Strategic Corporate Social Responsibility and Spillover

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Abstract

This paper investigates the firms' incentive of using corporate socially responsible (CSR) innovation as a device in the presence of spillover effect of such innovation. By modelling a two-period environment where a fraction of consumers is altruistic who have higher willingness to pay for the CSR product, we particularly study the firms' decision on CSR innovation with respect to the spillover effect and the fraction of the altruistic consumers. We find that a large (small) fraction of the altruistic consumers attracts (restricts) both firms to innovate. Moreover, if the leader has only one chance to innovate (i.e., makes decision on innovation in the first period onely), a relatively large fraction could be a credible threat from the follower to the leader of innovation. Furthermore, in the situation where the leader has option of innovating in both periods, there exists a "patient area" in which the leader wishes to delay its innovation and do it with its rival in the second period. By doing so, the leader can weaken the rival's benefit from being a follower of innovation.

Keywords: Corporate social responsibility, Innovation, Spillover, Altruism

JEL Classification: M14, O31, L13, L21

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1 Introduction

Economic activities such as corporate social responsibility (CSR) generally shows a consistency of interests between business and the environment (Kitzmueller and Shimshack, 2012). There are increasing amount of firms wish to invest more resources in public good provision to reduce negative externalities. The CSR is therefore considered as a form of self-regulated activity (Benedict, 2012). As opposed to the hard law, CSR activities can play a role of soft law to promote firms to commit to right ethic practice (Klarsfeld and Delpuech, 2008). Indeed, according to a report by KPMG, 93 percent of Fortune Global 250 firms regularly reported their CSR and 78 percent of them included CSR information in the annual financial report in 2015.[1]

In the perspective on economics, one convincing reason why firms tend to engage into CSR activities is its role of strategic use (Baron, 2001; Bénabou and Tirole, 2010). Consumer concerns to CSR is cared by the firms competing in the imperfectly competitive market. Those profit-seeking firms use CSR as a device for their strategy to attract altruistic consumers so that can better compete with their rivals. Is that true? One survey conducted by the Nielson Company from 60 countries across the globe (2015) points that, in addition to the brand trust, 57 percent of consumers also look for products that are both good for themselves and good for the society.[2] Obviously, social responsibility has become a crucial factor that affects consumer behaviour and also a device in the firms' strategy set.

Recent studies on the strategic use of CSR generally takes the differentiation of consumers and/or firms into consideration. Specifically, consumers are altruistic and care about the characteristics of social responsibility embodied in the products sold by firms (Baron, 2001;Bansal and Gangopadhyay, 2003; Tian, 2003; García-Gallego and Geogantzís, 2009; Manasakies et al., 2013; Manasakies et al., 2014; Iyer and Soberman, 2016).[3] By launching

[1]KPMG (2017), The KPMG Survey of Corporate Social Responsibility Reporting 2017.

[2]The Nielson Company (2015), Sustainable Selections: How Socially Responsible Companies are Turning a Profit.

[3]Some studies about consumer awareness based CSR are to evaluate the effect of government policies on competing firms' performance, for example, Bansal and Gangopadhyay (2003).

costly socially responsible products or innovating the existing basic products to be more socially responsible, firms can strengthen their ability to attract the altruistic consumers that in turn allows them to earn higher profit. In addition, firms may be differentiated in terms of their perspective on CSR. That is, firms take into account the consumer surplus and/or environmental externalities when making decision, i.e., the CSR firms (also known as "public firm" in Kopel (2015)), some examples are Whole Foods Market in the retail market, LUSH in the cosmetics industry (Kopel and Brand, 2012; Goering, 2014; Kopel, 2015; Planer-Friedrich and Sahm, 2016). By including the welfare of stakeholders (e.g., consumers) into its decision-making consideration, the CSR firm is able to increase consumers' willingness to pay on its product and, hence, their willingness to buy.

Nearly all the studies about strategic CSR, however, are conducted in the environment where firms simultaneous move on their CSR decision, which may not be appropriate to describe the real business climate.[4] Indeed, many CSR products are launched or innovated sequentially. For example, in the cosmetics industry, LUSH has campaigned to end animal testing before 1980s while its main competitor The Body Shop began to do so in 1989; in the market of hybrid electric vehicles (HEVs), Toyota is clearly a leader in such innovation and followed by its competitor Honda.[5] Therefore, sequential move on CSR by firms allows them to have more flexible decision during competition and brings more factors that may affect their decision. One main factor is the spillover from the leader to the follower. Such factor can be considered as a "transmission" from the first mover of the sequential move to the second mover(s). The spillover is not limited to the occurrence of innovation, but also the new product (e.g., the CSR product) launch. This is because that the spillover could be about information (Bondt, 1996). The follower of the move can do by employing the relevant information of the leader's CSR activities. The information may include innovative, technological and knowledge spillover, as well as the market information. Thus the spillover

[4]Graf and Wirl (2014) models that the CSR is strategically used by an incumbent firm to deter the potential entry of an entrant. This, however, exogenously limits the firm's motive of engaging in CSR.

[5]Toyota Prius was first launched in 1997 and Honda Insight was first launched in 1999. In 2017, global sales of HEVs are led by Toyota and followed by Honda.

is not necessary to work on cost-reduction in the follower's product process, but also on the characteristics of the new product such as the product performance.

Keeping the observations above in mind, this paper is therefore to investigate the oligopolistic firms' incentive of using CSR as a strategic device in the presence of spillover effect. Specifically, we construct a Hotelling model of (horizontal) product differentiation. Consumers in the market are exogenously divided into two groups: altruistic and normal consumers. The former has more willingness to pay for the CSR product while the latter only cares about the product performance improved by the firms' CSR activities.[6] Firms make their decision on R&D innovation sequentially. The follower can receive a spillover effect from the leader but the altruistic consumers have a higher consciousness on the CSR product sold by the leader. This implies that the firm can benefit in the production process by behaving a second mover, but may lose first-mover advantage in the altruistic consumer market.

We find that the firms' incentive of R&D innovation crucially depends on the fraction of the altruistic consumers and the spillover effect to the follower of innovation. Indeed, a large (small) fraction of the altruistic consumers attracts (restricts) both firms to innovate their products to be socially responsible. More importantly, when such fraction is not large enough, a potential leader of the innovation may not wish to innovate and, hence, the potential follower may be the monopolist in the sub-market of the socially responsible product. This mainly comes from the spillover effect of the leader, i.e., the benefit of the spillover effect to the follower dominates the leader's first-mover advantage, weakening the leader's incentive to innovate. Further, we recheck this result in a variation where a potential leader can make its innovation decision in either period 1 or period 2. It finds that the potential leader may have incentive to "wait" one period for its competitor's innovation decision. That is, a not so large fraction may cause the firm to delay its innovation but would not restrict its innovation. The potential leader in this case, may wish to compensate its loss in not being an actual

[6]In many cases, the CSR activity such as innovation is accompanied with improvement in product performance. The hybrid electric vehicle, for instance, not only saves fuel consumption, reduces noise and pollution to environment, but also enhances power with the additional engine.

leader by weakening the follower's benefit from the spillover in a head-to-head competition. We therefore call such range of the fraction as the "patient area".

The rest of the paper is organized as follows: Section 2 reviews some related literature, the baseline model is described in Section 3, Section 4 analyses the case where the firm (i.e., a potential leader) has only one chance to make innovation decision and Section 5 investigates a variation that such firm has chance to innovation in both periods, Section 6 concludes.

2 Related Literature

To our best knowledge, the recent literature about strategic use of CSR can be summarized into three main streams as follows. First, (altruistic) consumers have a higher willingness to pay for socially responsible products (Baron, 2001; García-Gallego and Geogantzís, 2009; Bénabou and Tirole, 2010; Manasakies et al., 2013; Manasakies et al., 2014; Iyer and Soberman, 2016). Altruistic consumers have an intrinsic preference on the socially responsible products, making firms to be more likely to engage in CSR activities. The main results of literatures in this stream are basically (1) the presence of altruistic consumers attracts firms to launch socially responsible products or/and do socially responsible innovation. But in most cases, such effect is non-monotonic. A typical reason is that the cost of innovation may generate a negative force that reduces the economic value of the innovative product and prevents the firms from investing more on CSR innovation; (2) the market structure affects the firm's incentive of engaging in CSR activities. When competition presents, the return to strategic CSR tends to be greater since it can limit the competitive advantage of the competing firms; (3) the CSR activities are welfare enhancing for consumers but may have opposite effect for firms because the CSR activities generally play a role of redistribution of surplus from the firms to consumers.

Second, some firms in the market are socially concerned and they take into account the consumer welfare when making decision (Kopel and Brand, 2012; Kopel, 2015; Planer-

Friedrich and Sahm, 2016). Instead of deciding how much to invest on CSR, socially concerned firms decide on the share of consumer surplus should be taken into its objective. It is found that the socially concerned firm's profit is concave in such share. Although the consumer surplus is considered in the firm's decision, directly benefiting the consumers, due to the possibility of profit reduction on the share of consumer surplus, the socially concerned firm may not exert too much effort on stakeholder interests.

Third, the CSR adoption is regulated by the government to reduce the negative externalities (Bansal and Gangopadhyay, 2003; Lambertini et al., 2016). The firms under the framework are profit-maximizers but the central regulator includes the externalities into the social objective. They find that if the market is sufficiently large, the CSR firms can sell more under regulation and accumulate more capital. This on one hand makes the CSR firms to earn high profit relative to their non-CSR counterparts. On the other hand, more benefit to the CSR firms can motivate firms to engage in more CSR activities. In addition, they find that a subsidy policy can be more efficient than a tax policy when guiding firms to behave more socially responsible.

The present paper follows the framework of the first stream of literature by paying more attention on the following two aspects. First, we focus on the sequential move of the firms' decision on CSR innovation, which to our knowledge, has not been fully considered. Second, we add spillover effect into the analysis which allows us to explain the firm's incentive of launching CSR campaign in a novel way other than the conventional wisdom.

3 The Model

Consider a Hotelling market (with length one) of (horizontally) differentiated products in which two profit-maximizing firms compete over their prices. The two firms are indexed by firm 1 and firm 2. The marginal cost of production is assumed to be zero. The products mentioned in the model are considered as "basic product" which can cause social bad when

they are consumed. The firms may therefore have incentive to innovate their product to be more socially responsible (e.g., environmentally friendly). Consequently, the social responsible feature embodied in the product may affect (at least) some consumers' willingness to pay. When either firm firstly innovates its product, it causes an increase in the marginal cost c. Different from the existing literature about CSR innovation such as Iyer and Soberman (2016), we pay less attention on the firm's endogenous decision on R&D but focus more on the firm's incentive of innovation. Therefore, we allow the firms may not engage into CSR innovation and, when a firm decides to do so, it only needs to incur a higher marginal cost, i.e., the firm's cost of R&D does not play a crucial role in the present model. In the situation where one firm innovates the product, its competitor also makes decision on whether or not to innovate its own product. We model this case as a type of spillover. Specifically, the follower of the CSR innovation can receive a "transmission" (e.g., innovative, knowledge and market information spillover) from the leader's action (for example, Bondt (1996)), so that its marginal cost of producing the CSR product is reduced, say by $1-\sigma$ and $\sigma \in (0,1)$, in turn the R&D follower's marginal cost becomes σc. Without loss of generality, we assume that firm 1 to be the leader of the innovation if the CSR innovation takes place.

Consumers are uniformly distributed on the Hotelling line with unit mass. Each consumer has a willingness to pay $V \in \Re^{+}$ which is assumed to be high enough that allows the consumer to purchase one product (basic or CSR product). Moreover, consumers are exogenously divided into two groups: altruistic group (group A) with fraction $\theta \in (0,1)$ and normal group (group N) with fraction $1-\theta$. the altruistic group concerns about the characteristics of social responsibility. Letting the increment in the consumer's preference from social responsibility be $a \in (0,1)$, then a socially responsible product can deliver an economic value a to an altruistic consumer. In addition, the altruistic consumer's preference from buying a socially responsible product by the R&D follower is reduced by $1-\gamma$ and $\gamma \in (0,1)$. This is because that the altruistic consumers are not only sensitive to the social responsibility but also to the firm who FIRST does so (this can also be considered as the consumer's loyalty towards

the firm's CSR activities). Thus, when both firms are observed to do the innovation, the leader will be ranked up by the altruistic consumers. To avoid corner solutions, we assume that $max\left\{\frac{c-3}{a}, \frac{c(1-\sigma)-3}{(1-\gamma)a}\right\} < \theta < \frac{3+(1-\sigma)c}{(1-\gamma)a}$. Further, to avoid firm 2 to have an absolute advantage to be a follower, i.e., can always benefit to be a follower of innovation, we assume that $\sigma > \gamma$. Thus the above assumption about θ is refined to $\frac{c-3}{a} < \theta < \frac{3+(1-\sigma)c}{(1-\gamma)a}$.

Each type of consumers chooses the product which can deliver higher net surplus. If only one firm (i.e., firm 1) innovates the product, an altruistic consumer who locates at $x^k \in [0,1]$ on the Hotelling line receives net surplus from purchasing firm 1's product is $u_1^A = V - p_1 - x^k + a$ and from purchasing firm 2's product is $u_2^A = V - p_2 - (1 - x^k)$, where $p_i,\ i = 1, 2$ denotes firm i's price. A normal consumer who is at the same location on the Hotelling line receives net surplus from purchasing firm 1's product is $u_1^N = V - p_1 - x^k$ and from purchasing firm 2's product is $u_2^N = V - p_2 - (1 - x^k)$. If both firms innovate the product, an altruistic consumer who locates at $x^k \in [0,1]$ on the Hotelling line receives net surplus from purchasing firm 1's product is $u_1^A = V - p_1 - x^k + a$ and from purchasing firm 2's product is $u_2^A = V - p_2 - (1 - x^k) + \gamma a$. A normal consumer who is at the same location on the Hotelling line receives net surplus from purchasing firm 1's product is $u_1^A = V - p_1 - x^k$ and from purchasing firm 2's product is $u_2^N = V - p_2 - (1 - x^k)$. Each firm's geographic boundary on the Hotelling line is governed by the location of the marginal consumer who receives the same net surplus from purchasing the two firms' products. Therefore, the two firms' demand functions in the two groups are given by

$$X_1^A(p_1, p_2) = \frac{1 + p_2 - p_1 + a}{2};\ X_2^A(p_1, p_2) = \frac{1 + p_1 - p_2 - a}{2}, \tag{1}$$

and

$$X_1^N(p_1, p_2) = \frac{1 + p_2 - p_1}{2};\ X_2^N(p_1, p_2) = \frac{1 + p_1 - p_2}{2}, \tag{2}$$

if only one firm innovates the product.

$$X_1^A(p_1,p_2)=\frac{1+p_2-p_1+(1-\gamma)a}{2};\ X_2^A(p_1,p_2)=\frac{1+p_1-p_2-(1-\gamma)a}{2}, \tag{3}$$

and

$$X_1^N(p_1,p_2)=\frac{1+p_2-p_1}{2};\ X_2^N(p_1,p_2)=\frac{1+p_1-p_2}{2}. \tag{4}$$

if both firms innovate the product. Note that equation (1)-(4) are all unweighted demands, firms take the weight θ into consideration when they set price to maximize their profit. Moreover, firms are not allowed to price discriminate consumers from different group.

In terms of the timing, (as shown in Figure 1) the two firms compete in two periods. Moreover, there are three stages in each period. In the first period, firm 1 at stage one makes decision on whether or not to innovate its product depending on its expected profit. At stage two, the two firms compete over their prices, and consumers make their purchase decision at stage three. In period 2, firm 2 makes decision on whether or not to innovate given firm 1's decision on innovation in the first period. The last two stages are the same as that in period 1. The discounting factor in the game is $\delta \in (0,1)$. We assume that the information of the game is perfect and complete. To complete the analysis on the effect of strategic CSR, we investigate a variation with which firm 1 is allowed to make innovation decision again in period 2 if it has not done so in period 1. In such a case, if both firms innovate in the same period, both γ and σ are equal to one, suggesting that there is no distinction between the leader and the follower of innovation. We wish to find out if firm 1 would like to "wait" for the competitor's decision.

As a benchmark, we first briefly introduce the case where none of the firms innovate the product. In such a case, consumers are not differentiated since they are facing exactly same products in the good market. The firm i's demand function in period t is therefore $X_i^t(p_i^t,p_{-i}^t)=\frac{1+p_{-i}^t-p_i^t}{2}$, and each firm simultaneously sets the price to maximize its profit $\pi_i^t \equiv \Pi_i^t(p_i^t,p_{-i}^t)=p_i^t\cdot X_i^t(p_i^t,p_{-i}^t)$. The result in this case is similar to the conventional

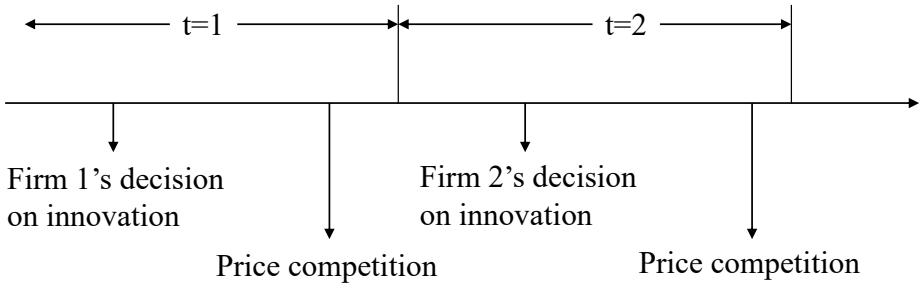

Figure 1: The timing

Hotelling model, each firm charges $p_1 = p_2 = \frac{1}{2}$ in each period and earns profit over two periods $\pi_1^* = \pi_2^* = \frac{1+\delta}{2}$. The two firms equally split the market.

4 Firm 1's one-shot decision on innovation

This section discusses the case where firm 1 has only one chance to innovate its product. Specifically, if firm 1 has not innovated in period 1, it does not have any chance to do so in period 2, i.e., the one-shot game. This implies that if firm 1 does not innovate its product in period 2, firm 2 will be the monopolist of innovated product in period 2 if it chooses to innovate.

4.1 Only one firm innovates

Once only firm 1 innovates its product in period 1, consumers are differentiated by the innovative product from period 1. Given demand function (1) and (2), the two firms' expected demand functions in period t are

$$X_1^t(p_1^t, p_2^t) = \frac{1 + p_2^t - p_1^t + \theta a}{2}, \tag{5}$$

and

$$X_2^t(p_1^t, p_2^t) = \frac{1 + p_1^t - p_2^t - \theta a}{2}, \tag{6}$$

respectively. The two firms set the price to maximize their profits $\pi_1^t = (p_1^t - c) \cdot X_1^t(p_1^t, p_2^t)$ and $\pi_2^t = p_2^t \cdot X_2^t(p_1^t, p_2^t)$. Note that the innovation only affects the consumer's preference and, hence, the prices and cost do no depend on each other over the two periods. Simultaneously solving the two first-order conditions $\frac{\partial \pi_1^t}{\partial p_1^t} = 0$ and $\frac{\partial \pi_2^t}{\partial p_2^t} = 0$ yields

$$p_1^t = 1 + \frac{2c}{3} + \frac{\theta a}{3};\ p_2^t = 1 + \frac{c}{3} - \frac{\theta a}{3}. \tag{7}$$

Substituting p_1^t and p_2^t into π_1^t and π_2^t yields the two firms' profits over two periods:

$$\pi_1 = \frac{(1+\delta)(3 - c + \theta a)^2}{18};\ \pi_2 = \frac{(1+\delta)(3 + c - \theta a)^2}{18}. \tag{8}$$

It is straightforward to derive the sub-game equilibrium profits in the case where only firm 2 innovates. Similar to (8), the benefit from innovating moves from π_1 to π_2 in their period 2 profits, which yields

$$\pi_1 = \frac{1}{2} + \frac{\delta(3 + c - \theta a)^2}{18};\ \pi_2 = \frac{1}{2} + \frac{\delta(3 - c + \theta a)^2}{18}. \tag{9}$$

4.2 Both firms Innovate

After observing firm 1 has innovated the product, firm 2 may follow firm 1 and also innovate its product as well. Given the demand function (3) and (4), the two firms' expected demand functions are

$$X_1^t(p_1^t, p_2^t) = \frac{1 + p_2^t - p_1^t + \theta(1-\gamma)a}{2}, \tag{10}$$

and

$$X_2^t(p_1^t, p_2^t) = \frac{1 + p_1^t - p_2^t - \theta(1-\gamma)a}{2}, \tag{11}$$

respectively. The two firms set the price to maximize their profits $\pi_1^t = (p_1^t - c) \cdot X_1^t(p_1^t, p_2^t)$ and $\pi_2^t = (p_2^t - \sigma c) \cdot X_2^t(p_1^t, p_2^t)$. Simultaneously solving the two first-order conditions $\frac{\partial \pi_1^t}{\partial p_1^t} = 0$ and $\frac{\partial \pi_2^t}{\partial p_2^t} = 0$ yields

$$p_1^1 = 1 + \frac{2c}{3} + \frac{\theta a}{3};\ p_2^1 = 1 + \frac{c}{3} - \frac{\theta a}{3}. \tag{12}$$

and

$$p_1^2 = 1 + \frac{(2+\delta)c}{3} + \frac{\theta(1-\sigma)a}{3};\ p_2^2 = 1 + \frac{(1+2\delta)c}{3} - \frac{\theta(1-\sigma)a}{3}. \tag{13}$$

This can be found that when both firms innovate, the benefit of innovation is different to the two firms since the altruistic consumers prefer the R&D leader's innovative product to the follower's one. Substituting p_1^t and p_2^t into π_1^t and π_2^t yields

$$\begin{aligned} \pi_1 &= \frac{(3+\theta a - c)^2}{18} + \frac{\delta(3-(1-\sigma)c + \theta(1-\gamma)a)^2}{18}; \\ \pi_2 &= \frac{(3-\theta a + c)^2}{18} + \frac{\delta(3+(1-\sigma)c - \theta(1-\gamma)a)^2}{18}. \end{aligned} \tag{14}$$

4.3 Equilibrium analysis

This section figures out the sub-game perfect Nash equilibrium (SPNE) of the game in the case where firm 1 makes one-shot decision on innovation. By working backward, we first find the sub-game equilibrium of which firm 2's incentive of following firm 1's R&D decision.

Lemma 1. *If firm 1 does not innovate in period 1, firm 2 will have incentive to innovate (in period 2) if $\theta > \theta_1$, where $\theta_1 = \frac{a}{c}$.*

Lemma 1 provides a condition under which the follower wishes to be a monopolist in the sub-market of the altruistic consumers. This reveals that when the fraction of the altruistic consumers exceeds a threshold, the follower would like to innovate if its competitor has not done so in the previous period. This condition may not be applied to the leader because in this repeated game, the condition may not be the leader's credible threat to the follower. Therefore, we have the following

Lemma 2. *If firm 1 innovates in period 1, firm 2 has incentive to innovate the product if the fraction of the altruistic consumers is characterised as* $\theta > \theta_2$*, where* $\theta_2 = \frac{\sigma c}{\gamma a}$.

Lemma 2 provides the condition under which firm 2 has incentive to follow firm 1 and to innovate its product. More specifically, firm 2's incentive of innovation crucially depends on the fraction of the altruistic consumers. This result is quite straightforward, when such fraction is so low, the sub-market of the altruistic consumers is not attractive and firm 2 does not wish to compete with the innovation leader. By intuition, firm 2's incentive to follow firm 1 in terms of innovation depends on the cost relative to the benefit of innovation, i.e., $\frac{c}{a}$. Due to the presence of the change on the consumer's preference on different firms' innovation and the spillover effect, such criterion is affected, which is

Lemma 3. *Firm 2 is more likely to follow firm1 if (1) the spillover effect is strong, i.e.,* σ *is small; (2) the consumer's preference on the follower's innovation is strong, i.e.,* γ *is large.*

By working backward with the results from Lemma 1 and Lemma 2, we can figure out the SPNE of the game. Specifically, there exists a critical value of θ, say θ_3 and $\theta_3 = \frac{-[6-2c+\delta(6+\sigma c)(2-\sigma)+\delta\gamma(2-\delta)c]+\sqrt{\Delta}}{2a[1-\delta\gamma(2-\gamma)]}$, where $\Delta = [6-2c+\delta(6+\sigma c)(2-\sigma)+\delta\gamma(2-\delta)c]^2 + 4c[1-\delta\gamma(2-\gamma)][(6-c)+\delta(6+\sigma)(2-\sigma)]$. Moreover, there exists some values of c and a such that $\theta_2 < \theta_3 < 1$,[7] we have the following

Proposition 1. *The SPNE of the game is characterised as follows:*

(i) If $\theta_3 < \theta < 1$*, both firms will innovate;*

(ii) If $\theta_2 < \theta < \theta_3$*, only firm 2 will innovate;*

(iii) If $\theta_1 < \theta < \theta_2$*, only firm 1 will innovate;*

(iv) If $0 < \theta < \theta_1$*, no firm will innovate.*

[7] For some other values of c and a, θ_3 could be smaller than θ_2, but we here focus on a more interesting case of $\theta_3 > \theta_2$.

The results in Proposition 1 show the firms' incentive of innovation. Different from some existing literature (such as Iyer and Soberman (2016) and García-Gallego and Geogantzís (2009)) which focuses on the condition that how much economic value that the CSR innovation can delivery to the consumer, the results in the proposition reveal that in a framework of sequential move on CSR innovation, firms' R&D decision depends on the fraction of the altruistic consumers. As shown in Figure 2, when the sub-market of the altruistic consumers is substantial, both firms would like to enter such sub-market (region i), no firm can benefit from letting its competitor be a monopolist in the sub-market. On the other hand, when the sub-market of the altruistic consumers is so small (region iv), no firm wishes to innovate.

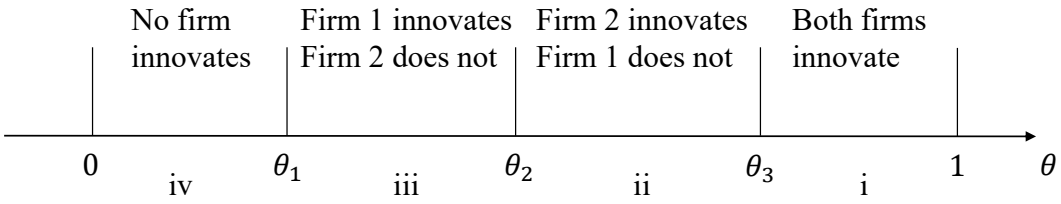

Figure 2: The equilibrium in Proposition 1

When the fraction of the altruistic consumers falls in an intermediate range (region ii and iii), only one firm wishes to innovate. When θ is relatively high, i.e., $\theta \in (\theta_2, \theta_3)$, firm 2's incentive of innovation can be a credible threat to firm 1 and prevent the former from innovating in period 1. This result comes from the presence of the spillover effect once firm 1 chooses to innovate. One can check further the critical value on θ with respect to σ, as σ falls, i.e., as the spillover effect becomes stronger, θ is more likely to fall in (θ_2, θ_3). On the other hand, if θ falls in (θ_1, θ_2), firm 2 will not have incentive to follow firm 1 in terms of innovation. This is because that the benefit from the spillover effect to firm 2 cannot compensate its disadvantage of being a follower with a small fraction of its potential market consists of the altruistic consumers. As a consequence, firm 2 does not wish to innovate once it observes that firm 1 does so in period 1.

5 Firm 1's decision on innovation in both periods

This section investigates a variation of the model by allowing firm 1 to make the innovation decision again in period 2. That is, if firm 1 has not innovated its product in period 1, it can make such decision with firm 2 in period 2, whereas if firm 1 has done so in period 1, the innovation is irreversible and it sells the innovated product in period 2. Accordingly, this setting does not change the results in the situation where firm 1 innovates in the first period. However, if firm 1 does not innovate in period 1, it can still have chance to compete with firm 2 in the sub-market of the altruistic consumers by innovating. Thus, the two firms in such a case play a simultaneous game in the second period. The game is illustrated in Table 1.

Table 1: The simultaneous game matrix

		Firm 2: CSR	Firm 2: Non-CSR
Firm 1	CSR	$\frac{1}{2};\frac{1}{2}$	$\frac{(3-c+\theta a)^2}{18};\frac{(3+c-\theta a)^2}{18}$
	Non-CSR	$\frac{(3+c-\theta a)^2}{18};\frac{(3-c+\theta a)^2}{18}$	$\frac{1}{2};\frac{1}{2}$

It is straightforward to find that if $\theta > \theta_1$, the action of CSR innovation is the dominate strategy for both firms and, hence, the sub-game equilibrium in the case where firm 1 does not innovate in period 1 is the same as that in the preceding section. This implies that regardless of any spillover effect, both firms would like to compete in the sub-market of the altruistic consumers as long as the size of such market is sufficiently large. Moreover, it is obvious that neither firm wishes to innovate if θ is below θ_1.

Moving to the first period, we figure out the SPNE of the game by analysing the firm 1's expected profit. There exists θ_4, where $\theta_4 = \frac{-[3-c+3\delta(1-\gamma)-\delta(1-\gamma)(1-\sigma)]+\sqrt{\Omega}}{a[1+\delta(1-\gamma)^2}$, and $\Omega = [3-c+3\delta(1-\gamma)-\delta(1-\gamma)(1-\sigma)]^2 + [1+\delta(1-\gamma)^2][c(6-c)+6\delta(1-\sigma)-\delta(1-\sigma)^2]$,

and $\theta_4 > \theta_3$.[8] Moreover, for some values of c and a, $\theta_4 < 1$.[9] We have the following

Proposition 2. *In the case where firm 1 has option of innovation in both periods, the SPNE of the game is characterised as follows:*

(i) If $\theta_4 < \theta < 1$, firm 1 will innovate in period 1 and firm 2 will innovate in period 2;

(ii) If $\theta_2 < \theta < \theta_4$, both firms will innovate in period 2;

(iii) If $\theta_1 < \theta < \theta_2$, only firm 1 will innovate (in period 1);

(iv) If $0 < \theta < \theta_1$, no firm will innovate.

The results provided in Proposition 2 reveal that firm 1 may have incentive to "wait" for its competitor if it is allowed to make innovation decision again in period 2. Compared with situation (ii) in Proposition 1, instead of NOT innovating, firm 1 wishes to delay its innovation and do it with its competitor in period 2 if the fraction of the altruistic consumers is not so large (i.e., $\theta_2 < \theta < \theta_4$). The intuition behind this results is that a relatively large θ can attract firm 2 to enter the sub-market of the altruistic consumers, and, it could benefit from being a second mover due to the presence of the spillover effect. To weaken such benefit (e.g., the second-mover advantage), firm 1 can make its innovation scheme into the second period and engage into a head-to-head competition with firm 2 in terms of innovation.

Further, it has shown that $\theta_4 > \theta_3$, suggesting that when the fraction of the altruistic consumers is not large enough, firm 1 may not wish to be a first mover of innovation. This is because that the benefit of being a first mover is dominated by the loss in the spillover effect on the second mover. Accordingly, if a firm can have a second choice on its CSR innovation, when the faction of the altruistic consumers is not so large, it may enter a "patient area" (which is illustrated in Figure 3) and wait for its competitor's innovation.

[8] The proof of $\theta_4 > \theta_3$ is provided in the appendix.

[9] Again, for some other values of c and a, θ_4 could be greater than 1, but we here focus on a more interesting case of $\theta_4 < 1$. It can be shown than $\theta_4 > \theta_3$ for sure.

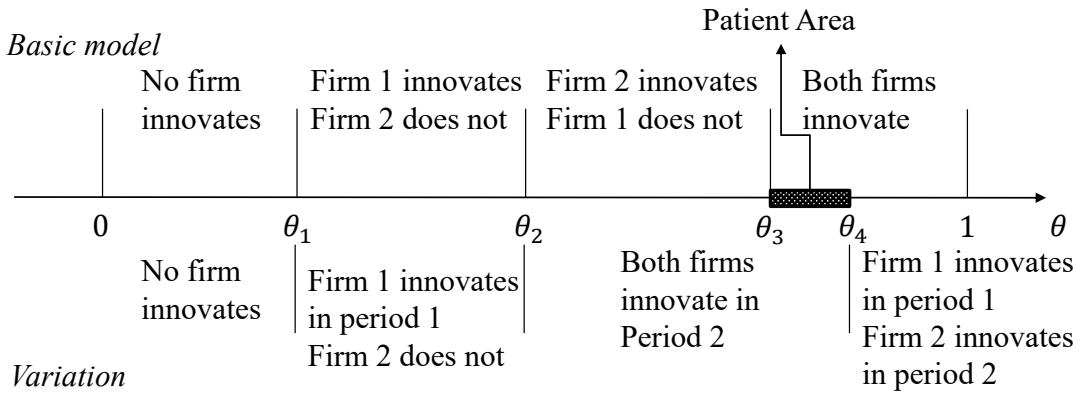

Figure 3: The patient area

6 Conclusion

This paper investigates the firms' incentive of using CSR innovation as a device in the presence of spillover effect. Such a effect may come from information including innovative, technological and knowledge spillover, as well as market information. By constructing a model of sequential move in CSR innovation, we particularly study the competing firms' decision on CSR innovation when the consumer's consciousness on the CSR product is varied in terms of the sequence of innovation. That is, the altruistic consumers (who have more willingness to pay for the CSR product) have a higher consciousness on the CSR product sold by the innovation leader.

The study shows that the firms' incentive of innovating crucially depends on the fraction of the altruistic consumers and the spillover effect. Specifically, in the case where the potential leader of innovation has only one chance to innovate (i.e., it can make decision on innovation in period 1 only), a so large (small) fraction of the altruistic consumers attracts (restricts) both firms to engage in CSR innovation. Moreover, innovation can be the potential follower's credible threat to the leader when such fraction is relatively large, and this threat is more likely to take place when the spillover effect becomes stronger. This is because that a substantial spillover effect is able to compensate the disadvantage of being a second mover of innovation. When the fraction of the altruistic consumers is relatively small, on

the other hand, the sub-market of the altruistic consumers is not attractive to the follower and, hence, the leader is the monopolist in such sub-market.

The variation of model allows the potential leader to have a second chance to innovate (i.e., if it has not innovated in period 1, it can make such decision again in period 2). We find that the results do not fundamentally change when the fraction of the altruistic consumers is so large and so small. However, when such fraction is relatively large, the leader has incentive to delay its innovation and do it with its competitor in the second period. This reveals that if the choice of innovation is flexible to a firm, it may wish to wait for its rival to weaken the spillover effect in an environment where the sub-market of the altruistic consumers is attractive.

A Appendix

Proof. $\theta_4 > \theta_3$. θ_3 and θ_4 are solved from inequality

$$\frac{(3+\theta a-c)^2}{18}+\frac{\delta(3-(1-\sigma)c+\theta(1-\gamma)a)^2}{18}>\frac{(1+\delta)(3-\theta a+c)^2}{18} \tag{A.1}$$

and

$$\frac{(3+\theta a-c)^2}{18}+\frac{\delta(3-(1-\sigma)c+\theta(1-\gamma)a)^2}{18}>\frac{1+\delta}{2}, \tag{A.2}$$

respectively. Moreover, both (A.1) and (A.2) are convex in δ, and both δ_3 and δ_4 are on the increasing segment of the corresponding function. In addition, $\frac{(1+\delta)(3-\theta a+c)^2}{18} > \frac{1+\delta}{2}$ in the case of $\theta > \frac{c}{a}$, suggesting that for a given θ, inequality (A.1) is more likely to be positive relative to (A.2). This implies that, solving equality (A.1) and (A.2), the solutions (i.e., θ_3 and θ_4) show that the one from the former is smaller than the one from the latter, i.e., $\theta_3 < \theta_4$. □

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