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# Why firms should care for consumers:

## Complementary goods

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### Abstract

Corporate social responsibility (CSR) is a business approach that cares about social and environmental issues, and customer orientation (CO) is a business strategy that centres on the needs and wishes of customers in all decision-making. This paper examines two games of Cournot duopoly where two profit-maximizing firms produce complementary goods. The first game is that both firms consider the surplus of all consumers (CSR) as corporate culture, and the second game is that both firms care only for their own customers (CO). This paper presents the respective optimal levels of CSR and CO. Furthermore, the paper shows that all the profits in these optimal levels are equal.

Keywords: Complementary goods; Consumer surplus; Cournot model; Customer surplus

JEL classification: C72; D21

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# 1. Introduction

Corporate social responsibility (CSR) has been a growing trend over recent decades. Nearly 90% of the 250 largest global companies issued CSR reports in 2015, up from 35% in 1999 (KPMG, 2015). Therefore, there are many theoretical research papers on CSR firms (e.g., see Besley and Ghatak, 2007; Goering, 2007; Baron, 2008; Kopel and Brand, 2012; Lambertini and Tampieri, 2012; Nakamura, 2013; Kopel, Lamantia and Szidarovszky, 2014; Xu, 2014; Kopel, 2015; Fanti and Buccella, 2016; Flores and García, 2016; Matsumura and Ogawa, 2016; Ouattara, 2017; García, Leal and Lee, 2019; Han, 2019; Ohnishi, 2022; Wang and Wang, 2022). These papers differ in their assumptions about the market structure (Cournot or Bertrand competition, horizontal or vertical differentiation, network externalities, etc.), the timing of decisions (simultaneous or sequential moves, endogenous or exogenous timing, etc.), the degree of CSR (partial or full CSR, etc.), and the role of government intervention (privatization policy, subsidy policy, tax policy, etc.).

Furthermore, customer orientation (CO) is a business strategy that focuses and centres on the needs and wishes of past, current and future customers in all decision-making. For example, Königstein and Müller (2001) develop a model where two firms compete on prices and CO levels. They examine the effects of CO on firms' profits in a duopoly market, and demonstrate that CO can increase the profits of both firms if the demand is sufficiently elastic, and the marginal cost of CO is low. Königstein and Müller also demonstrate that CO can enhance economic welfare by reducing prices and increasing consumer surplus.

Planer-Friedrich and Sahm (2018) extend the Cournot duopoly game model presented by Königstein and Müller (2001), considering a three-stage Cournot duopoly model in which two profit-maximizing firms can care only for their own customers (CO) or for all consumers (CSR). The firms produce perfectly substitutable goods. In the first stage, each firm simultaneously and independently chooses to care for the surplus of either all consumers (CSR) or only their own customers (CO). In the second stage, each firm simultaneously and independently chooses its level of CSR or CO. In the third stage, each firm simultaneously and independently decides upon its output level. Planer-Friedrich and

Sahm (2018) demonstrate that firms prefer to choose CSR as their corporate culture.

In the real world, we find numerous examples of complementary goods such as bread and jam, coffee and sugar, salad and salad dressing, and computer hardware and computer software. Therefore, we examine a Cournot duopoly model in which two profit-maximizing firms produce complementary goods. We consider two one-shot Cournot-Nash games: (i) both firms care for the surplus of all consumers (CSR), and (ii) both firms care for their own customers only (CO). This paper compares the CSR duopoly outcomes with those of the CO duopoly.

The remainder of this paper proceeds as follows. In Section 2, we provide the literature review. Section 3 describes the basic setting. Section 4 solves the two games. Finally, Section 5 concludes the paper.

## **2. Literature review**

In this section, we present a brief overview of the literature on CSR firms. The main topic in the literature on CSR is how it affects the behaviour and outcomes of firms in oligopolistic markets, where a few sellers compete with each other. In particular, the optimal level of CSR for each firm depends on its own objective function, its rival's objective function, and the market structure. We briefly review some of the theoretical literature on CSR firms below.

Han (2019) explores how partial ownership of a public firm affects CSR in a mixed oligopoly market. He considers a Cournot model where a public firm competes with private firms. The public firm is partially owned by private shareholders, and the private firms take both profits and consumer surplus into consideration. Han (2019) shows that partial ownership can increase or decrease the equilibrium CSR level depending on the degree of ownership and shareholder preferences. Ouattara (2017) investigates how strategic privatization affects CSR in a mixed duopoly market. He considers a Cournot model where a public firm competes with a CSR firm. Two types of ownership of the CSR firm are considered: (i) the SR firm is owned by domestic private investors and (ii) it is owned by foreign private investors. Ouattara (2017) shows that government should decrease the

degree of privatization if the CSR level increases. Furthermore, if the CSR level is high enough, then the optimal degree of privatization in a domestic mixed duopoly is lower than that obtained in an international mixed duopoly. Wang and Wang (2022) examine how CSR affects vertical product differentiation and privatization policy in a mixed duopoly market. They consider a Cournot model where a public firm competes with a CSR private firm. The government can choose to partially privatize the public firm. Wang and Wang (2022) show that CSR can affect the equilibrium quality levels, profits, and economic welfare depending on the degree of privatization. Besley and Ghatak (2007) examine how firms can provide public goods or reduce public bads through CSR, which is influenced by market power and consumer preferences. They show that CSR can arise as an equilibrium outcome when there is sufficient demand for public goods and when firms have market power.

Xu (2014) studies how CSR affects a hospital duopoly with price and quality competition. He considers a model where two hospitals compete on price and quality choices. One hospital has a CSR objective that cares about not only the profit but also the patient benefit. The other hospital has a profit-maximizing objective. Xu (2014) shows that CSR can increase or decrease the equilibrium price and quality levels depending on the degree of CSR and the cost structure of the hospitals. Matsumura and Ogawa (2016) examine how firms' preferences for CSR affect their choice between price and quantity contracts in a duopoly market. Matsumura and Ogawa show that if firms have a significant asymmetric weight of CSR in their objectives, they will choose Bertrand competition (price contracts), while if they have an insignificant asymmetric weight of CSR, they will choose Cournot competition (quantity contracts). Nakamura (2013) also studies how quantity and price competition affect CSR in a mixed duopoly market composed of a consumer-friendly firm and a profit-maximizing firm, and shows that quantity competition leads to higher equilibrium CSR levels than price competition and that quantity competition is more socially efficient than price competition. Flores and García (2016) use general demand and cost functions and examine how a non-profit firm affects output and welfare in a mixed duopoly with a profit-maximizing firm. They show that the non-profit firm's social responsibility can increase or decrease welfare depending on its technical efficiency.

Fanti and Buccella (2016) investigate how network externalities affect CSR in a duopoly market. The authors consider a Cournot duopoly model in which two firms produce homogeneous network goods, and show that if both firms are sensitive to consumer surplus, then they may obtain profits higher than they were only profit-seeking and an optimal degree of CSR by firms does exist. Fanti and Buccella (2018a) extend their previous work (Fanti and Buccella, 2016) to the case of network industries where firms can choose their network sizes and their CSR levels, and show that if firms cooperatively select a joint profit-maximizing level of CSR, then there may be a profit-maximizing positive level of CSR activities.

Baron (2008) examines how managerial contracts can be designed to induce CSR in a firm. He considers a model where a manager can choose between two projects: one that maximizes profits and one that maximizes social benefits. Baron (2008) shows that optimal contracts depend on the degree of alignment between the manager's and the firm's preferences, the observability of the project choice, and the market structure. Fanti and Buccella (2018b) examine the effects of managerial delegation on the equilibrium outcomes in a duopoly market in which firms adopt CSR behaviours. They consider three common manager's bonus schemes: sales delegation (D), relative profits (RP), and pure CSR objective function (PCSR). They show that the subgame perfect equilibrium is given by the common choice of the RP scheme, whereas the CSR firm's objective function is lowest under the D choice. Ohnishi (2022) considers a mixed duopoly model with a nonlinear demand function where a profit-maximizing firm and a socially concerned firm compete in output choices. Each firm can adopt a wage-rise contract, which is a contract that links the wage of its workers to its output. Ohnishi (2022) finds that the wage-rise contract can affect the equilibrium outputs and profits depending on the degree of CSR and the cost structure of the firms.

Lambertini and Tampieri (2012) study how CSR influences a mixed oligopoly market with pollution. They consider a Cournot model in which a CSR firm competes with profit-seeking firms and show that the CSR firm can earn higher profits compared to profit-seeking firms. Furthermore, they show that the presence of at least one CSR firm improves economic welfare.

García, Leal and Lee (2019) examine how endogenous timing affects the equilibrium outcomes in a mixed duopoly market. They consider a Cournot game model where a CSR firm competes against a private firm with a profit-maximizing objective. The firms can choose whether to move first or second in a sequential game. García, Leal and Lee (2019) demonstrate that multiple equilibrium solutions depend on the parameters of the model, and that endogenous timing can affect the equilibrium outputs, profits, and economic welfare.

Kopel, Lamantia and Szidarovszky (2014) examine how evolutionary competition affects CSR in a mixed market. They consider a Cournot oligopoly model where profit-maximizing firms and socially concerned firms have heterogeneous preferences for CSR. The firms' preferences evolve according to an evolutionary process based on their profits. Kopel, Lamantia and Szidarovszky (2014) demonstrate that there are multiple evolutionary equilibria depending on the initial conditions and parameters of the model and that evolutionary competition can lead to more or less CSR than static competition.

### 3. Basic setting

There are two profit-maximizing firms: firm 1 and firm 2. The firms produce complementary goods. Throughout this paper, subscripts 1 and 2 represent firms 1 and 2, respectively. Furthermore, when  $i$  and  $j$  are used to refer to firms in an expression, they should be understood to refer to 1 and 2 with  $i \neq j$ . We do not consider the possibility of entry or exit. Our equilibrium concept is Nash in pure strategies. There is a continuum of consumers of the same type, and the representative consumer maximizes consumer surplus:

$$CS = U(q_1, q_2) - p_1 q_1 - p_2 q_2, \quad (1)$$

where  $q_i$  is the amount of good  $i$  and  $p_i$  is its price. The function  $U(q_1, q_2)$  is quadratic:  $U(q_1, q_2) = (q_1 + q_2) - (q_1^2 + q_2^2 - q_1 q_2) / 2$ . The inverse demand (price) function is given by  $p_i = 1 - q_i + \delta q_j$ , where  $\delta \in (0, 1)$  is a measure of the degree of complementarity among products. For the sake of simplicity, we assume  $\delta = 0.5$ . Therefore, firm  $i$ 's profit is given by

$$\pi_i = q_i \left( 1 - q_i + \frac{1}{2} q_j \right). \quad (2)$$

Firm  $i$ 's corporate culture is either socially responsible, S, or customer oriented, C. Formally, CSR differs from CO in the objective function  $V_i$ : In addition to (2), the former contains (1), while the latter contains the surplus of firm  $i$ 's own customers:

$$C_i = q_i - \frac{1}{2} (q_i^2 - q_i q_j) - q_i \left( 1 - q_i + \frac{1}{2} q_j \right). \quad (3)$$

Hence,

$$V_i^S = \pi_i + \theta \cdot CS, \quad (4)$$

and

$$V_i^C = \pi_i + \theta \cdot C_i. \quad (5)$$

where  $\theta \in [0,1]$  is the level of CSR (or CO). We assume that the value of  $\theta$  is given exogenously. Each firm simultaneously and independently chooses its output level to maximize its objective function.

## 4. Results

We consider the following two cases: two CSR firms and two CO firms.

### 4.1. Two CSR firms

First, suppose that both firms consider the surplus of all consumers as corporate culture. By differentiating (4) with respect to  $q_i$ , we can obtain firm  $i$ 's best response function:

$$q_i(q_j) = \frac{2 + (1 - \theta^S) q_j}{2(2 - \theta^S)}. \quad (6)$$

Furthermore, by inserting one reaction function into the other, we obtain the Cournot-Nash equilibrium quantity of firm  $i$ :

$$q_i = \frac{2}{3 - \theta^S}. \quad (7)$$

Each firm anticipates these quantities and maximizes its profit:



$$\pi_i^S = \left(1 - q_i + \frac{1}{2}q_j\right)q_i = \frac{2(2 - \theta^S)}{(3 - \theta^S)^2}. \quad (8)$$

The maximization of (8) with respect to  $\theta^S$  is derived from  $d\pi_i^S/d\theta^S$ . That is,  $\theta^S = 1$ , so that  $\pi_i^S = 0.5$ .  $\pi_i^S$  is illustrated in Figure 1 as a function of  $\theta^S$ . When  $0 \leq \theta^S \leq 1$ ,  $\pi_i^S$  is a strictly increasing function of  $\theta^S$ .

#### 4.2. Two CO firms

Next, suppose that both firms adopt CO as corporate culture. By differentiating (5) with respect to  $q_i$ , we obtain firm  $i$ 's best response function:

$$q_i(q_j) = \frac{2 + q_j}{2(2 - \theta^C)}. \quad (9)$$

We have the Cournot-Nash equilibrium quantity of firm  $i$ :

$$q_i = \frac{2}{3 - 2\theta^C}. \quad (10)$$

Each firm anticipates these quantities and maximizes its profit:

$$\pi_i^C = \frac{4(1 - \theta^C)}{(3 - 2\theta^C)^2}. \quad (11)$$

The maximization of (11) with respect to  $\theta^C$  is derived from  $d\pi_i^C/d\theta^C$ . That is,  $\theta^C = 0.5$ , so that  $\pi_i^C = 0.5$ .  $\pi_i^C$  is illustrated in Figure 2 as a function of  $\theta^C$ . If  $0 \leq \theta^C \leq 0.5$ , then  $\pi_i^C$  is a strictly increasing function.

#### 4.3. Comparison

In this subsection, we compare the outcomes of CSR duopoly with those of the CO duopoly. The optimal level of CSR is 1, and that of CO is 0.5. However, all the profits are 0.5. The result of this comparison is summarized in the following proposition.

**Proposition 1:** The optimal level of CSR in the CSR duopoly is different from that of CO in the CO duopoly, but all the profits in these optimal levels are equal.

This proposition states that the profits at CSR duopoly equilibrium are equal to those at CO duopoly equilibrium. Planer-Friedrich and Sahn (2018) examine a Cournot duopoly model with homogeneous goods where two profit-maximizing firms can care for the surplus of either all consumers (CSR) or their own customers only (CO), and shows that the firms prefer to choose CSR. Therefore, we find that our result is different from that of Planer-Friedrich and Sahn (2018).

## **5. Conclusion**

We have examined two games of Cournot duopoly in which two profit-maximizing firms produce complementary goods. We have shown that the profits at the CSR duopoly solution are equal to those at the CO duopoly solution. We have examined one-shot games. However, in the real world, firms typically face long-term competition. Therefore, in future research, we will examine various dynamic models consisting of CSR and CO firms.

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