1-e_i)(1-e_d)(-D) - A - h(e_d). \tag{3}$$

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The above equation reflects the fact that whenever the activist group is unsuccessful, consumers bear the loss of D, but whenever the activist group is successful the consumers are compensated for entire amount of the social damages generated.

In turn equation (3) can be simplified as:

$$\pi_a = e_i C - D(1 - e_d) - A - h(e_d). \tag{4}$$

Note that π_a also represents the expected consumer welfare from the innovation.

Since the players move sequentially in this game and the activist group can observe the effort level chosen by the firm before it chooses its own effort level, we solve the game using the method of backward induction. So, first we solve the activist group's problem. The activist group maximizes the expected surplus of the consumers, π_a by choosing an appropriate value of e_d. Since $D > 0$ and as $e_d \to 0$, $h'(e_d) \to 0$, as $e_d \to 1$, $h'(e_d) \to \infty$, an interior solution e_d^* exists for the activist group's problem. At e_d^*, $\frac{\partial \pi_a}{\partial e_d} = 0$ such that:

$$h'(e_d^*) = D. \tag{5}$$

The assumption $h''(e_d) > 0$ ensures that at e_d^* the second order condition for payoff maximization is also satisfied. From equation (5) it can be noted clearly that e_d^* is a function of nothing else but D i.e. whatever value of e_i is chosen by the firm the optimum reaction of the activist group is the play of e_d^* as in (5).

While choosing e_i at the initial stage of the game, the firm can foresee that the dominant strategy of the activist group is to play e_d^* as in (5). However, in absence of

any concern about CSR the firm does not try to control D. It simply maximizes π_f by choosing an optimal value of effort, e_i. Since $V > 0$ and as $e_i \to 0$, $g'(e_i) \to 0$, as $e_i \to 1$, $g'(e_i) \to \infty$, an interior solution e_i^* exists for the firm's optimization problem. At e_i^*, $\dfrac{\partial \pi_f}{\partial e_i} = 0$ and the following equation holds:

$$g'(e_i^*) = V. \tag{6}$$

Furthermore, the assumption that $g''(e_i) > 0$ ensures that at e_i^* the second order condition for maximization is also satisfied.

Clearly, (e_i^*, e_d^*) as in (5) and (6) are the dominant strategies of the firm and activist group respectively at the interior equilibrium. The independence of each player's equilibrium strategy of the other player's choice is a natural consequence of the fact that we are considering a situation without CSR. Here, while choosing e_i^* the firm can foresee that the choice of e_d^* by the activist group in the next period depends on D as follows:

$$\frac{de_d^*}{dD} = \frac{1}{h''(e_d^*)} > 0 \qquad \text{(from equation (5))}. \tag{7}$$

However, the firm it refrains from making any investment that can reduce the value of D. The strategic interdependence is obtained once we allow the firm to consider an innovation strategy with CSR investment that reduces D. We discuss the case of strategic interdependence in further details in the next subsection.

Indeed, equation (7) implies that as the social cost D rises, the effort supplied by the activist group in accumulating hard evidence, e_d, also rises, leading to a higher

probability of the consumers being entirely compensated. Finally, since e_i^* is a function of only V, from equation (6) we have:

$$\frac{de_i^*}{dV} = \frac{1}{g''(e_i^*)} > 0. \tag{8}$$

This in turn implies that as the innovation profit increases, both the firm's innovation effort and the probability of successful innovation rise.

At equilibrium, the expected profit level of the firm π_f^* and the expected surplus of the activist group π_a^* are determined by the choices of both the firm and the activist group as:

$$\pi_f^* = e_i^* V - e_d^* D - g(e_i^*) \tag{9}$$

$$\pi_a^* = e_i^* C - A - (1 - e_d^*)D - h(e_d^*). \tag{10}$$

According to the above, the firm will undertake investment in innovation with $e_i^* > 0$, if and only if $\pi_f^* > 0$. Similarly, the activist group will fight against the corresponding innovation strategy of the firm and invest effort of $e_d^* > 0$ to gather hard evidence on the social damages that could be generated, if and only if $\pi_a^* > 0$. When will these happen? We turn to this question now.

PROPOSITION 1: (i) *While R&D effort e_i^* increases with the magnitude of innovation profit, V, the firm invests in innovation if and only if the potential damages are limited, i.e. $D < \hat{D}$, where $\hat{D}$ is such that $\pi_f^*(\hat{D}) = 0$.*

(ii) In the absence of an activist group, there is no incentive for a firm to undertake CSR investment.

Proof. (i) That R&D effort e_i^* increases with V is directly inferred from equation (8). The interesting feature of this proposition, however, is the fact that it is the magnitude of the potential damage, D, that determines whether the firm will initiate R&D effort in the first place.

Taking the derivative of π_f^* with respect to D and using equation (7) we have:

$$\frac{d\pi_f^*}{dD} = -e_d^*(D) - D\frac{de_d^*(D)}{dD} < 0. \tag{11}$$

In other words, π_f^* is a decreasing function of D. In addition, note that $\pi_f^* \to (e_i^* V - g(e_i^*)) > 0$ as $D \to 0$ and $\pi_f^* \to -\infty$ as $D \to \infty$. Therefore, there exists a value of $\hat{D} > 0$ such that $\pi_f^*(\hat{D}) = 0$ and for all $D < \hat{D}$, $\pi_f^*(D) > 0$.

(ii) In the absence of the activist group $e_d^* = 0$. In that situation, if $e_i^* > 0$, the payoff of the firm becomes $\bar{\pi}_f = e_i^* V - g(e_i^*) > 0$. Since, $\bar{\pi}_f$ is independent of D, the firm does not need to be concerned about the magnitude of the social cost it generates in the process of innovation creation. However, if an activist group exists, from equation (11) we know that lowering damages D improves the expected profit π_f^* for the firm. This happens because of two reasons. First, a lower damage, D, implies a lower expected compensation payment by the firm. Second, by equation (7), a lower damage, D, also means a lower effort on the part of the activist group to collect hard evidence and therefore, a lower

probability of paying compensation. Hence, there is an incentive for the firm to practice CSR as part of its innovation strategy.

PROPOSITION 2: *(i) There exists minimum levels of consumer surplus, $\underline{C}$, and firm profit, $\underline{V}$; and maximum levels of damages, $\overline{D}$, and costs of creation of activist group, $\overline{A}$, such that an activist group emerges to champion the cause of consumers against an innovating firm with $e_d^* > 0$ if and only if : $C > \underline{C}, V > \underline{V}$, $D < \overline{D}$ and $A < \overline{A}$.*

(ii) The lower the social costs generated by the innovation, D, the smaller the effort, e_d^*, put in by the activist group.

(iii) The lower the fixed costs of creating the activist group, A, the greater the social damages, D, that is pursued.

(iv) If at A=0, the functions π_f^* and π_a^* are such that $\hat{D} < \overline{D}$, then there exists a $\overline{A} > 0$ such that $\hat{D} = \overline{D}$. Then for $A > (<) \overline{A}$, $\overline{D} < (>) \hat{D}$.

Proof. (i) Now π_a^* cannot be positive unless $e_i^* C > A$, since the other two terms defining π_a^* are negative. Again as $\dfrac{de_i^*}{dV} > 0$, it means that the profit generated, *V*, and the consumer surplus generated, *C* must be sufficiently high and greater than the fixed costs of the activist group, *A*, so that it can champion the cause of consumers. Then, taking the derivative of π_a^* with respect to *D* we have:

$$\frac{d\pi_a^*}{dD} = e_d^*(D) + D\frac{de_d^*(D)}{dD} - 1 - \left(\frac{dh}{de_d}\right)\left(\frac{de_d^*(D)}{dD}\right).$$

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By equation (5) the above becomes:

$$\frac{d\pi_a^*}{dD} = e_d^* + D\frac{de_d^*}{dD} - 1 - D\left(\frac{de_d^*}{dD}\right) = e_d^* - 1 < 0$$

By the above, for any given configuration of *V*, *C* and *A*, π_a^* is a decreasing function of *D*. Therefore, if $e_i^*C > A$, $\pi_a^* \to (e_i^*C - A) > 0$ as $D \to 0$ and $\pi_a^* \to -\infty$ as $D \to \infty$, such that there exists a damage value $\bar{D} > 0$ with $\pi_a^*(\bar{D}) = 0$. Thus, when $e_i^*C > A$ *and* $D < \bar{D}$ the expected payoff from investment in effort is positive for the activist group and the proposition holds.

(ii) This follows directly from equation (7).

(iii) When *A* increases then π_a^* shifts down ceteris paribus, and thereby $\bar{D}$ also decreases by definition of π_a^* and $\bar{D}$.

(iv) This proposition essentially permits us to understand the impact of social damages on the strategies of the firm and the activist group. If at *A*=0, the functions π_f^* and π_a^* are such that $\hat{D} > \bar{D}$, nothing can be predicted. However, at *A* = 0 if $\bar{D} > \hat{D}$, then there exists a $\bar{A} > 0$ such that $\hat{D} = \bar{D}$, because $\bar{D}$ is a decreasing function of *A*, and $\hat{D}$ independent of *A*. By the same logic, for $A > (<) \bar{A}$, $\bar{D} < (>) \hat{D}$.

The two propositions enable us to describe the sub-game perfect Nash equilibria of the game without CSR, when both the firm and the activist group play their dominant strategies.

PROPOSITION 3: *There are three possible sub-game perfect Nash equilibria.*

- *If $D > \hat{D}$, then both firm and activist group choose zero effort, i.e. $e_i^* = e_d^* = 0$.*

- *If $\bar{D} < D < \hat{D}$, then only the firm will choose positive investment effort, i.e. $e_i^* > 0; e_d^* = 0$.*

- *Both the firm and the activist group will choose positive effort, i.e. $e_i^* > 0; e_d^* > 0$, if and only if $e_i^* C > A$ and $D < \min\{\hat{D}, \bar{D}\}$, where $\hat{D}$ and $\bar{D}$ are such that $\pi_f^*(\hat{D}) = 0$ and $\pi_a^*(\bar{D}) = 0$ respectively.*

Proof. These follow directly from propositions 1 and 2 and they clearly explain the influence of the social costs D on the equilibrium strategy profile. There are three possibilities. First, the firm can give up on innovation creation and the activist group need not emerge. This happens, when $D > \hat{D}$ and the game is not played at all. Second, the firm may engage in innovation but the activist firm need not emerge. For instance, when $D < \hat{D}$, even if the profit and consumer surplus generated are very high such that $e_i^* C > A$, if $\bar{D} < D < \hat{D}$ then only the firm will invest effort in innovation, but the activist group will not be able to emerge. And by proposition 2, this situation of $\bar{D} < \hat{D}$ can arise when the fixed costs of starting an activist group is significantly high i.e. $A > \bar{A}$. Here, again there is no game, as only the firm is involved. Third, whenever the cost and profit configurations correspond to those described in propositions 1 and 2 to induce positive efforts, both the firm and the activist group participate in the game.

This completes our analysis of the no-CSR situation. Now, we turn to our attention to the firm, which innovates and invests in CSR as well. In order to understand the

determinants of CSR investment as part of an innovation strategy, for the rest of the analysis, we assume that the necessary and sufficient conditions for the existence of equilibrium with positive efforts invested by both players, as given in propositions 1 and 2 hold. In other words, in what follows, we focus on situations where the activist group exists while the firm innovates, so that the latter also has an incentive to practice CSR.

2.2 INNOVATION STRATEGY WITH CSR INVESTMENT

In the previous section, we have shown that if the activist group exists, the lowering of the social cost raises the expected profit of the firm from the innovation, as it not only lowers the payment of the firm if the damage is proved, but also lowers the activist group's effort to search for hard evidence of the damage. This motivates the firm to invest effort in lowering the social cost of innovation, which we define as a CSR activity.

In order to model this scenario, we modify the game discussed in the previous section. Now the firm moves first, choosing an innovation effort e_i and a CSR effort e_c such that $(e_i + e_c) \in [0,1]$. The CSR effort e_c reduces the extent of damage D caused by the creation and commercialization of the innovation, i.e. $\dfrac{dD}{de_c} < 0$. The firm tries to pre-empt the effort e_d put in by the activist group in the next period. The payoff functions of the firm and the activist group are given below (following the same logic as equations (2) and (4)):

$$\tilde{\pi}_f = e_i V - e_a D(e_c) - g(e) ; \quad \tilde{\pi}_a = e_i C - D(e_c)(1 - e_d) - A - h(e_d). \tag{12}$$

This leads us to identify the sub-game perfect Nash equilibrium of the game and the determinants of the CSR strategy at equilibrium, as follows.

PROPOSITION 4: *(i) If the CSR investment has a significant impact in bringing down the social costs of innovation then the firm will invest in CSR in the continuing presence of activists; i.e. there exists a lower limit L such that if $\dfrac{d^2 D}{de_c^2} > L$, then $e_c^* > 0$ and $e_i^* > 0$.*

(ii) At an interior equilibrium, the higher the innovation profit, V, the higher the firm's investment in innovation, e_i^*, and the lower its investment in strategic CSR, e_c^*.

Proof. (i) The optimization problem of the firm consists of choosing an appropriate combination (e_i, e_c) such that its expected profit with CSR investment, $\tilde{\pi}_f$, is maximized subject to the to the constraint $e_i + e_c = e \leq 1$. This gives the Lagrange expression for the constrained optimization problem of the firm as follows, where $\lambda \geq 0$ represents the Lagrange multiplier.

$$\underset{(e_i, e_c, \lambda)}{Max} \quad \Phi = e_i V - e_d D(e_c) - g(e) + \lambda[1-e].$$

The activist group chooses an effort level $\tilde{e}_d$ such that the first order condition is satisfied, i.e. $h'(\tilde{e}_d) = D$ and an interior solution exists satisfying the second order conditions for payoff maximization given our assumptions on $h(.)$. Again, their effort level increases with the damages caused since $\dfrac{de_d}{dD} = \dfrac{1}{h''(\tilde{e}_d)} > 0$.

Suppose $(\tilde{e}_i, \tilde{e}_c, \tilde{\lambda})$ solves the firm's problem corresponding to an optimal effort of activist group $\tilde{e}_d$. Given our assumption that as $e \to 1$, $g'(e) \to \infty$ in any equilibrium with positive innovation and CSR efforts, $\tilde{e}_i > 0$, $\tilde{e}_c > 0$ we will have $\tilde{e}_i + \tilde{e}_c = \tilde{e} < 1$ such that $\tilde{\lambda} = 0$. The new damage level will be $\tilde{D} = D(\tilde{e}_c)$. In such a situation, the Kuhn-Tucker conditions for the firm's payoff maximization imply that the following equations must hold:

$$V - g'(\tilde{e}) = 0. \tag{13}$$

$$-\frac{dD}{de_c}[\tilde{e}_d + D(\tilde{e}_c)\frac{d\tilde{e}_d}{dD}] - g'(\tilde{e}) = 0. \tag{14}$$

For satisfaction of the second order condition, it is essential that:

$$-\left[\left(\tilde{e}_d + D(\tilde{e}_c)\frac{d\tilde{e}_d}{dD}\right)\frac{d^2D}{de_c^2} + 2\left(\frac{dD}{de_c}\right)^2\frac{d\tilde{e}_d}{dD}\right] - g''(e) < 0.$$

We already know that $\frac{d\tilde{e}_d}{dD} > 0$ and $g''(e) > 0$. Therefore, if $D(e_c)$ is a convex function with $\frac{d^2D}{de_c^2} > 0$, then an interior solution satisfying the second order conditions will always be found for the first term of the above expression within brackets will be positive. Furthermore, even if the function $D(e_c)$ is concave, i.e. $\frac{d^2D}{de_c^2} < 0$, if $\frac{d^2D}{de_c^2}$ is not sufficiently negative to outweigh all other positive terms in the first term, we can have an interior solution[13]. Therefore, for any given configuration of parameters, a lower limit L

exists such that if $\dfrac{d^2 D}{de_c{}^2} > L$, i.e. if $D(e_c)$ is convex or slightly concave, there will be an interior solution with satisfaction of the second order condition for profit maximization. Hence, the proposition holds.

(ii) Taking the derivative of equation (13) with respect to V we get:

$$1 - \frac{d^2 g}{de^2}\left[\frac{d\tilde{e}_i}{dV} + \frac{d\tilde{e}_c}{dV}\right] = 0.$$

Similarly taking the derivative of equation (14) with respect to V we get:

$$\frac{d}{dV}\left[-\frac{dD}{de_c}[\tilde{e}_d + D(\tilde{e}_c)\frac{d\tilde{e}_d}{dD}]\right] - \frac{d^2 g}{de^2}\left[\frac{d\tilde{e}_i}{dV} + \frac{d\tilde{e}_c}{dV}\right] = 0.$$

Recalling that all the derivatives of $h(e)$ of order greater than 2 are zero by assumption, we can solve for $\dfrac{d\tilde{e}_i}{dV}$ and $\dfrac{d\tilde{e}_c}{dV}$ in a comparative static exercise to obtain the following.

$$\frac{d\tilde{e}_i}{dV} = \frac{Z + g''(\tilde{e}_i + \tilde{e}_c)}{\Delta} \tag{15}$$

$$\frac{d\tilde{e}_c}{dV} = -\frac{g''(\tilde{e}_i + \tilde{e}_c)}{\Delta}. \tag{16}$$

$$\text{where } Z = \left[\left(\tilde{e}_d + D(\tilde{e}_c)\frac{d\tilde{e}_d}{dD}\right)\frac{d^2 D}{de_c{}^2} + 2\left(\frac{dD}{de_c}\right)^2\frac{d\tilde{e}_d}{dD}\right] \tag{17}$$

and $\Delta = g''(\tilde{e}_i + \tilde{e}_c)Z.$ (18)

Since $g'' > 0$ by assumption, note that the necessary and sufficient condition to ensure $\Delta > 0$ is $Z > 0$. We already know from the discussion on part (i) of this

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proposition that at any interior equilibrium $Z > 0$ and therefore $\Delta > 0$. Since $g'' > 0$ by assumption, it follows from equations (17) and (18) that $\dfrac{d\tilde{e}_i}{dV} > 0$ and $\dfrac{d\tilde{e}_c}{dV} < 0$.

The intuition can be understood as follows. If the innovation profit is low, the success of the innovation does not increase the payoffs of the firm much, and thus it is worthwhile for the firm to cut back on potential losses by astute management of the damage associated with the innovation, by investing in CSR. But, if the innovation-profit is high, the firm does not care much about the damage factor, and therefore, invests less in CSR.

Next, we compare the welfare levels of the CSR equilibrium with no-CSR equilibrium and from there derive some policy implications.

2.3   WELFARE COMPARISON

Let us start by defining a welfare function as $W = \pi_f + \pi_a$. Using equations (9) and (10) we can calculate the welfare level (W^*) associated with the no-CSR equilibrium as:

$$W^* = e_i^*(V + C) - D - A - [g(e_i^*) + h(e_d^*)] \tag{19}$$

Similarly, the welfare level associated with the CSR equilibrium derived earlier ($\tilde{W}$) is:

$$\tilde{W} = \tilde{e}_i(V + C) - \tilde{D} - A - [g(\tilde{e}) + h(\tilde{e}_d)]. \tag{20}$$

Comparing (19) and (20) we can state the next proposition of the model as below.

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PROPOSITION 5: *For any given configuration of parameters, there exists an upper limit H such that in the presence of activist groups, CSR investment by the firm raises the social welfare as compared to the no-CSR level if and only if the sum of the firm's profit from the innovation, V, and the consumer surplus, C, is less than H, i.e. $V + C < H$.*

Proof. From equations (19) and (20) we obtain:

$$W* - \tilde{W} = (V + C)(e_i^* - \tilde{e}_i) - (D - \tilde{D}) - (g(e_i^*) - g(\tilde{e})) - (h(e_d^*) - h(\tilde{e}_d)). \quad (21)$$

The comparison of equation (5) and (13) implies that $e_i^* = \tilde{e}_i + \tilde{e}_c$. Therefore, it must be the case that $e_i^* > \tilde{e}$ and $g(e_i^*) - g(\tilde{e}_i + \tilde{e}_c) = 0$. Since, e_d is a function of D only and the CSR investment reduces the value of D, it must be the case that $\tilde{D} < D$ and $\tilde{e}_d < e_d^*$.

Since $h' > 0$, it also follows that $h(e_d^*) - h(\tilde{e}_d) > 0$. Therefore, $W* > = < \tilde{W}$ if and only if:

$$V + C >=< H = \frac{(D - \tilde{D}) + [h(e_d^*) - h(\tilde{e}_d)]}{e_i^* - \tilde{e}_i} > 0.$$

The statement of the proposition follows.

As compared to the no-CSR equilibrium, society gains from the CSR as the amount of damage and the activist group's effort fall. On the other hand, it loses out on the expected benefit from the innovation because the firm's innovation effort also falls as its CSR investment rises. The gain can outweigh the loss, if and only if, the foregone benefits corresponding to the innovation effort (i.e. $V + C$), is sufficiently low.

The statement of proposition 5 stands in contrast with the conclusions arrived by Maxwell, Lyon and Hackett (2000) in analysing the CSR practiced in the case of pollution abatement. In their paper, through the CSR activity, the society unambiguously

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gains in terms of welfare. However, proposition 5 shows that their conclusion cannot be generalized. In the case of innovation, the CSR can invite welfare loss. This happens because the pollution abatement is an activity, which is not associated with any kind of social loss other than the cost of abatement. The abatement cost gets internalised in the firm's decision. Therefore, all players gain through such CSR. The CSR practiced in the case of innovation, however, has an additional unmitigated cost – the opportunity cost of the foregone innovation value. Proposition 5 argues that there is a possibility that the society loses through the CSR activity of the firm, if the foregone benefits are very high. Therefore, the present paper adds an additional insight for evaluating the CSR activities of firms in the context of innovation.

3. TESTABLE HYPOTHESES, CASE STUDIES AND POLICY INFERENCES

The propositions developed in the previous section give rise to three testable hypotheses and some policy inferences that we outline below. Each hypothesis is illustrated with stylized facts or a very brief case study of firms in France or India[14].

Hypothesis 1: *Firms engaged in the creation of incremental innovations are likely to practice little or no CSR.*

If the innovation value to be appropriated is very low, i.e. if V is very small and consequently e_i^* is low, and C is small, it follows from proposition 2 that the activist group may not exist at all, especially if the fixed costs A are high. Then, according to proposition 1, the firm will not practice any CSR.

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There seems to be some evidence for this. There are a number of internationally renowned firms in both France and India like Lafarge (construction, France), Moet and Chandon (champagne, France) or Infosys (software, India) and Biocon (biotech, India) which are steady innovators. Their innovations are using usually cost reducing process innovations, scale enhancing process innovations, quality enhancing product innovations but not radical innovations. Activists do not pursue them, confirming the results of our model. The CSR practiced by these firms (if any) are examples of corporate philanthropy.

Hypothesis 2: *In sectors, where expected innovation profit risks being reduced due to high competition in the final product market, an innovating firm is likely to practice more strategic CSR.*

High degrees of competition in final product markets reduce potential innovation profit and by proposition 4, the firm has more incentive to practice CSR as part of its innovation strategy, whenever the activist group exists.

We present two examples to illustrate the case where final market competition is high due to the existence of a variety of substitutes to the new product, motivating the innovating firm to invest more in CSR.

Since the last decade, car makers in Korea, China and India have been engaged in a technological race to produce the world's cheapest car to be accessible to the emerging middle class in Asia, making this industry one with stiff downstream competition. Tata Motors, one of the oldest and respected companies of India, renowned for their investment in CSR and corporate philanthropy, won the race. In January 2008, Tata

Motors unveiled its 'Nano car' costing only $2500. Plans were underway at that time to open a large manufacturing unit on land obtained from farmers in Singur in the State of West Bengal in India. However, the relocation of farmers was not done correctly and it caused civic strife, violence and heavy casualties. So, faced with protests from activists and before being forced to relocate in Gujarat, Tata Motors was working on several CSR initiatives like training programs to provide employment to displaced farmers and projects to develop the Singur locality. Going by proposition 4, it could be that Tata Motors was trying to outwit the competition from rival companies like Bajaj Auto (collaborating with Renault and Nissan) and Maruti-Suzuki Limited, which had already announced their plans to bring out similar low-cost cars in "near future", through its CSR activities.

Another interesting example is Yves Rocher, a French cosmetics company, again renowned for its investment in CSR with respect to preserving biodiversity. Jacques Rocher, one of the directors of this family owned company, initiated the systematic CSR drive in 1987, when the Brundtland report was published and the term sustainable development was widely discussed for the first time. It consistently carried out a number of CSR initiatives such as stopping of animal testing (1989), introducing deodorants with pure air propellants (1990), using recycled cardboard for packaging (1993), selling eco-refills for some of its creams (1996), engaging in organic farming (1997), starting annual eco-citizenship reports (2006), while bringing out innovations every year in its portfolio of cosmetics. Cosmetics are again an industry in which the number of product substitutes is abundant, and hence there is an incentive to undertake CSR. There are activist groups that act as watch-dogs, but since it is a strictly regulated industry, the damages are not

much and hence the effort of the activist groups to gather hard evidence is low, again confirming the findings of our model.

Hypothesis 3: *In sectors where innovations can be protected well by intellectual property rights to ensure high appropriation of resulting profit, firms can be expected to practice less strategic CSR.*

Whenever upstream competition is low, either because of the technological retard of competitors, or because of a strong intellectual property rights regime (IPR), the leading firm is able to appropriate the innovation profit better and this lowers its incentive to invest in CSR. This is particularly true today in the wake of the international homogenization of IPR imposed by the World Trade Organization (WTO) since 1995, which is necessary for all member countries of WTO to follow. According to proposition 1, this should discourage CSR by innovating firms. However, proposition 2 ensures that, with this institutional change, if innovation profit is high, then activist groups would also exist with higher probability. So, in today's world with stronger enforcement of property rights, other things remaining the same, we should expect to observe lower levels of CSR practiced by innovating firms and more confrontations with activists, when expected profit is high.

An interesting case study to illustrate this corollary is that of the firm STMicroelectronics (STM) in Crolles near the city of Grenoble in France. It started in 1971 as the first French company to specialize in MOS (metal oxide semiconductor) and CMOS (complementary metal oxide semiconductors), which are a major class of integrated circuits. STM invests strongly in innovation creation and its mission is to be a

technology leader in specific application niches requiring smaller multifunctional chips. Thus, it is one of the leading European companies integrating nanotechnology and given that 1 job opening in STM is held to create about 3 jobs in the Grenoble region, it benefits from strong support of the local government. In the upstream technology market, it has an entire team to manage its IPR and engage in cross-licensing and litigations. STM considers that by its very existence and compliance with regulation and its investment in cleaning up the water used in the plants, it fulfills its CSR obligations. However, locally it has provoked the emergence of a small but strong anti-nanotechnology activist group, the PMO, which nevertheless has wide support. It contests the environmental degradation being provoked by the investment of the firm and the region in nanotechnology. Given the high innovation profit and consumer surplus generated, the high efforts of the PMO to produce evidence against the risks posed by incorporation of nanotechnology, fits our propositions.

Hypothesis 4: *In sectors, where appropriation of innovation profit is constrained by demand factors such as lack of consumer acceptance, firms will invest in CSR more.*

Consumer acceptance is a crucial factor that enables appropriation of innovation profit. So when there is a history of confrontation with activist groups in order to gain consumer acceptance, it tarnishes the reputation of the firm so that the next innovations need investment and dialogue with end-users to ensure that there is consumer acceptance from the start. This reduces the innovation profit of the firm that can be appropriated lowering the incentives for investment in CSR. Therefore, a firm with a chequered past is likely to spends more on CSR. This seems to be the case with Monsanto, the world's

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leader in genetically modified seeds, which continues to provoke protests from activists all over the world. Monsanto engages heavily in CSR and corporate philanthropy while steadily increasing its profit through the creation and sales of ever new varieties of genetically modified seeds. At the same time, activists continue their protests against putting trust in a firm that has lied to consumers and to the US government in the past, while raising concerns about biodiversity and the livelihoods of poor farmers all over the world (Robin, 2008), confirming proposition 2.

Now we turn to the policy questions: should firms be encouraged to practice CSR? Should there be public policies to promote activism? Proposition 5 indicates that with respect to innovating firms, we should be cautious in pushing them to practice CSR, because it could mean a lower innovation effort, and consequently, a loss of welfare. The answer to the second question follows from propositions 1 and 2. Without the existence of the activist group, the innovating firm does not care about the social cost that it creates in the process of innovation. In the absence of any form of monitoring and control, there is a risk that radical innovations might provoke high social costs in their wake. Therefore, policies to promote activism, we argue, are good for society. For example, the recently enacted laws in some countries, such as 'The Public Interest Disclosure Act of 1998' in the UK or the ordinance in process in the USA such as the 'Whistle Blower Protection Enhancement Act of 2007' should be promoted in other countries as well. Such laws enacted to protect individuals and activist groups that are whistle blowers of corporate malpractices help the formation of activist groups and lower their start-up and fixed costs. According to our propositions 1-5, this would then create incentives for firms to include CSR investment in their innovation strategies.

4. CONCLUSIONS

The virtues of CSR as a means to increase firm profits through appropriate investment in sustainable development and environmental security are being increasingly discussed in the economics literature. At the same time, given its newness as a possible norm for carrying out the diverse activities of a firm, the application of CSR to the innovation strategy of a firm remains little studied. Innovations may generate not only high innovation value but also negative social and environmental externalities, mobilizing tertiary stakeholders, like NGOs and activist groups representing consumers to press for compensation. In this context, our paper had a three-fold objective, to identify the determinants of the CSR investment as part of the innovation effort of the firm, to identify the determinants of the effort by activist groups, and to evaluate the impact of CSR investment in the innovation strategy on social welfare. All three questions were answered in the form of five propositions, and some counter-intuitive outcomes were highlighted in the form of corollaries and illustrated with brief case studies.

We developed a basic model for simplicity of analysis and future extensions can consider dropping our simplifying assumptions to unravel the influence of other variables. For instance, the monopoly profit and consumer surplus, were taken as parameters. These can be made endogenous by considering the demand for the innovation explicitly and thereby the influence of the demand parameters on CSR investment can be identified.

Second, we made the limiting assumption that the activist group is self-less, though this is not always the case in reality (see Rose-Ackerman, 1996 for a review). We also assumed that if the activist group succeeds, the firm is forced to compensate the

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consumers, irrespective of whether or not the firm succeeds in commercializing the innovation. These can be modified to model other realities.

Third, we assumed that the activist group goes to court to demand compensation. Of course, this is not to suggest that going to the court is the only option available to activists. There can be other options like boycotting the product, initiating a cooperative movement, lobbying etc. and these can also be considered.

To conclude, our model helps to understand the different patterns of CSR investment by innovating firms and the involvement of activist groups better. It provides a theoretical rationale for recent empirical work that confirms that leading innovators face a tradeoff between investing in CSR and in creating innovation value, and that activists are often attracted to radical innovations whose commercial success they can make or break rather than incremental innovations (Rao, 2008). The paper also developed arguments to support policy against pressuring all innovating firms to invest in CSR as it may or may not improve social welfare, even while advocating dialogue with activist groups and protection of whistle blowers. Finally, a partial explanation was provided for the phenomenon of rising activism. Earlier, when powerful multinationals commercialized radical innovations in the different countries of the world, in order to tackle any negative externalities generated, an activist group would have to emerge in each locality. In areas where the start-up and fixed costs were high, an activist group would not be able to emerge. Today, thanks to the internet technology, the cost of circulating information on any undesirable social or environmental impact of radical innovations has come down drastically, lowering the functioning costs of activist groups,

thereby enabling more protests against the 'big-bang' innovations of our times than ever

before.

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NOTES

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[1] For example the trials and experiments associated with the commercialization of genetically modified Bt-cotton seeds in India by Monsanto (Ramani, 2008), Starlink seeds by Aventis (before it was purchased by Bayer in 2002) and Bt-10 maize seeds by Syngenta (Clapp, 2008) have led to contamination of Bt-seeds with the non-Bt seeds for foods and feeds with uncertain effect on human health and world bio-diversity.

[2] For example, Delta PineLand, a company that Monsanto was trying to acquire in 1998, invented Terminator sterile seeds, attempting to change the centuries old tradition of developing country farmers, of sorting and saving seeds from one season's harvest for the next season. Had Terminator seeds been commercialized, in each season the farmers would have to go to the market to buy new virile seeds, making their livelihood completely dependent on the seeds supplied by Monsanto. In developing countries, with inadequate dissemination of information, had poor farmers adopted the seeds without fully realizing its consequence, the livelihood-risk of the agrarian society would have increased tremendously (Niiler, 1999; Specter, 2000). World wide protests against 'Terminator technology' eventually led to its ban in most developing countries.

[3] For example, there is the 'Nano' car of Tata Motors, India. See section 3 for details.

[4] For example, ST Microelectronics involved in research in nanotechnology and located in the Alpine region of France near Grenoble, have been accused of capture of local resources and degradation of the environment (see Mukherjee and Ramani, 2008).

[5] Refer to footnote 1.

[6] For example consider the state of biotechnology regulation in developing countries (Ramani, 2008).

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[7] In case of Tata Motors, the compulsion of West Bengal Government was the attraction of industrial investments in the state, which was supposed to fulfill the poll promise of industrialization.

[8] CSR related to innovation creation can take the following forms: (i) voluntary investment by firms, beyond compliance to existing regulations, targeted to reduce any damage engendered by the commercialization of a radical innovation; (ii) investment in the creation of innovations that generate positive externalties; (iii) R&D costs in innovation creation which are greater than the increase in profit in the short run.

[9] See Fleckinger and Glachant (2007) for a related paper.

[10] In reality a part of D can be a monotonically increasing function of e_i i.e. higher is the scale of innovation effort; the higher is the consequent social damage. We assume away this part for analytical convenience. If this assumption does not hold, the results of the present paper will be true under more restrictive conditions.

[11] In this model we assume, the probability of discovering the social cost D for the activists group is 1. But, had we assumed that it discovered the social cost by an exogenously given value of probability (e.g. as it is the case with detection of genetic contamination mentioned in footnote 2), all the results derived from the model still would go through.

[12] This game can also be modeled as a simultaneous game without any loss of generality.

[13] Consider the following example of the concave function $D = k e_c^{\frac{1}{k}}$ where $k > 1$. Observe, $Z < 0$ if and only if $k \geq 3$. For the lower values of k in the range of $1 < k < 3$, we obtain $Z > 0$.

[14]These case studies are drawn from Mukherjee and Ramani (2008).