Strategic Corporate Social Responsibility with Spillover Effect in Innovation

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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 only), 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, dynamic game
JEL Classification: M14, O31, L13, L21

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 number of firms wish to invest more resources in public good provision to reduce negative externalities. 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] The CSR is therefore considered as a form of self-regulated activity by firms (Benedict, 2012) and 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).

In an economic perspective, one convincing reason explains that firms engage into CSR activities is *strategic use* (Baron, 2001; Bénabou and Tirole, 2010). As increasing altruistic consumers are concerned about CSR by firms, profit-seeking firms tend to use CSR as a device in their strategies to attract the altruistic consumers. Is that true? One survey conducted by the Nielson Company from 60 countries across the globe in 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 behavior and also an important 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 feature 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 socially responsible products or innovating the existing basic products to be more socially responsible, firms can strengthen their ability to attract the altruistic consumers in the market, which assists them to better capture the market and in term earns higher profit. In addition, firms sometimes take into account the consumer surplus and/or environmental externalities when making decision, i.e., the CSR firms (also known

[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).

as “public firm” in Kopel (2015)), some examples are Whole Foods Market in the retailing industry and 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, communities and environment) into its decision-making consideration, the CSR firm can 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 simultaneously make their CSR decision, which is not appropriate to describe the real business world.[4] It can be widely found that many CSR campaigns are launched sequentially rather than simultaneously. 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] Sequential move on CSR innovation by firms takes place in a couple of notable industries and brings us to investigate that if there exists some factors attract firms to do so. One possible factor that comes to us is the spillover from the leader to the follower in the process of innovation. 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 introduction of new products (e.g., the CSR product). This is because that the spillover could be about information (Bondt, 1996). The follower can do better 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. Accordingly, the spillover is not necessarily valid for cost reduction in innovation, but also for the performance of the innovated product.

Keeping the above observations in mind, this paper is therefore to study the oligopolistic firms' incentive of using CSR as a strategic device in the presence of spillover effect. Specifically, we construct a Hotelling model in which consumers are exogenously divided into two groups: altruistic and normal consumers. The altruistic consumers have more willingness to pay for the CSR product while the normal consumers only care about the product performance improved by the firms' CSR

[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.

activities.[6] Firms make their decision on CSR innovation sequentially. The follower of the innovation 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' motivation of CSR innovation depends on the fraction of the altruistic consumers and the spillover effect to the follower of innovation. A large (small) fraction of the altruistic consumers attracts (restricts) both firms to engage into CSR innovation. More importantly, when such fraction is not large enough, a potential leader of the CSR innovation may not wish to innovate and hence, the potential follower may be the monopolist in the market of the socially responsible product. This finding comes from the spillover effect from the leader of the CSR innovation to the follower, the benefit of the spillover effect to the follower dominates the leader's first-mover advantage, weakening the leader's motivation on the CSR innovation. In addition, we reexamine this result in a variation model where a potential leader can make its innovation decision in either period 1 or period 2. We demonstrate that a not so large fraction of the altruistic consumers may cause the potential leader to delay its innovation to period 2. We therefore call range of the fraction of the altruistic consumers mentioned above 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

[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.

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 literature 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.

Although plenty of literature cited above have studied the strategic CSR by competing firms, nearly all of them consider a simultaneous move in competition. There are two main reasons that

attract us to focus on the sequential game in CSR innovation by firms. First, as stated above, some facts have revealed that firms may engage into the CSR innovation dynamically. Second, a sequential game brings some effects in terms of time span, which may affect the consumer's behavior and the firms' decision. Accordingly, the present paper will fill the gap in the existing literature in terms of the firm's motivation on the CSR innovation in a dynamic competition. The contribution of this paper is to take more realistic possibilities into the firm's CSR innovation into account such as the spillover effect in the CSR innovation and the discount on consumer's preference on the follower of innovation. In a two-period model of the CSR innovation, the leader of innovation may not always enjoy the first-mover advantage and consumers may not have the same preference on both leader and follower's innovated products. That is, it is possible that no firm wishes to (first) engage into the CSR innovation which is not desired by the society. The findings of this paper therefore shed some lights on policies that are needed to promote the CSR innovation in an industry.

3 The Model

Consider a Hotelling market (with length one) of differentiated products in which two profit-maximizing firms compete over prices. The two firms are indexed by firm 1 and firm 2 and their marginal costs of production are assumed to be zero. The firms have possibility to innovate their basic products to be more socially responsible (e.g., environmentally friendly) for the purpose of profit maximization. As stated in Baron (2001), this practice may benefit other stakeholders of the community, but the motivation for that practice is to increase the profit. The rationale behind this is the socially responsible feature embodied in the product may affect the willingness to pay of the consumers who are concerned about this. Moreover, when either firm firstly innovates its product, an increase in marginal cost is incurred and it becomes 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 possibility that firms do not engage into CSR innovation, meanwhile, 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 only one firm innovates the product, its rival

can also benefit from that in its possible innovation process. 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)), causing a reduction on its marginal cost of producing the CSR product, 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 CSR innovation.

Consumers are uniformly distributed on the Hotelling line with unit mass and hence, the population of the consumers in the market is normalized to one. Each consumer has a willingness to pay $V \in \Re^+$ which is assumed to be high enough which allows they can 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 consumers concern about the feature of social responsibility embodied in the product and they can receive an additional economic value $a \in (0,1)$ when they consume a socially responsible product. Such economic value is similar to the intrinsic preference mentioned by Iyer and Soberman (2016).

In addition, the altruistic consumer's preference from buying a socially responsible product by the *follower of the CSR innovation* 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). Accordingly, when both firms are observed to engage into the CSR innovation, the leader of the innovation 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

Assumption 1: $\frac{c-3}{a} < \theta < \frac{3+(1-\sigma)c}{(1-\gamma)a}$.

Let $p_i,\ i = 1,2$ be the firm i's price, 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 utility from purchasing firm 1's product is $u_1^A = V - p_1 - x^k + a$ and from purchasing firm 2's product is $u_2^A = V - p_2 - (1 - x^k)$. A normal consumer who is at the same location on the Hotelling line receives utility

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, on the other hand, both firms innovate the product, an altruistic consumer who locates at $x^k \in [0,1]$ on the Hotelling line receives utility 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 utility 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 determined by the location of the marginal consumer who receives the same utility from purchasing the two firms' products. Therefore, the two firms' demand functions in the two groups are given by

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

and

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

if only one firm (i.e., firm 1) innovates the product.

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

and

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

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 profit-maximizing price. Moreover, firms are not allowed to price discriminate consumers from different groups.

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. At stage one of the first period, firm 1 makes decision on whether or not to innovate its product depending on its expected profit. At stage two, the two firms compete over 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 can 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 the CSR innovation. In this variation, we wish to find out if firm 1 would like to *wait for* its rival's decision.

As a benchmark, we first study the case where none of the firms innovate the product. In such a case, consumers are not differentiated since they face the same products in the 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 consistent with the conventional 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.

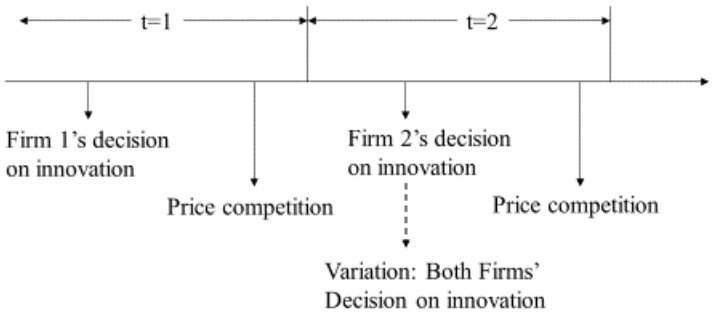

Figure 1 The description of the timing

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., a one-shot play in the CSR innovation. 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. In the following subsections, we analyze the sub-games regarding each firm's decision on innovation and find the equilibrium of the game by working backward.

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. The two firms' demand functions are weighted by θ, given unweighted demand function (1) and (2), the two firms' expected demand functions in period t are

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

and

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

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 $\pi_2^t = p_2^t \cdot X_2^t(p_1^t, p_2^t)$. 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

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

Substituting p_1^t and p_2^t into π_1^t and π_2^t and add up $\pi_i^1 + \delta \pi_i^2$, $i = 1,2$ yields the two firms' profits over two periods:

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

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

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

In (9), the first term stands for the firm's profit in period 1. In such a period, no firms engage into the CSR innovation, leading to a result which is the same as that in the conventional Hotelling model.

4.2 Both firms Innovate

This sub-game investigates the case where firm 2 follows firm 1's action on innovation. Given the unweighted demand function (3) and (4), the two firms' weighted demand functions are

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

and

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

respectively. Note that in this case, since firm 2 is the follower of the innovation, the altruistic consumers' intrinsic preference on its product is reduced by γ. 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

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

and

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

This can be found that when both firms innovate, the benefit of innovation is different to the two firms since the altruistic consumers more prefer the R&D leader's innovative product to the follower's one. Substituting p_1^t and p_2^t into $\pi_i^1 + \delta\pi_i^2$ yields

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

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* $\theta_1 = ac$.

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. On the other hand,

Lemma 2. *If firm 1 innovates in period 1, firm 2 has incentive to innovate the product if* $\theta > \theta_2$*, 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 in period 2. Qualitatively same as the result provided by Lemma 1, firm 2's incentive of innovation crucially depends on the fraction of the altruistic consumers in the case of Lemma 2. It is straightforward to show that $\theta_1 < \theta_2$, which implies that firm 2 is more likely to innovate in the situation where firm 1 has not done so in period 1. This result comes from the second period competition over the altruistic consumers. If the fraction of the altruistic consumers is large enough, firm 2's potential post-innovation market will be substantial.[7] By comparing the critical

[7] This result is crucially due to Assumption 1, and it will not be completely violated if the assumption is relaxed.

values in Lemma 2 and Lemma 3, it can be found the factors that affect the firm 2's action in different cases regarding firm 1's innovation decision. To be a brief summary, we have following

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.*

At stage one of the first period, 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 $\Delta = [6-2c+\delta(6+\sigma c)(2-\sigma)+\delta\gamma(2-\delta)c]^2 + 4c[1-\delta\gamma(2-\gamma)][(6-c)+\delta(6+\sigma)(2-\sigma)]$, and there exists some values of c and a such that $\theta_2 < \theta_3 < 1$,[8] 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.*

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 Proposition 1 reveal that in a framework of sequential move on CSR innovation, firms' R&D decision depends on the fraction of the altruistic consumers. As illustrated in Figure 2, when the scale of the altruistic consumers is large, both firms would like to innovate and compete for those consumers (i.e., in region i). Alternatively, no firm can benefit from letting its competitor be a monopolist in the sub-market. On the other hand, when the scale of the altruistic consumers is so small (i.e., region iv), no firm wishes to innovate.

Thus, we will continue our analysis by following Assumption 2.

[8] 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 $\theta_3 > \theta_2$.

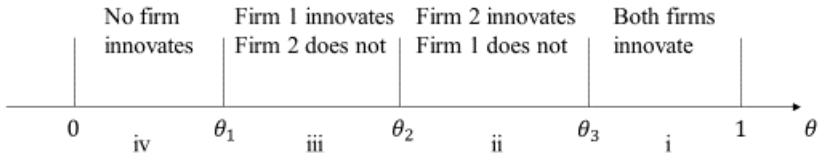

Figure 2 The equilibrium shown in Proposition 1

When the fraction of the altruistic consumers falls in an intermediate range (i.e., in region ii and iii), only one firm wishes to innovate. Specifically, 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 firm 1 from innovating in period 1. This result comes from the presence of the spillover effect from the leader of innovation. One can check further the critical value on θ with respect to σ, as σ falls, θ is more likely to fall in the interval (θ_2, θ_3), suggesting that firm 2 enjoys a strong spillover effect as a "free rider" and limits the firm 1's motivation of innovation. On the other hand, however, if θ falls in the interval (θ_1, θ_2), firm 2 will not have incentive to follow firm 1 in terms of innovation. This is because that the benefit of 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. Consequently, 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

In this section, we investigate a variation of the model in which we allow 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 in period 2, but 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 market of the altruistic consumers by innovating. Thus, the two firms in such a case play a simultaneous game in the second period. The simultaneous game is illustrated in

Table 1 The simultaneous game matrix

		Firm 2	
		CSR	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 show that if $\theta > \theta_1$, the action of CSR innovation is a 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 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 demonstrate the SPNE of the game by analyzing the firm 1's profit over two periods. To be more specific, there exists a 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 $\theta_4 > \theta_3$.[9] Moreover, for some values of c and a, $\theta_4 < 1$.[10] 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.

Most results provided in Proposition 2 are qualitatively same as that in Proposition 1, but the second part in Proposition 2 delivers the most interesting result in this paper, that is, by predicting that firm 2 wishes to innovate, firm 1 may have incentive to *wait for* firm 2 if it has chance to make innovation decision again in period 2.

Having examined the equilibrium regarding part (ii) in Proposition 2 in comparison with that in Proposition 1, we find that, instead of NOT innovating, firm 1 wishes to delay its innovation and does it with its rival in period 2 if the fraction of the altruistic consumers is not large enough (i.e., $\theta_2 < \theta < \theta_4$). The intuition behind this result is that a relatively large θ is attractive for firm 2 to

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

[10] 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.

enter the market of the altruistic consumers, and, it can benefit from being a second mover due to the spillover effect. To weaken such benefit (e.g., the second-mover advantage), firm 1 makes its innovation scheme into the second period and engage into a head-to-head competition with firm 2 in the markets of both normal and altruistic consumers.

Further, it has proved that $\theta_4 > \theta_3$, suggesting that when the fraction of the altruistic consumers is not large enough, i.e., when $\theta \in (\theta_3, \theta_4)$, firm 1 does 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's CSR innovation option is not restricted over periods, and when the faction of the altruistic consumers is not so large, the firm may enter a *patient area* (which is illustrated in Figure 3) and *wait for* its rival's innovation.

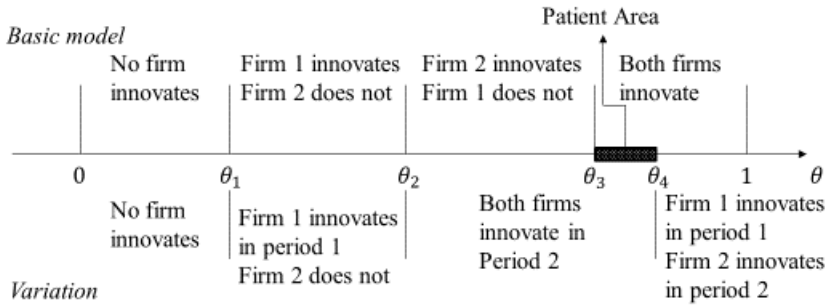

Figure 3 The illustration of patient area

6 Concluding Remarks and Implications

We have studied a firms' incentive of using CSR innovation as a device to compete with its rival. In particular, we have demonstrated that a firm may not always wish to firstly engage into the CSR innovation to dominate the market of the altruistic consumers. This conclusion is built on two premises. First, the CSR innovation has a spillover effect that can benefit the follower of such innovation. This spillover effect can come from information including innovative, technological and knowledge spillover, as well as market information. Second, the altruistic consumer's consciousness on the CSR product is varied in terms of the sequence of innovation. That is, the altruistic consumers have a higher consciousness on the CSR product sold by the innovation leader.

We have demonstrated that the firms' innovation decision crucially depends on the fraction of the altruistic consumers and the spillover effect. Specifically, in the case where the leader of CSR innovation has only one chance to innovate (i.e., it can make decision on innovation in period 1

only), a 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 can 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 presence of the altruistic consumers is not attractive to the follower and hence, the leader will be the monopolist in the market of the socially responsible product.

The variation of model allows a firm has chance to innovate in period 2 if it has not done so in period 1. The results in variation do not fundamentally change but when the fraction of the altruistic consumers is relatively large, a firm wishes to delay its innovation and does it in the second period. This reveals that if the choice of innovation is not restricted to a firm, it may wish to wait for a simultaneous game in the market of the innovative product for the purpose of weakening the spillover effect to the follower of innovation.

One interesting implication of our finding is that a firm may not wish to firstly engage into a CSR innovation even if it can bring an advantage due to the altruistic consumers' preference on the first mover. The presence of the spillover effect prevents the fact of winner-take-all. This phenomenon brings us to the second implication, if the spillover effect is large and is accompanied by a relatively small proportion of the altruistic consumers, neither firms will not engage into a CSR innovation. From a market perspective, this consequence is not desired. Thus, policies are needed to avoid the situation of no innovation. Based on our findings, one possible policy is to subsidise the first mover of CSR innovation. Such subsidy can promote the firm to take the initiative of innovation at beginning by compensating its potential loss to the rival due to the spillover effect. A conjecture from this policy is, when the subsidy or equivalency is considerable, no firms do not wish to be the second mover of innovation.

Appendix

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

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

and

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

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., $\theta_3<\theta_4$. Q.E.D.

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