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Should partially cooperating firms care for consumers?

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Abstract

This paper considers a multi-stage game model with two partially cooperating firms whose objective functions include maximizing not only their own profits but also a portion of their rivals' profits. In the first stage, each firm independently and simultaneously decides whether to incorporate consumer surplus into its objective function. In the second stage, any firm that chooses to do so selects its level of consumer orientation. In the third stage, after observing the rival's choices in the first two stages, each firm independently and simultaneously chooses its output level. The paper characterizes the model's equilibrium and conducts the welfare analysis.

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1. Introduction

In their influential 1973 paper, Cyert and DeGroot introduced the idea of “partial cooperation,” under which each firm maximizes its own profit along with weighted portions of competitors’ profits. Since then, theoretical research on oligopoly markets with partially cooperating firms has grown extensively (e.g., Chen, Matsumura, and Zeng, 2024; Cracau, 2015; Escrihuela-Villar, 2015; Hirose and Matsumura, 2022; López and Vives, 2019; Matsumoto, Merlone, and Szidarovszky, 2010; Ohnishi, 2021, 2023; Sato and Matsumura, 2020; Szidarovszky, 2008). This literature varies widely in its assumptions regarding the nature of strategic interaction (Cournot vs. Bertrand competition, homogeneous vs. differentiated products, symmetric vs. asymmetric cost structures, etc.), the behavioral foundations of partial cooperation (exogenous vs. endogenous cooperation parameters, unilateral vs. mutual cooperation, stability of cooperative attitudes, etc.), the timing of decisions (simultaneous vs. sequential moves, multi-stage games, endogenous timing, etc.), and the scope of cooperation (pairwise vs. industry-wide cooperation, partial vs. full internalization of rivals’ profits, etc.). It also differs in its treatment of market outcomes (output, price, welfare, and stability), the role of uncertainty or dynamics (adaptive learning, adjustment processes, evolutionary stability), and the implications for policy intervention (competition policy, regulation of cooperative behavior, welfare comparisons with cartel or competitive benchmarks).

In this paper, we investigate whether partially cooperating firms incorporate Corporate Social Responsibility (CSR) into their corporate culture. CSR has grown substantially in prominence over the past several decades. Consequently, a sizable theoretical literature has emerged on CSR-oriented firms (e.g., Baron, 2008; Besley and Ghatak, 2007; Fanti and Buccella, 2016, 2018; Flores and García, 2016; García, Leal, and Lee, 2019; Goering, 2007; Han, 2019; Kopel, 2015; Kopel and Brand, 2012; Kopel, Lamantia, and Szidarovszky, 2014; Lambertini and Tampieri, 2012; Matsumura and Ogawa, 2016; Nakamura, 2013; Ohnishi, 2022; Ouattara, 2017; Sharma, 2019; Wang and Wang, 2022; Xu, 2014). This literature varies widely in its assumptions regarding market structure (Cournot vs. Bertrand competition, horizontal vs. vertical differentiation, network externalities, etc.), the timing of decisions (simultaneous vs. sequential moves, endogenous vs. exogenous timing, etc.), the degree of CSR (partial vs. full CSR), and the role of government intervention (privatization, subsidies, taxation, etc.). For example, Planer-Friedrich and Sahm (2018) extend the Cournot duopoly model of Königstein and Müller (2001) by examining a three-stage setting in which two profit-maximizing firms may either care only about their own customers (CO) or about all consumers (CSR). The firms produce perfectly substitutable goods. In stage one, each firm chooses whether to adopt CSR or CO. In stage two, they

select the level of CSR or CO. In stage three, they choose their output. Planer-Friedrich and Sahm show that firms prefer CSR as their corporate culture.

We consider a multi-stage game model with two partially cooperating firms. In the first stage, each firm independently and simultaneously decides whether to incorporate CSR into its business strategy. In the second stage, any firm that chooses to do so selects its CSR level. In the third stage, after observing the rival's choices in the first and second stages, each firm independently and simultaneously chooses its output level. As far as the author is aware, this economic situation has not been analyzed in the existing literature. We characterize the model's equilibrium and conduct the welfare analysis.

The rest of the paper is organized as follows. In Section 2, we describe the model. Section 3 presents the model's equilibrium and the welfare analysis. Finally, Section 4 concludes the paper.

2. Basic Setting

Let us consider a Cournot model composed of two partially cooperating firms: firm 1 and firm 2. There is no possibility of entry or exit. The price is determined by the normalized linear inverse demand function: $P = 1 - Q$, where $Q = \sum_{i=1}^2 q_i$ is the industry output. Firm i 's cost is given by $c(q_i) = q_i^2/2$.

Therefore, firm i 's profit function is given by

$$\pi_i = \left[1 - (q_i + q_j)\right] q_i - \frac{1}{2} q_i^2 \quad (i, j = 1, 2; i \neq j). \quad (1)$$

and firm i 's objective function is given by

$$\Pi_i = \pi_i + \theta_i \cdot \pi_j, \quad (2)$$

where θ represents the degree of common ownership. Without loss of generality, we assume that $\theta = 0.25$, which ensures partial cooperation without implying control over the rival firm. Moreover, if firm i considers social responsibility, its objective function is rewritten as

$$V_i = \Pi_i + \lambda_i \cdot CS, \quad (3)$$

where

$$CS = CS(q_i, q_j) = \int_0^{q_i+q_j} P(y, z) d(y+z) - P(q_i, q_j)(q_i + q_j) = \frac{1}{2} (q_i + q_j)^2$$

is consumer surplus and $\lambda \in [0, 1]$ is the level of CSR.

The game timing is as follows. In the first stage, each firm i independently and simultaneously decides whether to incorporate CSR. In the second stage, if firm i chooses

to incorporate CSR, it then determines its CSR level λ_i . In the third stage, after observing the rival's choices in the first and second stages, each firm i independently and simultaneously chooses its output level q_i . Our equilibrium concept is subgame perfection, and the three cases of the next section are solved by backward induction.

3. Analysis

In Subsections 3.1-3.3, we introduce three fixed-timing games and solve them in turn. In Subsection 3.4, we present the equilibrium of the model introduced in the previous section. In Subsection 3.5, we compare the producer surplus, consumer surplus, and social welfare across the three fixed-timing games.

3.1. Both Firms Choose CSR

First, suppose that each firm i considers CSR at the first stage and each firm i chooses its CSR level $\lambda_i \in [0, 1]$ at the second stage. At the third stage, firm i chooses its output q_i in order to maximize its objective function (3) for any given weight λ_i of the rival firm. From the first-order condition $\partial V_i / \partial q_i = 0$, we derive firm i 's reaction function:

$$q_i(q_j) = \frac{4 - (5 - 4\lambda_i)q_j}{4(3 - \lambda_i)}, \quad (i, j = 1, 2; i \neq j).$$

Substituting one reaction function into the rival's, we derive the equilibrium quantity of firm i as a function of λ_i and λ_j :

$$q_i = \frac{4(7 + 4\lambda_i - 4\lambda_j)}{7(17 - 4\lambda_i - 4\lambda_j)}.$$

In the second stage, each firm anticipates these quantities and the corresponding price, and selects its CSR level λ_i to maximize:

$$\Pi_i = \frac{1715 - 560\lambda_i - 1400\lambda_j + 320\lambda_i\lambda_j - 496\lambda_i^2 + 176\lambda_j^2}{(119 - 28\lambda_i - 28\lambda_j)^2}.$$

Accordingly, we derive the first-order condition:

$$\frac{\partial \Pi_i}{\partial \lambda_i} = 525 - 2388\lambda_i + 656\lambda_i\lambda_j - 440\lambda_j + 16\lambda_j^2 = 0.$$

Using firm symmetry, we can solve for the equilibrium CSR weight $\lambda_i^{CC} = \lambda_j^{CC} = (101 - \sqrt{8401})/48 \approx 0.195$ along with the corresponding quantity $q_i^{CC} = q_j^{CC} \approx 0.259$ and payoffs $\Pi_i^{CC} = \Pi_j^{CC} \approx 0.114$.

3.2. Only One Firm Chooses CSR

Second, suppose that only firm i considers CSR at the first stage. Further suppose that firm i chooses its weight λ_i at the second stage. At the third stage, each firm independently and simultaneously chooses its output. From the first-order conditions $\partial V_i / \partial q_i = 0$ and $\partial \Pi_j / \partial q_j = 0$, we derive the reaction functions:

$$q_i(q_j) = \frac{4 - (5 - 4\lambda_i)q_j}{4(3 - \lambda_i)},$$

$$q_j(q_i) = \frac{4 - 5q_i}{12}.$$

By solving for the equilibrium quantities as functions of λ_i , we obtain

$$q_i = \frac{4(7 + 4\lambda_i)}{7(17 - 4\lambda_i)},$$

$$q_j = \frac{4(7 - 4\lambda_i)}{7(17 - 4\lambda_i)}.$$

In the second stage, each firm maximizes its anticipated payoff:

$$\Pi_i = \frac{1715 - 560\lambda_i - 496\lambda_i^2}{(119 - 28\lambda_i)^2},$$

$$\Pi_j = \frac{1715 - 1400\lambda_i + 176\lambda_i^2}{(119 - 28\lambda_i)^2}.$$

From the first-order condition $\partial \Pi_i / \partial \lambda_i = 0$, we can derive the equilibrium CSR weight $\lambda_i^{CN} = 175/796 \approx 0.2198$ along with the corresponding quantities ($q_i^{CN} \approx 0.279$ and $q_j^{CN} \approx 0.217$) and payoffs ($\Pi_i^{CN} \approx 0.123$ and $\Pi_j^{CN} \approx 0.111$).

3.3. Neither Firm Considers CSR

Finally, suppose that neither firm considers CSR at the first stage. At the third stage, each firm chooses its output to maximize its objective function (2). From the first-order condition $\partial \Pi_i / \partial q_i = 0$, we derive firm i 's reaction function:

$$q_i(q_j) = \frac{4 - 5q_j}{12}.$$

Substituting one reaction function into the rival's, we can obtain the equilibrium quantities $q_i^{NN} = q_j^{NN} = 4/17 \approx 0.235$ and payoffs $\Pi_i^{NN} = \Pi_j^{NN} = 35/289 \approx 0.121$.

3.4. Equilibrium

Based on the results of the three scenarios, we now turn to the firms' CSR decisions in

the first stage. The actions available to each firm and their continuation payoffs can be shown in Table I.

Table I: Payoff Matrix

		Firm 2	
		CSR	No CSR
Firm 1	CSR	$\Pi_1^{CC} \approx 0.114, \Pi_2^{CC} \approx 0.114$	$\Pi_1^C \approx 0.123, \Pi_2^N \approx 0.111$
	No CSR	$\Pi_1^N \approx 0.111, \Pi_2^C \approx 0.123$	$\Pi_1^{NN} \approx 0.121, \Pi_2^{NN} \approx 0.121$

Notice that the equilibrium arises at (CSR, CSR), and the corresponding equilibrium payoffs are (0.114, 0.114). We can now state the following proposition.

Proposition 1: There exists an equilibrium in which each firm incorporates CSR into its business strategy.

It is important to note that although the equilibrium occurs when both firms adopt CSR, this outcome does not maximize either firm's objective function. In fact, the payoffs achieved under the (CSR, CSR) equilibrium are lower than those obtained when only one firm adopts CSR or when neither firm does.

3.5. Welfare Comparisons

Table II presents the producer surplus, consumer surplus, and social welfare for the three fixed-timing games (both firms choose CSR, only one firm chooses CSR, and neither firm considers CSR).

Table II: Welfare Comparisons

<i>fixed-timing game</i>	Q	P	<i>Producer surplus</i>	<i>Consumer surplus</i>	<i>Social welfare</i>
<i>Both firms choose CSR</i>	0.518	0.482	0.183	0.136	0.318
<i>Only one firm chooses CSR</i>	0.496	0.504	0.187	0.123	0.311
<i>Neither firm considers CSR</i>	0.471	0.529	0.194	0.111	0.304

In the previous subsection, we showed that although the equilibrium arises when both firms adopt CSR, this outcome does not yield the maximum value of either firm's objective function. As indicated in Table II, producer surplus is maximized when neither firm adopts CSR, whereas consumer surplus and social welfare are highest when both firms adopt CSR.

Table II demonstrates that when both firms adopt CSR, consumer surplus and social welfare reach their highest levels, benefiting consumers and society as a whole. Total output—and thus consumer surplus—is greater when both firms choose CSR, so consumers would prefer this outcome. These results highlight the trade-offs faced by partially cooperating firms when integrating CSR into their strategic decisions.

4. Conclusion

We have considered a multi-stage Cournot game involving two partially cooperating firms, each deciding whether to incorporate CSR into its objective function. We have shown that there exists an equilibrium in which both firms choose to adopt CSR. We have also found that this equilibrium does not yield the highest possible value of either firm's objective function, but it does generate the highest consumer surplus and social welfare.

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