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The strategic incentive of corporate social responsibility in a vertically related market

Chih-Wei Chang, Chia-Chun Li, and Yan-Shu Lin*

Abstract

We build a duopoly supply chain model to find the optimal degree of CSR. It shows that a unique interior solution exists when the two brand firms decide their manufacturers' degree of CSR; but when they decide the distributors' degree of CSR, they enforce these distributors to fully participate in the CSR activities. Moreover, in the former case, even though consumer surplus and social welfare are better off, the two brand firms' revenues are worse off; in contrast, in the latter case, although consumer surplus and social welfare are worse off, the two brand firms can obtain more revenue.

Key words: corporate social responsibility, vertically related market, two-part tariff

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I. Introduction

It was generally believed in the past that the existence of an enterprise was for earning profits and enhancing shareholder value. However, with society's gradual emphasis on sustainable development, corporate social responsibility (CSR) has become a major indicator of economic expansion and the coordination between society and the environment. Although there is no clear exact definition of CSR, more and more attention has been paid to it from all walks of life. For example, KPMG International Cooperative Taiwan Co., Ltd. released its KPMG Survey of Corporate Responsibility Reporting 2015,[1] indicating that the proportion of firms issuing CSR reports has been over 90% among the world's 250 largest companies since 2011. In addition, the Taiwan Stock Exchange has also required listed firms to prepare CSR reports since 2015.[2] This shows that disclosing non-financial performance information such as that for CSR has become a trend.

Many top journals in recent years have published issues related to CSR,[3] pointing out that the topic is more and more related to enterprises' profits. However, there are still many different opinions about CSR's influence on business profits (Lee,

[1] Source of information: https://home.kpmg.com/xx/en/home/insights/2015/11/kpmg-international-survey-of-corporate-responsibility-reporting-2015.html.

[2] Please refer to "Taiwan Stock Exchange Corporation Rules Governing the Preparation and Filing of Corporate Social Responsibility Reports by TWSE Listed Companies;" material source: http://twse-regulation.twse.com.tw/ENG/EN/law/DAT08.aspx?FLCODE=FL075209.

[3] The literature includes Di Giuli and Kostovetsky (2014), Krüger (2015), Lys et al. (2015), Martin and Moser (2016), and Dimson et al. (2015), who discuss issues related to CSR.

2008), and the only widely accepted view at present is that enterprises incur additional costs in the short run if they undertake CSR. In reality, some enterprises have taken initiatives on corporate social responsibility. For example, IKEA forbids its manufacturers from employing child labor; they must commit to promote the rights of children; and they must give consideration to the mutual development of society and the economy. General Motors has constructed a green manufacturing system, from procurement to distribution, in order to build an entirely green supply chain, which not only can enhance the performance of its cars, but also achieve a win-win situation for the environment and the economy. As the public now cares more and more about what companies do or even boycott products related to "black heart" manufacturers, each firm is afraid of being infected with this name. Thus, "The CSR Guidelines for Suppliers" are also becoming increasingly common. Firms under this standard must consider the costs to society and the environment. In addition to their profit-making targets, they must also consider the non-profit target of their partner companies. In view of this, we use a supply chain model to explore the impact of CSR on a firm's profits and social welfare, given that the firm can decide whether to request its manufacturers or distributors to engage in CSR.

In real-world business situations, two famous supply chains can be an example here: Apple Inc. and Samsung Electronics are both committed to engaging in CSR activities. With Tim Cook assuming Apple leadership in 2011, the focus on CSR aspect of the business was increased to a considerable extent. Tim Cook is a member of Paulson Institute's CEO Council for Sustainable Urbanization, working with other CEOs of top Chinese and Western companies to advance sustainability in China.

There is also like Samsung Electronics, their programs and initiatives are facilitated through the Sustainability Management Council, which consists of 14 related departments that handle issues from 10 different areas, including society and the environment. Samsung Electronics addresses CSR aspects of the business in four directions: social contributions, green management, health and safety and sharing growth.

Many studies in the literature have explored the competition between CSR firms and profit maximizing firms (PMF).[4] For example, compared to two PMFs' traditional wisdom, Nokamura (2013) and Kopel (2015) show that consumer surplus and social welfare are greater under Cournot competition. Furthermore, different from the above two papers, by supposing both firms in the market are involved in CSR activities, Bian et al. (2016) use the principal-agent model to discuss whether the owners have a motivation to ask their managers to engage in CSR activities under horizontal competition and explore the impact of CSR on firms' profits and social welfare.

In accordance with consideration over competition, more and more enterprises are adopting the mode of vertical specialization for their products, implying that supply chain management is turning increasingly important. Thus, both Panda (2014) and Hsueh (2014) discuss the impact of CSR on channel coordination, based on different extents of CSR and authorization methods; both articles find that upstream and downstream firms engaging in CSR may not necessarily increase their profits, but

[4] There is a number of different terms in the literature that denote firms undertaking CSR, such as Nokamura (2013), who calls them consumer-friendly firms, and Kopel (2015), who names them as socially concerned firms. In this article, we collectively refer to them as CSR firms.

it can reduce the problem of double-marginalization, and that manufacturers can obtain the appropriate compensation through a revenue sharing contract. Goering (2012) points out the optimal two-part tariff contract is highly related to the CSR activities of either the upstream manufacturer or the downstream distributor. Brand and Grothe (2015) find that when the manufacturer chooses its degree of CSR to be twice that of the distributor, the two firms' social responsibility can soften the classical double marginalization problem and result in a form of Pareto improvement.

The influence of CSR is extensive, as the main stakeholders involved in the activity include suppliers and consumers related to market operations, along with stockholders and management teams related to the company's internal activities. This article focuses on an economic analysis of the issue, and thus we consider all people in the market as potential consumers, evaluate enterprises' CSR by using consumer surplus, and use a two-part tariff as authorization for vertically related markets. We mainly refer to the setting in Goering (2012) and extend his model to discuss the competition among firms in a duopoly supply chain; in addition, we assume that the brand firm can endogenously choose the degree of CSR of its manufacturer or distributor. Based on this, we set up two cases: one is when the two brand firms decide their manufacturer's degree of CSR; the other is when both brand firms select to enforce the downstream distributor in their supply chain to participate in CSR activities. We also explore the strategic incentive of CSR and its impact on consumer surplus and social welfare and find out optimal degree of CSR in the two cases, respectively.

In this paper, we want to know whether firms' social responsibility results in a

Pareto improvement. Interestingly, we note that different from the case of successive monopoly, if there are two supply chains competing in the market, then in the former case the upstream firms will fall into the prisoner's dilemma when they both are engaged in CSR activities; in the latter case, as the downstream firms participate in more CSR activities, producer surplus will increase, but consumer surplus and social welfare become worse off. Hence, in the latter case, it seems to be that the firms deliberately wear the mask of goodwill of CSR in order to seek higher revenue by cutting down on consumer surplus and social welfare. This highlights the importance of imposing CSR requirements on the right supply chain partners.

The rest of this paper is structured as follows. Section 2 introduces the basic model framework. Section 3 analyzes the results of the two cases and then compares the difference between those outcomes in section 4. The last section concludes our findings.

II. Basic Model Framework

Suppose there are two supply chains 1, 2 in the market. In each supply chain, there is a brand firm (hereafter, the owner) which owns a manufacturer to produce its product, and the upstream manufacturer authorizes the product to the exclusive downstream distributor via a two-part tariff,[5] so that the distributor can sell the products.[6] We use superscripts u and d to represent the upstream manufacturer and the downstream

[5] The two-part tariff fits more in our story, since the downstream distributors only sell the products made by upstream manufacturers, rather than buy some materials from upstream firms to produce a new good. The results set in a one-part tariff can be available upon request.

[6] We assume both supply chains maintain an exclusive distribution relationship - that is, the downstream distributor only can sell products produced by the upstream manufacturer in the same supply chain.

distributor, respectively. For simplification and without loss of generality, we assume the manufacturers in the two supply chains have same costs function, such that the marginal costs of the manufacturers are c, while fixed costs are zero. Moreover, there is no additional cost to the distributors after paying the manufacturers' two-part tariff. Suppose the inverse demand of the market is $p = p(Q)$, where $p' < 0$, $p'' = 0$, and the total output Q in the market will be the sum of the sales of the distributors in the two supply chains - that is, $Q = \sum_{1,2} q_i, i = 1,2$. Therefore, the distributor i's profit function is $\pi_i^d = (p - w_i)q_i - F_i, i = 1,2$, where p is the product's market price, q_i is the quantity, and w_i and F_i are the royalty rate and fixed franchise fee paid to its upstream manufacturer i, respectively. Similarly, we express the manufacturers' profit function $\pi_i^u = (w_i - c)q_i + F_i, i = 1,2$.

We further suppose the owner in the marketing chain is "socially concerned" and can endogenously choose the degree of CSR of its manufacturer or distributor. Let the parameter $\theta_i^u, \theta_i^d \in [0,1]$ respectively represent the degree to which the owner requires its manufacturer or distributor to participate in CSR activities. However, it is a little harder to deal with the process whereby the owner endogenously chooses θ_i^u and θ_i^d at the same time;[7] hence, we suppose the owners either simultaneously choose their own manufacturer's degree of CSR, $\theta_i^u, i = 1,2$, or simultaneously decide the degree of CSR of the downstream distributors in the same supply chain, $\theta_i^d, i = 1,2$.[8] For convenience, we call the former case as CSR manufacturers and PMF distributors (CP regime hereafter) and the latter case as PMF manufacturers and

[7] The owner simultaneously chooses that θ_i^u and θ_i^d can be used as further research in the future.
[8] In this article, we do not analyze the situation whereby one owner chooses θ^u while the other owner chooses θ^d. This can be used as further research in the future.

CSR distributors (PC regime hereafter).

As so far, the timing of the game can be expressed as follows. First, the two owners simultaneously determine the optimal degree of CSR, θ_i^u in the CP regime (or θ_i^d in the PC regime), to maximize their own revenue R_i.[9] Afterwards, for the given θ_i^u (or θ_i^d) in the first stage, the two upstream manufacturers choose the optimal royalty rate w_i and fixed franchise fee F_i to maximizes the new objective function $V_i^u = (w_i - c)q_i + F_i + \theta_i^u CS$ in the CP regime (or maximizes its own profit π_i^u in the PC regime).[10] Finally, given the pair of authorization fees $\{w_i, F_i\}$ determined by its upstream manufacturer, in order to maximize its own profit in the CP regime (or maximize the new objective function $V_i^d = (p - w_i)q_i - F_i + \theta_i^d CS$ in the PC regime),[11] the two downstream distributors decide the quantities of sales to the end consumers.

According to Goering (2012), if there is only one supply chain in the market (i.e. successive monopoly), then we can infer that the optimal θ^u is equal to zero in the CP regime, since the manufacturer already extracts all industrial profits via using a two-part tariff. Therefore, if the owner asks its manufacturer to participate in CSR activities, then this will cause the royalty rate and fixed franchise fee to deviate from the optimal two-part tariff, in turn leading to the quantities of output to no longer equal the monopoly level and then inducing a loss in owner's revenue. In the PC regime, no matter whether or not the owner asks the downstream distributor to

[9] Because the manufacturer i authorizes the product to the downstream distributor i in the supply chain via a two-part tariff, it implies that the owner i is maximizing its revenue R_i to equal maximizing the manufacturer i's profit function π_i^u.

[10] The manufacturer's objective function is modified to include not only its profit, but also consumer surplus, since the owner enforces its manufacturer to participate in CSR activities.

[11] In the PC regime, the distributor is now concerned not only about its profit, but also consumer surplus, since the owner asks its downstream distributor to participate in CSR activities.

participate in a set amount of CSR activities, the manufacturer can put up a corresponding two-part tariff to force the distributor's quantities of output to still equal the monopoly level, so as to extract all industrial profits. In other words, regardless of the value of θ^d, the owner's revenue does not change.

III. Analysis and Results

Based on basic model framework, this section can be separate into two subsections. In both subsection, we use backward induction to derive the equilibrium outcomes of the cases of CP regime and PC regime, respectively.

3.1 CP regime

Based on backward induction, we first deal with the third stage: the two distributors compete in quantity. Therefore, differentiating π_i^d with respect to output q_i, we can derive the reaction functions as:

$$\frac{\partial \pi_i^d}{\partial q_i} = p' \cdot q_i + (p - w_i) = 0, i = 1,2. \quad (1)$$[12]

In addition, we further deduce the result of comparative static analysis through Equation (1): $\partial q_i/\partial w_i = 2/3p' < 0, i = 1,2$ and $\partial q_j/\partial w_i = -1/3p' > 0, i, j = 1,2, i \neq j$. This result is in line with a standard feature of Cournot competition: its own rise in marginal production cost (i.e. royalty rate) will decrease the amount of sales and cause the opponent's amount of sales to increase.

In the second stage, because the distributors can only sell products produced by

[12] Both the second-order condition $2p' < 0$ and stability condition $3(p')^2 > 0$ are satisfied.

the manufacturer in the same supply chain, it implies the manufacturers still can take advantage of the two-part tariff to extract the full benefits from the distributors - that is, we deduce that the fixed franchise fee will be set at $F_i = (p - w_i)q_i, i = 1,2$. Therefore, now the manufacturers' objective function will be rewritten as $V_i^u = (p - c)q_i + \theta_i^u CS, i = 1,2$. Differentiating the objective function with respect to the royalty rate w_i, we now have:

$$\frac{\partial V_i^u}{\partial w_i} = p' \cdot \frac{\partial Q}{\partial w_i} \cdot q_i + (p - c) \cdot \frac{\partial q_i}{\partial w_i} - \theta_i^u \cdot p' \cdot \frac{\partial Q}{\partial w_i} \cdot Q = 0, i = 1,2. \quad (2)^{13}$$

The optimal royalty rates solved by the above simultaneous Equation (2) are a function of the manufacturer's degree of CSR θ_i^u, which is determined by the owners in the first stage, i.e. $w_i = w_i^u(\theta_i^u, \theta_j^u)$.

Taking the results of comparative static analysis of the third stage into the total derivative of Equation (2), we can derive how θ_i^u influences the royalty rates decided by the manufacturers: $\partial w_i / \partial \theta_i^u = (4 - \theta_j^u)p'Q/(5 - \theta_i^u - \theta_j^u) < 0, i = 1,2$ and $\partial w_j / \partial \theta_i^u = -(1 - \theta_j^u)p'Q/(5 - \theta_i^u - \theta_j^u) > 0, i, j = 1,2, i \neq j$. These results indicate that when the owner asks its manufacturer to participate in more CSR activities, this will cause its own manufacturer to set a lower royalty rate; however, if the rival owner increases the extent to which its manufacturer participates in CSR activities, then this will lead to our manufacturer to choose a higher royalty rate. The reason is that in this stage of the game, even though now the two manufacturers decide the royalty rate to maximize the new objective functions V_i^u rather than the

[13] In this stage, the both second-order condition $p' \frac{\partial Q}{\partial w_i}\left[(2 - \theta_i^u)\frac{\partial q_i}{\partial w_i} - \theta_i^u \frac{\partial q_j}{\partial w_i}\right] < 0$ and stability condition $\left(p' \frac{\partial Q}{\partial w_i}\right)^2 \left\{2\theta_i^u \left[\left(\frac{\partial q_i}{\partial w_i}\right)^2 + \left(\frac{\partial q_j}{\partial w_i}\right)^2\right] - 2\frac{\partial q_i}{\partial w_i}\frac{\partial q_j}{\partial w_i} + \left[\left(\frac{\partial q_i}{\partial w_i}\right)^2 - \left(\frac{\partial q_j}{\partial w_i}\right)^2\right]\right\} > 0$ are also satisfied.

original profit functions π_i^u, the two reaction functions are still strategic substitutes[14] (see the following Figure 1; the proof of the reaction functions is a negative slope; please refer to Appendix A).

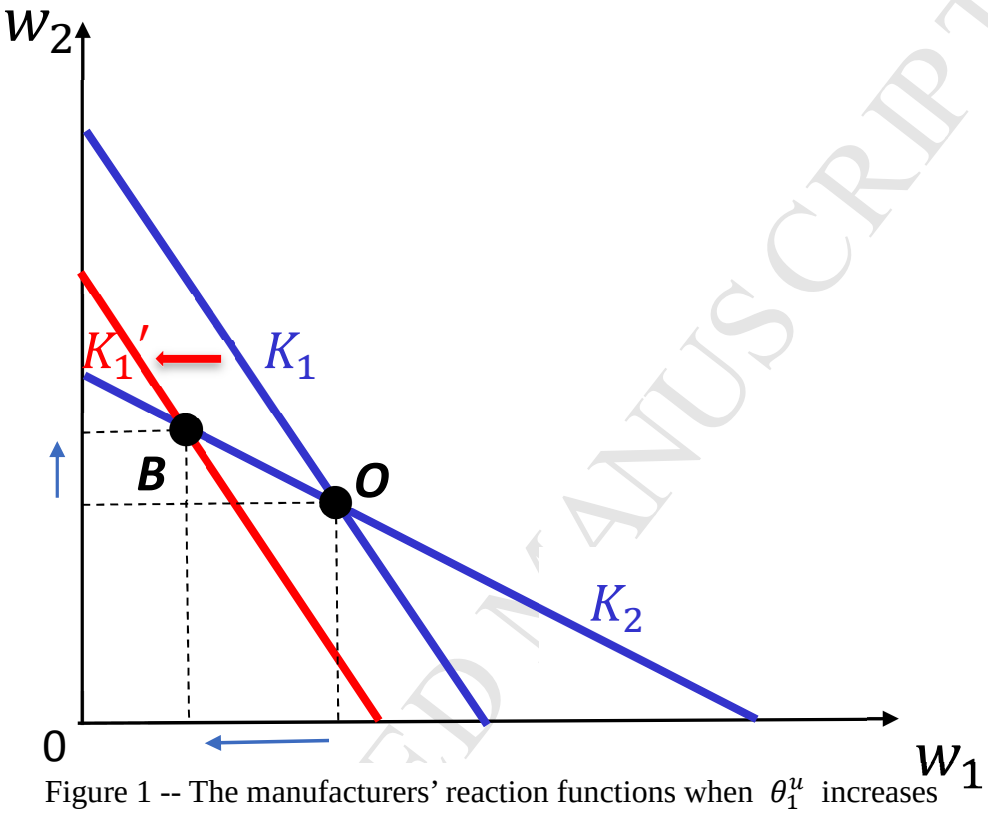

Figure 1 -- The manufacturers' reaction functions when θ_1^u increases (**CP regime**)

In Figure 1, K_1 and K_2 represent the two manufacturers' reaction functions, respectively. When θ_1^u increases, K_1 shifts inward to K_1' and K_2 is unchanged, thus inducing the combination of optimal royalty rates moving from the original equilibrium point O to the new equilibrium point B, so that w_1 falls and w_2 rises.

Finally, in the first stage it is known that the manufacturer, using a two-part tariff scheme, can fully extract the distributor's profit. Thus, we can rewrite the owner's objective function as $\pi_i^u = (p-c)q_i, i = 1,2$. Therefore, the corresponding

[14] Differentiating Equation (2) with respect to w_j, we have $\partial^2 V_i^u/\partial w_i \partial w_j = (1-\theta_i^u)/9p' < 0$.

first-order conditions are:

$$\frac{\partial \pi_i^u}{\partial \theta_i^u} = \underbrace{\frac{\partial w_i}{\partial \theta_i^u} \cdot \left[p' \cdot \frac{\partial Q}{\partial w_i} \cdot q_i + (p-c) \cdot \frac{\partial q_i}{\partial w_i}\right]}_{\text{"-" } Owner\ Effect}$$

$$+ \underbrace{\frac{\partial w_j}{\partial \theta_i^u} \cdot \left[p' \cdot \frac{\partial Q}{\partial w_j} \cdot q_i + (p-c) \cdot \frac{\partial q_i}{\partial w_j}\right]}_{\text{"+" } Strategic\ Effect} = 0, i, j = 1,2, i \neq j. \quad (3)$$

We can prove that both the second-order condition and stability condition are also satisfied in this stage through the results of comparative static analysis in the second and third stages.[15] We call the first term in the right-hand side of Equation (5) the *Owner Effect*, and from Equation (2) we know that this effect is negative. The *Owner Effect* shows that when the owner asks the manufacturer to participate in more CSR activities, its manufacturer will set up a lower royalty rate, so as to induce a loss in the owner's revenue. We call the second term in the right-hand side of Equation (3) the *Strategic Effect*, which is positive. The *Strategic Effect* means that when the owner asks its own manufacturer to participate in more CSR activities, this will lead the manufacturer in the opponent supply chain to set up a higher royalty rate, so as to increase the owner's revenue. These two effects imply that the optimal equilibrium outcomes in the first stage will present a set of interior solution - that is $\{\theta_1^{u*}, \theta_2^{u*}\}$. Here, we offer our first proposition.

Proposition 1: Under the existence of competition, there is a unique interior

[15] In the first stage, the second-order condition is $p'\left(\frac{\partial q_i}{\partial w_i} + \frac{\partial q_j}{\partial w_i}\right)\frac{\partial w_i}{\partial \theta_i^u}\left[\left(2\frac{\partial q_i}{\partial w_i} + \frac{\partial q_j}{\partial w_i}\right)\left(\frac{\partial w_i}{\partial \theta_i^u} + \frac{\partial w_j}{\partial \theta_i^u}\right) + 2\frac{\partial q_i}{\partial w_j}\frac{\partial w_j}{\partial \theta_i^u}\right] \leq 0$, and the stability condition is $\left\{p'\left(\frac{\partial q_i}{\partial w_i} + \frac{\partial q_j}{\partial w_i}\right)\left[\left(2\frac{\partial q_i}{\partial w_i} + \frac{\partial q_j}{\partial w_i}\right)\left(\frac{\partial w_i}{\partial \theta_i^u} + \frac{\partial w_j}{\partial \theta_i^u}\right) + 2\frac{\partial q_i}{\partial w_j}\frac{\partial w_j}{\partial \theta_i^u}\right]\right\}^2 \left[\left(\frac{\partial w_i}{\partial \theta_i^u}\right)^2 - \left(\frac{\partial w_j}{\partial \theta_i^u}\right)^2\right] \geq 0.$

solution, i.e. $\theta_i^{u*} \in (0,1), i = 1,2$, when the two owners simultaneously decide their manufacturers' degree of CSR.

Compared with Goering (2012), when there is only one supply chain in the market, as long as the manufacturer uses the two-part tariff to charge the authorization fee to the downstream distributor, it is enough for the owner to extract all industrial profits; hence, the optimal θ^u will be zero (i.e. the owner will not allow the manufacturer to participate in any CSR activities). However, in our model because there are two supply chains competing in the market, the downstream distributors are engaged in Cournot competition. In order to occupy a greater market share, each owner will ask its manufacturer to participate in some CSR activities and to set up a lower royalty rate, so that the distributor in the supply chain can have a cost advantage and sell more products.

3.2 PC regime

This subsection focuses on the CSR distributors - that is, the two owners simultaneously enforce the downstream distributors in their supply chain to participate in CSR activities. Differentiating the objective function V_i^d with respect to q_i, we obtain:

$$\frac{\partial V_i^d}{\partial q_i} = p' \cdot q_i + (p - w_i) - \theta_i^d \cdot p' \cdot Q = 0, i = 1,2. \quad (4)^{16}$$

Different from the previous subsection, the quantities derived by simultaneously solving Equation (1) are just only a function of the royalty rates and are not directly

[16] Both the second-order condition $(2 - \theta_i^d)p' < 0$ and stability condition $(3 - 2\theta_i^d)(p')^2 > 0$ are satisfied.

affected by θ_i^u. However, in this case, simultaneously solving Equation (4) we now obtain $q = q_i\left(w_i\left(\theta_i^d, \theta_j^d\right), w_j\left(\theta_i^d, \theta_j^d\right), \theta_i^d, \theta_j^d\right), i, j = 1,2, i \neq j$. It implies that the distributors' degree of CSR, θ_i^d, $i = 1,2$, not only indirectly affects the quantities through the royalty rates, but also directly influences the distributors' decision.

We therefore can derive the results of comparative static analysis from a total derivative of Equation (4): $\partial q_i/\partial w_i = \left(2 - \theta_j^d\right)/\left(3 - \theta_i^d - \theta_j^d\right)p' < 0$ and $\partial q_j/\partial w_i = -\left(1 - \theta_j^d\right)/\left(3 - \theta_i^d - \theta_j^d\right)p' > 0, i, j = 1,2, i \neq j$. These results are consistent with the previous subsection, whereby when the manufacturer charges a higher royalty rate, the distributor in the same supply chain will decrease its sales, while the sales of the distributor in the opponent supply chain increase. Moreover, through the above results, we can further derive the impact of the distributors' degree of CSR on the quantities: $\partial q_i/\partial \theta_i^d = \left(2 - \theta_j^d\right)Q/\left(3 - \theta_i^d - \theta_j^d\right) > 0$ and $\partial q_j/\partial \theta_i^d = -\left(1 - \theta_j^d\right)Q/\left(3 - \theta_i^d - \theta_j^d\right) < 0, i, j = 1,2, i \neq j$; when the distributor participates in more CSR activities, it tends to sell more products, resulting in a reduction in its rival's sales. These results are also consistent with the intuition behind competition in quantities: when the firm pays more attention to consumer surplus, the higher the output is, the lower the opponent's output is.

In the second stage, the distributors' profits again will be completely extracted by the manufacturers through the two-part tariff, so we know that now the two manufacturers aim at: $Max_{w_i}\, \pi_i^u$, where $\pi_i^u = (p - c)q_i, i = 1,2$. Thus, the necessary conditions for the manufacturers to find the optimal royalty rate can be expressed as follows:

$$\frac{\partial \pi_i^u}{\partial w_i} = p' \cdot \frac{\partial Q}{\partial w_i} \cdot q_i + (p - c) \cdot \frac{\partial q_i}{\partial w_i} = 0, i = 1,2. \quad (5)^{17}$$

Similarly, from the total derivative of Equation (5) and the results of comparative static analysis in the third stage, we can derive that when the owners ask the distributors to participate in more CSR activities that this will lead to both manufacturers to set up higher royalty rates: $\partial w_i / \partial \theta_i^d = -\left(2 - \theta_j^d\right)\theta_j^d p' Q / \left(3 - \theta_i^d - 2\theta_j^d\right) > 0$ and $\partial w_j / \partial \theta_i^d = -\left(1 - \theta_j^d\right)\theta_j^d p' Q / \left(3 - \theta_i^d - 2\theta_j^d\right) > 0, i, j = 1,2, i \neq j.$

Unlike the previous subsection, although the reaction functions of the manufacturers are still strategic substitution in this stage,[18] however, the quantities sold by the distributors are not only indirectly affected by θ_i^d through the royalty rates, but the distributors' degree of CSR also directly affects its sales in the case of the PC regime. When the distributors in supply chain 1 have to participate in CSR activities, it implies the derived demand will increase, and so the manufacturer in supply chain 1 tends to set up a higher royalty rate, causing only a slight increase in q_1.

If the manufacturer in supply chain 2 also raise the royalty rate, then although this will cause q_2 to drop, the advantage is that total market output will decrease (because the competition in quantities between the two distributors is also strategic substitution; and the increase in q_1 will be less than the decrease in q_2). This then induces the market price to rise, resulting in an increase in the benefit of per unit of

[17] In this stage, both the second-order condition $2p' \frac{\partial Q}{\partial w_i} \frac{\partial q_i}{\partial w_i} < 0$ and stability condition $\left(p' \frac{\partial Q}{\partial w_i}\right)^2 \left\{2 \frac{\partial q_i}{\partial w_i}\left(\frac{\partial q_i}{\partial w_i} - \frac{\partial q_j}{\partial w_i}\right) + \left[\left(\frac{\partial q_i}{\partial w_i}\right)^2 - \left(\frac{\partial q_j}{\partial w_i}\right)^2\right]\right\} > 0$ are also satisfied.

[18] Differentiating Equation (8) with respect to w_j, we have $\partial^2 \pi_i^u / \partial w_i \partial w_j = \left(1 + \theta_i^d - \theta_j^d\right) / \left(3 - \theta_i^d - \theta_j^d\right)^2 p' < 0$.

sales. That is why the reaction function of the manufacturer in supply chain 2 also moves outward when θ_1^d increases. See the following Figure 2.

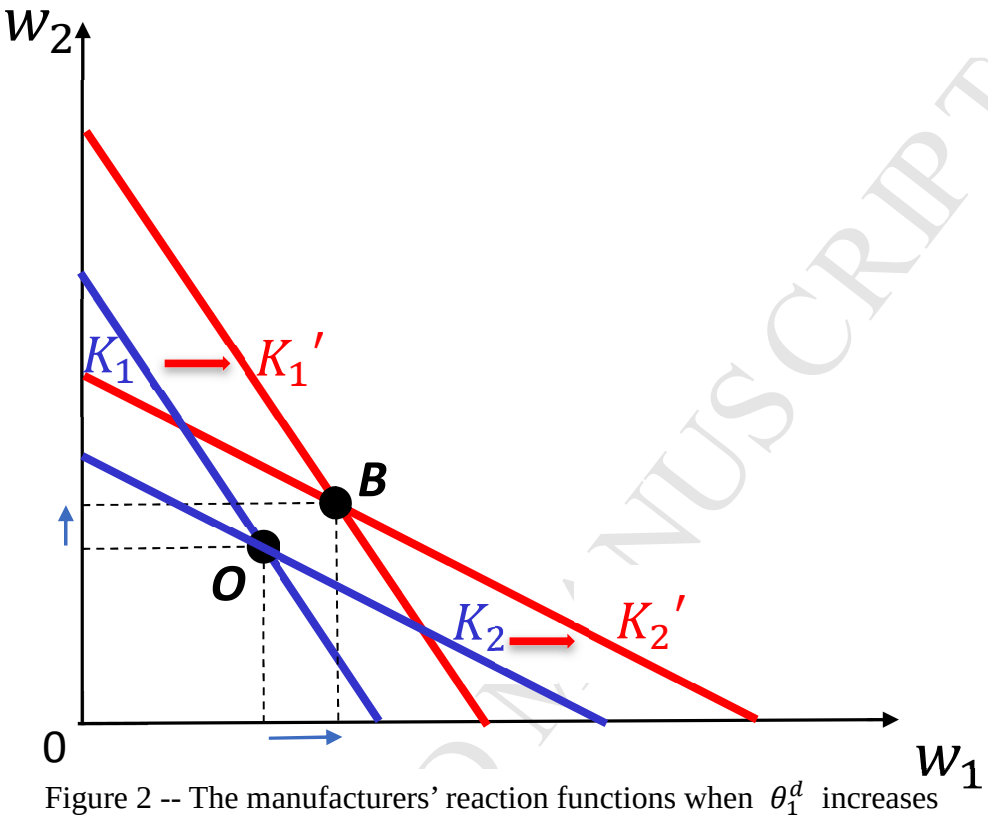

Figure 2 -- The manufacturers' reaction functions when θ_1^d increases (**PC regime**)

We so far know that when the owner asks the distributor in the same supply chain to participate in more CSR activities, this will not only affect the reaction function of its own manufacturer, but also affect the opponent manufacturer's reaction function. Therefore, when θ_1^d increases, K_1 and K_2 will shift to K_1' and K_2', respectively, inducing the combination of optimal royalty rates to move from the original equilibrium point O to the new equilibrium point B, and then both w_1 and w_2 increase.

Finally, the owners determine the optimal degree of CSR of the distributors. In the PC regime, the owner has the same objective function as its own manufacturer,

but the endogenous variables chosen are different. Note that, because the distributors' degree of CSR not only indirectly affect the quantities through the royalty rates, it also directly influences the distributors' decision, i.e., $q = q_i\left(w_i\left(\theta_i^d, \theta_j^d\right), w_j\left(\theta_i^d, \theta_j^d\right), \theta_i^d, \theta_j^d\right), i, j = 1,2, i \neq j$, and so now the first-order conditions for the owners to maximize revenues are:

$$\frac{\partial \pi_i^u}{\partial \theta_i^d} = \underbrace{\frac{\partial w_i}{\partial \theta_i^d} \cdot \left[p' \cdot \frac{\partial Q}{\partial w_i} \cdot q_i + (p-c) \cdot \frac{\partial q_i}{\partial w_i}\right]}_{\text{"0" via stage 2, } Owner\ Effect} + \underbrace{\frac{\partial w_j}{\partial \theta_i^d} \cdot \left[p' \cdot \frac{\partial Q}{\partial w_j} \cdot q_i + (p-c) \cdot \frac{\partial q_i}{\partial w_j}\right]}_{\text{"+" } Strategic\ Effect} + \underbrace{\left\{\frac{\partial q_i}{\partial \theta_i^d} \cdot [p' \cdot q_i + (p-c)] + \frac{\partial q_j}{\partial \theta_i^d} \cdot p' \cdot q_i\right\}}_{\text{"0" } Output\ Effect}, i, j = 1,2, i \neq j. \quad (6)$$

Similar to the previous subsection, here we call the first term in the right-hand side of Equation (6) the *Owner Effect*, and this effect is zero since this term is just equal to the first-order condition of the second stage, i.e., the manufacturers who make the decision in the second stage can internalize the effect of the distributors participating in the CSR activities. For the second term in the right-hand side of Equation (6), the *Strategic Effect* remains the same and still is positive.

In the case of the PC regime, there is an additional effect we call the *Output Effect*, which is the final term in the right-hand side of Equation (6) and represents the direct impact of θ_i^d on the distributors' decision. Fortunately, from Equation (5) and the results of comparative static analysis in the second and third stages, we can derive that this effect will also be zero. The sum of these three effects shows that Equation (6) is always positive, implying that the optimal distributors' degree of CSR will be the corner solution, i.e., $\{\theta_1^{d^*}, \theta_2^{d^*}\} = \{1,1\}$. Here, we present our second proposition.

Proposition 2: Under the existence of competition, given the owners decide to enforce the distributors to participate in CSR activities, they will set the degree of

CSR equal to one, i.e. $\theta_i^{d^*} = 1, i = 1,2$.

In this case our model has two differential points from Goering (2012): First, we consider the duopoly supply chain; second, we assume the distributor's degree of CSR is determined by the owner rather than itself. Nevertheless, from Goering (2012), there is only one supply chain in the market; even if the distributor's degree of CSR is determined by the owner, we can infer that the optimal θ^d will be an arbitrary value between 0 and 1. The reason is that the number of CSR activities the distributor participates in does not affect the owner's ultimate revenue, because the manufacturer can always set up a corresponding two-part tariff to extract all industrial profits. However, Proposition 2 shows that if there are two supply chains competing in the market, then the two owners will set the distributors' degree of CSR up to 1, i.e., $\theta_i^{d^*} = 1, i = 1,2$. The intuition behind this runs as follows. When the owner increases the distributor's degree of CSR, the final outputs of the rival supply chain will be closer to the case of vertical integration under no CSR activities.[19] This provides an incentive for the two owners to ask the distributors in their supply chain to participate in more CSR activities, such that reducing each other's final output can achieve the situation that resembles collusion.

IV. Comparison

In this section we compare the equilibrium outcomes under the cases of CP regime, PC regime, and without any CSR. In addition, we will compare consumer surplus,

[19] Based on the results of the second and third stages in this case, the optimal quantities sold by the distributors can be expressed as $q_i = -\left(2 - \theta_j^d\right)(p - c)/p', i, j = 1,2, i \neq j$. In the case of vertical integration under no CSR activities, the optimal quantities will be $q_i = -(p - c)/p', i = 1,2$.

owner's revenue, and social welfare under these three regimes. We use superscripts CP, PC, and N to respectively represent the results that correspond to these three cases. In order to be able to compare those results, here we assume that the inverse demand function of the market is $p(Q) = a - bQ$ and then summarize the equilibrium outcomes (i.e., optimal quantities, royalty rates, fixed franchise fee, owner's revenue, degree of CSR, consumer surplus, and social welfare) of these three cases in Table 1 below.[20]

From the results shown in Table 1, we first look at the optimal quantities and royalty rates, when the owners enforce their manufacturers to participate in CSR activities, which induce the manufacturers to set up a lower royalty rates. Hence, the distributors will sell more products since the marginal costs (i.e., royalty rates) are lower. However, if the owners decide the degree of CSR by the distributors rather than the manufacturers, then this will lead to the distributors being tempted to sell more products, while at the same time the derived demand will increase and induce the manufacturers to set up higher royalty rates, thus inhibiting the final outputs. As for the part of the fixed franchise fee, it is in line with general intuition: the higher the royalty rate is, the lower the fixed franchise fee is, since the downstream distributor has lower profit.

We next explore owner's revenue, consumer surplus, and social welfare in these three cases. Notice that the profit of the entire supply chain is equal to the owner's revenue, since the manufacturer charges the distributor by means of a two-part tariff.

[20] In Table 1, under PC regime, observe that the fixed fee of a two-part tariff is negative. To assure the downstream distributors can survive, the manufacturers have to set a lower fixed franchise fee, which is why the fixed franchise fee will eventually be negative.

Interestingly, from Table 1 we can see that the owners obtain higher revenue when they ask the distributors to completely participate in CSR activities (i.e., the case of the PC regime). On the other hand, in terms of consumer surplus, in the CP regime, there are some firms (manufacturers) involved in CSR activities, and intuitively the consumer surplus is also higher; but in the PC regime, although there are still some firms (distributors) being asked to consider CSR, the consumer surplus is instead lower. Therefore, in total we observe that social welfare is the lowest in the PC regime. Summarizing the above, we offer the following proposition.

Proposition 3: Overall consumer surplus and social welfare are better (worse) if the owners ask their manufacturers (distributors) to engage in CSR; however, if the owners force their distributors (manufacturers) to participate in CSR activities, then this leads to an increase (decrease) in industry profit.

To figure out the economic intuition behind this third proposition, we first know that, under Cournot competition, the key factor determining consumer surplus and social welfare is the total outputs in the market. In addition, because the manufacturers charge the distributors via the two-part tariff, given that the rival supply chain is unchanged, the owner's ultimate revenue will increase if the distributor in the same supply chain can sell more products.

In the CP regime the owner only can control its manufacturer's degree of CSR. In the beginning, the owner hopes its manufacturer can set up a lower royalty rate, so that the distributor in the same supply chain can sell at lower marginal costs and hence occupy a greater market share. In the end, there are too many outputs in the

market, which brings about a decline in overall industrial profits, but enhances consumer surplus and social welfare. Interestingly, although the two owners know that it would be better if they both do not allow their manufacturers to participate in any CSR activities, they will fall into the situation of prisoner's dilemma, resulting in their ultimate revenues turning lower than in the case of no CSR activities (for the proof, please refer to Appendix B).

For the PC regime, when the owner asks the distributor in the same supply chain to participate in more CSR, both the manufacturer and the rival manufacturer will set up a higher royalty rate. In addition, compared with the distributor's degree of CSR, the royalty rate has a greater impact on the quantities sold by the distributor. Therefore, as the two owners ask the distributors to participate in more CSR, the final output will be closer to the case of vertical integration under no CSR. That is why in this case the overall industrial profits eventually increase, while consumer surplus and social welfare deteriorate.

Combining the above results, we see from Table 1 that the sequence of quantities is $q_i^{CP} > q_i^N > q_i^{PC}$, which also leads to the ranking of consumer surplus and social welfare as $CS^{CP} > CS^N > CS^{PC}$ and $W^{CP} > W^N > W^{PC}$. However, as far as overall industrial profits are concerned, the sequence completely reverses: $\pi_i^{u\_CP} < \pi_i^{u\_N} < \pi_i^{u\_PC}$. Thus, from the point of view of society, the government should encourage owners to enforce upstream manufacturers instead of downstream distributors to be involved in CSR activities, unless the government wants to deliberately favor a certain industrial sector.

V. Conclusion

This paper establishes a three-stage game. In the first stage, the owner determines the optimal degree of CSR to maximize its own profit. In the second stage, the upstream manufacturer chooses the optimal royalty rate and fixed franchise fee. In the third stage, the downstream distributor sells the product to the final market of end consumers. We find that owners have an incentive to ask their manufacturers (or distributors) to participate in CSR activities. The difference is that, under the CP regime, the two owners try to involve their manufacturers in some CSR activities, making the distributors in their supply chain claim more advantages in competition and occupy a greater market share. Because both of them consider the same situation, it turns into a prisoner's dilemma. The ultimate revenues of the two owners are thus lower versus the case of no CSR, but consumer surplus and social welfare benefit from the increase in total output. In the PC regime, the owners now decide the distributors' degree of CSR; the manufacturers will set higher royalty rates, resulting in a final reduction of total market output, causing the two owners to form a situation that resembles collusion. As a result, consumer surplus and social welfare are undermined. Corporate social responsibility thus becomes a part of owners' marketing tactics.

This paper has expanded and compared the model of Goering (2012). Under the existence of competition, we show that the owner has incentive to ask it manufacturer to participate in CSR activities, and so the distributor in the supply chain has a cost advantage to sell more products and occupy a greater market share. This result differs very much from Goering (2012). In his finding, the manufacturer does not participate

in any CSR activities when there is only one supply chain occupying the entire market. Moreover, the model of Goering (2012) implies that no matter whether the owner asks the downstream distributor to participate in a number of CSR activities, the owner's revenue does not change. However, under the existence of competition, we find that the owner will force its distributors to fully participate in the CSR activities. While more and more articles, such as Brand and Grothe (2015), point out that CSR can simultaneously increase a firm's profit and consumer surplus, in this paper we show that CSR does not give consideration to both of these two factors. In the PC regime, the owners voluntarily force their distributors to participate in CSR activities, but consumer surplus and social welfare turns worse than for the case of no CSR. These results are worth pondering, because, although there is no clear and unified indicator to evaluate corporate social responsibility at present, the literature, the business world, and society are paying greater attention to it. CSR is no longer just used for the internal self-regulation of enterprises. Aside from the influence of internal suppliers in the supply chain, CSR also affects the choice of cooperation among manufacturers or even further influences the mode of market competition.

The topic of corporate social responsibility is certainly becoming more and more diversified. In terms of future research, the direction of this article can be first extended to the case when an owner can choose the degrees of CSR of both the manufacturer and the distributor at the same time. Second, we can introduce an asymmetrical strategy into the model - that is, one owner chooses the manufacturer's degree of CSR, while the other owner chooses the distributor's degree of CSR. We could also just modify our model via changing the competition scheme of the

distributors (i.e., Bertrand competition). Moreover, we can look into different structures of the supply chain - for example, when there is only one manufacturer, both brand firms will trust the manufacturer to produce their product, and then those end products can be authorized for sale by multiple distributors. If these extensions can take into account actual laws and regulations, then the findings would be closer to the reality of the market situation, making them more useful for policy reference.

Reference

Bian, J., Li, K., and Guo, X. (2016), "A strategic analysis of incorporating CSR into managerial incentive design," *Transportation Research Part E: Logistics and Transportation Review* 86, 83-93.

Brand, B. and Grothe, M. (2015), "Social responsibility in a bilateral monopoly," *Journal of Economics* 115, 275-289.

Chang, C. W., Wu, D. R., and Lin, Y. S. (2017), "Price Control and Privatization in a Mixed Duopoly with a Public Social Enterprise," *Journal of Economics*, forthcoming. J Econ DOI 10.1007/s00712-017-0564-2

Di Giuli, A., and Kostovetsky, L. (2014), "Are red or blue companies more likely to go green? Politics and corporate social responsibility," *Journal of Financial Economics* 111, 158-180.

Dimson, E., Karakaş, Q., and Li, X. (2015), "Active Ownership," *Review of Financial Studies* 28, 3225-3268.

Goering, G. E. (2012), "Corporate social responsibility and marketing channel coordination," *Research in Economics* 66, 142-148.

Hsueh, C. F. (2014), "Improving corporate social responsibility in a supply chain through a new revenue sharing contract," *International Journal of Production Economics* 151, 214-222.

Kopel, M. (2015), "Price and quantity contracts in a mixed duopoly with a socially concerned firm," *Managerial and Decision Economics* 36, 559-566.

Krüger, P. (2015), "Corporate goodness and shareholder wealth," *Journal of Financial Economics* 115, 304-329.

Lambertini, L. and Tampieri, A. (2010), "Corporate social responsibility and firms

ability to collude," in Boubaker, S., Nguyen, D. K. (Eds.), *Board Directors and Corporate Social Responsibility*, 167-178.

Lee, M. P. (2008), "A review of the theories of corporate social responsibility: its evolutionary path and the road ahead," *International Journal of Management Reviews* 10, 53-73.

Lys, T., Naughton, J. P., and Wang, C. (2015), "Signaling through corporate accountability reporting," *Journal of Accounting and Economics* 60, 56-72.

Martin, P. R., and Moser, D. V. (2016), "Managers' green investment disclosures and investors' reaction," *Journal of Accounting and Economics* 61, 239-254.

Nokamura, Y. (2013), "Quantity competition and price competition with a duopoly in a consumer-friendly firm: a welfare analysis," *Modern Economy* 4, 776-782.

Panda, S. (2014), "Coordination of socially responsible supply chain using revenue sharing contract," *Transportation Research Part E: Logistics and Transportation Review* 67, 92-104.

Appendix A

Given the inverse demand function of the market is $p(Q) = a - bQ$, here we will prove that the slopes of the reaction functions in Figures 1 and 2 are negative and show the movement direction of those reaction functions when the degree of CSR (i.e., $\theta_i^k, i = 1,2, k = u, d$) increases.

(1) **CP regime**

The first-order conditions of Equation (2) are:

$$\frac{\partial V_i^u}{\partial w_i} = -\frac{1}{9b}\left[(1 + 2\theta_i^u)a - 6c + (4 - \theta_i^u)w_i + (1 - \theta_i^u)w_j\right] = 0, i, j = 1,2, i \neq j.$$

Total differentiating the above Equations, we have $\left(2a - w_i - w_j\right)d\theta_i^u + (4 - \theta_i^u)dw_i + (1 - \theta_i^u)dw_j = 0, i, j = 1,2, i \neq j$; hence, the slopes of the two reaction functions in Figure 1 are respectively:

$$\frac{dw_2}{dw_1}\Big|_{\frac{\partial V_1^u}{\partial w_1}=0} = -\frac{4-\theta_1^u}{1-\theta_1^u} < 0;\ \frac{dw_2}{dw_1}\Big|_{\frac{\partial V_2^u}{\partial w_2}=0} = -\frac{1-\theta_2^u}{4-\theta_2^u} < 0. \quad \text{(A.1.1)}$$

Again, total differentiating the above Equations, we derive that:

$$\frac{dw_i}{d\theta_i^u}\Big|_{\frac{\partial V_i^u}{\partial w_i}=0} = -\frac{2a-w_i-w_j}{4-\theta_i^u} < 0, \frac{dw_i}{d\theta_j^u}\Big|_{\frac{\partial V_i^u}{\partial w_i}=0} = 0,\ i, j = 1,2, i \neq j. \quad \text{(A.1.2)}$$

Equation (A.1.1) indicates that the slopes of the reaction functions in Figure 1 are negative. Equation (A.1.2) shows that, when the owner increases θ_i^u, its manufacturer's reaction function will move outward, but the opponent manufacturer's reaction function is unchanged.

(2) **PC regime**

The first-order conditions of Equation (5) are:

$$\frac{\partial \pi_i^u}{\partial w_i} = -\frac{1}{\left(3-\theta_i^d-\theta_j^d\right)^2 b}(Z_1 + Z_2) = 0, i, j = 1,2, i \neq j,$$

where $Z_1 \equiv \left[\left(1-\theta_j^d\right)^2 - \theta_i^d\left(3-\theta_j^d\right)\right]a - \left[\left(1-2\theta_j^d\right)\left(1-3\theta_j^d\right) + \theta_i^d\left(2-\theta_j^d\right)\right]c$ and $Z_2 \equiv 2\left(2-\theta_j^d\right)w_i + \left(1+\theta_i^d-\theta_j^d\right)w_j$. Total differentiating the above Equations, we obtain $-\left[\left(2-\theta_j^d\right)(a-c) + \left(a-w_j\right)\right]d\theta_i^d + \left[\left(3a-2w_i-w_j\right) - \left(5-\theta_i^d-2\theta_j^d\right)(a-c)\right]d\theta_j^d + 2\left(2-\theta_j^d\right)dw_i + \left(1+\theta_i^d-\theta_j^d\right)dw_j, i, j = 1,2, i \neq j$; hence, the slopes of the two reaction functions in Figure 2 are respectively:

$$\left.\frac{dw_2}{dw_1}\right|_{\frac{\partial \pi_1^u}{\partial w_1}=0} = -\frac{4-2\theta_2^d}{1+\theta_1^d-\theta_2^d} < 0; \left.\frac{dw_2}{dw_1}\right|_{\frac{\partial \pi_2^u}{\partial w_2}=0} = -\frac{1-\theta_1^d+\theta_2^d}{4-2\theta_1^d} < 0. \quad \text{(A.2.1)}$$

Thus, from Equation (A.2.1), we know that both of the two reaction functions in Figure 2 are downward sloping.

Total differentiating the above Equations, we next have:

$$\left.\frac{dw_i}{d\theta_i^d}\right|_{\frac{\partial V_i^u}{\partial w_i}=0} = \frac{\left(2-\theta_j^d\right)(a-c)+\left(a-w_j\right)}{2\left(2-\theta_j^d\right)} > 0, \quad \text{(A.2.2)}$$

$$\left.\frac{dw_i}{d\theta_j^d}\right|_{\frac{\partial V_i^u}{\partial w_i}=0} = \frac{\left(5-\theta_i^d-2\theta_j^d\right)(a-c)-\left(3a-2w_i-w_j\right)}{2\left(2-\theta_j^d\right)}, \; i, j = 1,2, i \neq j. \quad \text{(A.2.3)}$$

Substituting the optimal equilibrium royalty rates $w_i^* = c + 2(a-c)/3, i = 1,2$ into (A.2.3), the numerator term in the right-hand side of Equation (A.2.3) can be rewritten as $\left(4-\theta_i^u-2\theta_j^u\right)(a-c)$, which is always positive. Therefore, from Equations (A.2.2) and (A.2.3), we show that the two reaction functions will move outward as θ_i^d increases.

Appendix B

Given that the inverse demand function of the market is $p(Q) = a - bQ$, this appendix shows that, in the CP regime, the two owners will fall into the situation of a

prisoner's dilemma, resulting in a reduction in their ultimate revenues.

In section 4, we already obtain the two owners' equilibrium revenues $\pi_i^{u\_CP}$ and $\pi_i^{u\_N}$ in the CP regime and without any CSR, respectively. Thus, in order to establish the payoff matrix for the game whereby the two owners can freely decide whether to ask their manufacturers to participate in CSR activities, we still have to derive the two owners' equilibrium revenues for the case when one of the owners does not involve its manufacturer in any CSR activities. To distinguish between the previous two cases, we use the superscripts YC and NC to respectively represent the equilibrium outcomes corresponding to participation and non-participation, where participation means the owner involves its manufacturer in CSR activities, while non-participation indicates the owner does not allow its manufacturer to engage in any CSR activities.

First, suppose that the owner of supply chain 1 decides to involve its manufacturer in CSR activities, while the owner of supply chain 2 does not. Using backward induction, we obtain $\pi_1^{u\_YC} = (a-c)^2/12b$ and $\pi_2^{u\_NC} = (a-c)^2/18b$; similarly, if now owners 1 and 2 swap strategies, then the results are completely the opposite - that is, $\pi_1^{u\_NC} = (a-c)^2/18b$ and $\pi_2^{u\_YC} = (a-c)^2/12b$. We can express the payoff matrix as follows.

Supply chain 2 / Supply chain 1	Non-participation	Participation
Non-participation	$\left(\frac{2(a-c)^2}{25b}, \frac{2(a-c)^2}{25b}\right)$	$\left(\frac{(a-c)^2}{18b}, \frac{(a-c)^2}{12b}\right)$
Participation	$\left(\frac{(a-c)^2}{12b}, \frac{(a-c)^2}{18b}\right)$	$\left(\frac{140(a-c)^2}{2209b}, \frac{140(a-c)^2}{2209b}\right)$

According to the above payoff matrix, given that the owner of supply chain 2 does not allow its own manufacturer to participate in any CSR activities, we can clearly see that the owner of supply chain 1 have an incentive to involve its own manufacturers in CSR activities, because $\pi_1^{u\_YC} > \pi_1^{u\_N}$; and when the owner of supply chain 1 does that, the owner of supply chain 2 can obtain higher revenue via asking its manufacturer to participate in some activities, since $\pi_2^{u\_CP} > \pi_2^{u\_NC}$. Now that the owner of supply chain 2 also asks its own manufacturer to participate in CSR activities, even though the revenue of the owner of supply chain 1 drops to $\pi_1^{u\_CP}$, but

because of $\pi_1^{u\_CP} > \pi_1^{u\_NC}$, the owner still allows its own manufacturers to participate in some CSR activities.

Second, if we start from the owner of supply chain 1 not allowing its own manufacturer to participate in any CSR activities, then the results eventually will locate both owners into CSR participation. Therefore, even though both owners clearly know that $\pi_i^{u\_CP} < \pi_i^{u\_N}, i = 1,2$, i.e., they can still acquire higher revenue if they both select non-participation. However, the two owners still cannot avoid the problem of falling into the prisoner's dilemma, and the Nash equilibrium is that both owners will decide to ask their manufacturers to participate in some CSR activities.

Table 1: Equilibrium outcomes of the three cases and the sequence.

	CP regime	**PC regime**	**Without any CSR**	**The sequence**
q_i	$q_i^{CP} \approx \frac{20(a-c)}{47b}$	$q_i^{PC} = \frac{a-c}{3b}$	$q_i^N = \frac{2(a-c)}{5b}$	$q_i^{CP} > q_i^N > q_i^{PC}$
w_i	$w_i^{CP} \approx c - \frac{13(a-c)}{47}$	$w_i^{PC} = c + \frac{2(a-c)}{3}$	$w_i^N = c - \frac{(a-c)}{5}$	$w_i^{CP} < w_i^N < w_i^{PC}$
F_i	$F_i^{CP} \approx \frac{400(a-c)^2}{2209b}$	$F_i^{PC} = -\frac{(a-c)^2}{9b}$	$F_i^N = \frac{4(a-c)^2}{25b}$	$F_i^{CP} > F_i^N > F_i^{PC}$
θ_i	$\theta_i^{CP} \approx \frac{3}{20}$	$\theta_i^{PC} = 1$	none	$\theta_i^{CP} < \theta_i^{PC}$
π_i^u	$\pi_i^{u\_CP} \approx \frac{140(a-c)^2}{2209b}$	$\pi_i^{u\_PC} = \frac{(a-c)^2}{9b}$	$\pi_i^{u\_N} = \frac{2(a-c)^2}{25b}$	$\pi_i^{u\_CP} < \pi_i^{u\_N} < \pi_i^{u\_PC}$
CS	$CS^{CP} \approx \frac{800(a-c)^2}{2209b}$	$CS^{PC} = \frac{2(a-c)^2}{9b}$	$CS^N = \frac{8(a-c)^2}{25}$	$CS^{CP} > CS^N > CS^{PC}$
W	$W^{CP} \approx \frac{1080(a-c)^2}{2209b}$	$W^{PC} = \frac{4(a-c)^2}{9b}$	$W^N = \frac{12(a-c)^2}{25b}$	$W^{CP} > W^N > W^{PC}$