Strategic Corporate Social Responsibility

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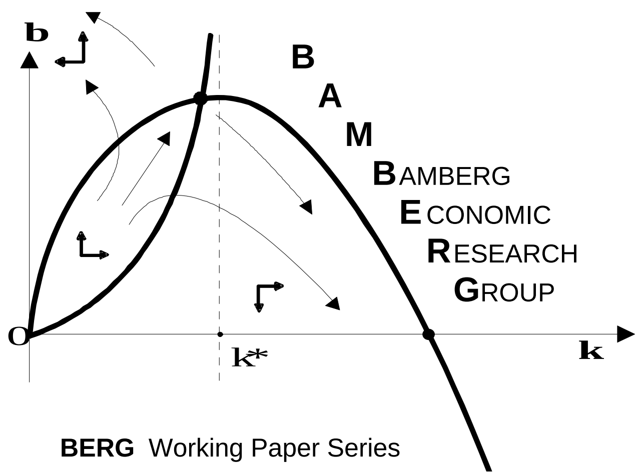
Working Paper No. 124

May 2017



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ISBN 978-3-943153-44-6

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Strategic Corporate Social Responsibility

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This Version: May 29, 2017

Abstract

We examine the strategic use of Corporate Social Responsibility (CSR) in imperfectly competitive markets. The level of CSR determines the weight a firm puts on consumer surplus in its objective function before it decides upon supply. First, we consider symmetric Cournot competition and show that the endogenous level of CSR is positive for any given number of firms. However, positive CSR levels imply smaller equilibrium profits. Second, we find that an incumbent monopolist can use CSR as an entry deterrent. Both results indicate that CSR may increase market concentration. Third, we consider heterogeneous firms and show that asymmetric costs imply asymmetric CSR levels.

Keywords: Corporate Social Responsibility, Market Concentration, Cournot Competition, Entry Deterrence, Strategic Delegation, Evolutionary Stability

JEL classification: D42, D43, L12, L13, L21, L22

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1 Introduction

In 2012, the pharmaceutical company GlaxoSmithKline (GSK) decided to combine their profit-making and their charitable activities with the introduction of a least developed countries operating unit. As incentives for this unit are based on sales volume rather than profit, drugs became accessible at much lower prices in the least developed countries. While GSK hoped to gain a larger market share, other pharmaceutical firms recognized the potential of this market strategy and followed GSK's example such that competition became increasingly fierce in these countries. The reported case[1] is an example of what Baron (2001) calls 'strategic CSR' .

Corporate Social Responsibility (CSR) has become a major concern for many firms, particularly large ones (Benn and Bolton, 2011, KPMG, 2015). It refers to all social and environmentally friendly activities of a firm beyond its legal requirements (Kitzmueller and Shimshack, 2012). Among the various motives for CSR, its strategic use in markets with imperfect competition plays an important role (Garriga and Melé, 2004, Bénabou and Tirole, 2010). The basic idea is that even pure profit-maximizing firms engage in CSR because it may serve as a commitment device for their strategy choices in oligopolistic environments. Based on this notion, our paper investigates the interplay between the market structure and the level of firms' social concern. We find a mutual impact: On the one hand, higher market concentration leads to higher levels of CSR. On the other hand, the strategic use of CSR increases market concentration.

We employ a simple model of a market for some homogeneous good with linear demand and constant marginal costs. As usual, we assume that firms have the original goal of profit-maximization. However, we consider competition between them as a two-stage game. In the first stage, firms decide upon their level of CSR modeled as the weight with which consumer surplus enters their objective function in addition to profit. This can be thought of as signing an appropriate corporate charter or employing a manager who is known to have an appropriate social concern[2]. In the second stage, the firms' managers choose their production output in order to maximize their objective function. We examine two different scenarios.

In our first scenario, we consider Cournot competition between symmetric firms and characterize the subgame-perfect equilibrium (SPE). We find that the equilibrium level of CSR is positive for any given number of active firms, but decreases as this number rises. Moreover, for any given number of firms, the equilibrium profits will be smaller than in the regular Cournot model without

[1]For more information, see http://uk.reuters.com/article/uk-glaxosmithkline-africa-idUKBRE8720A020120803 or http://www.fiercepharma.com/pharma/gsk-tries-volume-goodwill-over-margins-africa.

[2]In the example above, GSK introduced a whole new operating unit with incentives on volume within the company for this purpose.

CSR. In the presence of fixed costs, this leads to the conclusion that, in the long run, the strategic use of CSR may reduce the number of active firms and foster market concentration.

Our framework for the analysis of strategic CSR in Cournot competition is similar to the one proposed by, e.g., Kopel and Brand (2012), Kopel et al. (2014) and Kopel (2015), but allows for a continuous choice of CSR levels. The suggested two-stage game may as well be understood as an indirect evolutionary game (Güth and Yaari, 1992, Königstein and Müller, 2001). Following this notion, our results show that the evolutionary stable level of CSR is positive and induces higher market concentration.

These findings imply opposing long run effects on consumer surplus and welfare. On the one hand, the lower number of active firms, ceteris paribus, reduces overall output. On the other hand, the positive CSR levels, ceteris paribus, increase output. Moreover, the lower number of active firms reduces aggregate fixed costs and mitigates the problem of excessive market entry (Mankiw and Whinston, 1986, Amir et al., 2014). Thus there is no general answer to the question whether strategic CSR is socially desirable or may even be anticompetitive. However, we provide an example in which CSR increases total welfare but reduces consumer surplus in the long run equilibrium.

The same example illustrates that although CSR is associated with equilibrium profits that are smaller than regular Cournot profits in the short run, the opposite may hold in the long run due to the implied market consolidation. This raises the question whether CSR may also be used as a strategy to induce market exit or deter market entry. We address the latter question in our second scenario, considering a market with an incumbent monopolist and one potential entrant. Here, the first stage of the game is split into two sequences: First the incumbent chooses its CSR level, then the potential entrant decides whether to incur the entry cost and, if so, which CSR level to enter with. Finally, in the case of entry, the second stage of the game again consists in Cournot competition between the two firms.

We show that the strategic use of CSR yields a pattern that is well-known in models of entry (Dixit, 1980, Maskin, 1999): If entry costs are sufficiently high, entry will be blockaded and the incumbent will not engage in CSR because CSR is not profitable for a monopolist as such. However, for an intermediate range of entry costs, the incumbent finds it optimal to choose positive levels of CSR in order to deter entry. This observation reinforces our conclusion that the strategic use of CSR increases market concentration. Finally, if entry costs are sufficiently low, the incumbent will prefer to accommodate entry. In this case, both the incumbent and the entrant choose positive CSR levels with the former as the leader setting a higher level than the latter as the follower. Those findings suggest the testable hypothesis that well-established firms exhibit more CSR than market newcomers.

In the model of entry deterrence, our results imply the same opposing welfare effects of CSR as in the model of Cournot competition. We must trade off the the negative output effect of higher market concentration against the positive output effect of positive CSR levels and, with respect to total surplus, the positive effect of saved entry costs. A closer analysis shows that total surplus is always higher in the equilibrium with than without strategic CSR. In contrast to the existing literature (Belleflamme and Peitz, 2015, p. 429), though, consumer surplus depends non-monotonically on the level of entry costs.

As two extensions show, CSR will have the same strategic impact as in our baseline model if we allow for more general demand functions or for firms with heterogeneous marginal costs. In the latter case, we find in addition that strategic CSR complements cost advantages and reinforces differences in the firms' profitability and thus may accelerate the adoption of superior technologies. Moreover, heterogeneous costs may explain the equilibrium coexistence of firms that engage in CSR and firms that abstain from CSR.

The remainder of the paper is organized as follows. In Section 2, we review the related literature. Section 3 introduces the basic model which we use to analyze the strategic use of CSR in Cournot competition in Section 4 and as a means of entry deterrence in Section 5. Section 6 extends the model to heterogeneous firms and general demand functions. Section 7 concludes.

2 Related Literature

Within the fast-growing literature on CSR, we focus on the work dealing with its strategic use. Among the various ways of modeling CSR,[3] two approaches are particularly well-established by now: One approach relies on the assumption that (some) consumers have a higher willingness to pay for socially responsibly (Baron, 2009, García-Gallego and Georgantzís, 2009, Manasakis et al., 2013, 2014, Liu et al., 2015) or environmentally friendly (Arora and Gangopadhyay, 1995, Cremer and Thisse, 1999, Tian, 2003, Bansal and Gangopadhyay, 2003) produced goods and models CSR as a form of product differentiation. The second approach relies on the assumption that firms (may have a strategic incentive to) take the interest of a wider group of stakeholders into consideration and models CSR as an alternative objective that (partially) includes consumer surplus besides profits.[4]

[3]For example, the CSR attribute of a product or its CSR byproduct can be compared to the private provision of a public good; see, e.g., Bagnoli and Watts (2003) or Kotchen (2006). CSR can also be used as a commitment to an environmentally friendly (and more expensive) production technology in future periods which mitigates the durable goods problem (Goering, 2010). Another way of modelling CSR is to let firms take workers (as one stakeholder group) into account (Becchetti et al., 2016).

[4]Including consumer surplus in the objective function of a firm is a widely-used way of taking all kinds of non-profit motives into account; see, e.g., Goering (2007, 2008b), Lien (2002) or Saha (2014). Lambertini and Tampieri (2012, 2015), Lambertini (2013) and Lambertini et al. (2016) include both consumer surplus and some environmental externality in the objective function of a socially responsible firm.

For the purpose of this paper, we abstract from the product differentiating character of CSR and follow the latter approach. Within this approach, Kopel (2015) and Kopel and Brand (2012) consider a mixed duopoly with one pure profit maximizer and one CSR firm. As in our analysis, the level of CSR is measured by the weight the firm puts on consumer surplus but, other than in our analysis, exogenously given. Kopel (2015) shows that the choice of the socially concerned firm between a quantity and a price contract as well as its profits crucially depend on the level of CSR. Kopel and Brand (2012) consider a model of quantity competition with the possibility of strategic delegation and find that CSR pays off as long as its level is not too high. This is in line with our result that Cournot competitors will choose a positive but finite level if the decision on CSR is endogenous.

Kopel et al. (2014) also consider a mixed Cournot oligopoly and adopt a dynamic approach in which the firms can endogenously choose to either adopt a certain positive level of CSR or act as a pure profit maximizer. Moreover, they may switch their objective over time if they deem it profitable. Similarly, Kopel and Lamantia (2016) analyze the evolutionary survival of CSR in a Cournot oligopoly. In both set-ups, mixed industry outcomes prevail under certain conditions.[5] These results, though, are due to the fact that the endogenous choice of CSR is, in contrast to our model, discrete in their framework. Our much simpler static approach shows that there exists the same incentive to use strategic CSR for every firm and may, therefore, explain the recent growth of engagement in CSR activities (KPMG, 2015).

Except for Goering (2014) and Planer-Friedrich and Sahm (2016), none of the papers modeling CSR as a weight on consumer surplus in the objective function allows for all considered firms to choose the level of CSR endogenously. Goering (2014) focuses on the vertical market structure of a successive monopoly where the manufacturer uses CSR to extract profit from its retailer.[6] Instead we consider a horizontal market structure to analyze the endogenous choice of the CSR intensity in oligopoly and in monopoly threatened by entry. In a model of Cournot duopoly, Planer-Friedrich and Sahm (2016) explore the endogenous choice between two organizational strategies, CSR and costumer orientation, where the latter is modeled as the (partial) inclusion of the surplus of the firm's own customers in its objective function (Königstein and Müller, 2001, Brekke et al., 2012). The authors show that CSR outperforms customer orientation as a commitment to higher quantities and, thereby, provide a further argument for the importance of CSR.

We also explore the strategic use of CSR as an entry deterrent. To our knowl-

[5]The question whether socially responsible behavior survives in a dynamic framework is also addressed by Wirl et al. (2013) in a more abstract model of perfect competition between CSR firms.

[6]Goering (2012) explores CSR in a very similar successive monopoly set-up, but does not allow for the endogenous choice of the weight on consumer surplus.

edge, this topic has received little attention so far. Exemptions are the articles by Tzavara (2008) and Graf and Wirl (2014). Other than our work, however, both studies model CSR as a mode of product differentiation and consider price competition à la Bertrand. In such an environment, CSR is usually not used as an entry deterrent but only as an optimal response to entry ensuring (maximum) differentiation. A related empirical paper by Boulouta and Pitelis (2014) examines the use of CSR in order to deter entry on an international level. High CSR levels may constitute non-tariff barriers towards less responsible countries. The authors find that CSR has a stronger effect on countries with a low innovation level. They suspect that innovative countries already produce differentiated products and thus additional CSR-based differentiation will not have a strong impact.

In general, empirical evidence on the impact of firms' CSR activities on their financial performance is mixed. For example, Jo and Harjoto (2011), Eccles et al. (2014) and Flammer (2015) find a positive effect, whereas López et al. (2007) find a negative effect. Meta-analyses (Margolis and Walsh, 2003, Margolis et al., 2009) and studies including further variables such as R&D (McWilliams and Siegel, 2000) suggest a neutral effect. In line with our theoretical predictions, however, there is a tendency towards negative effects (prisoner's dilemma) in the short run (López et al., 2007) and positive effects (market consolidation) in the long run (Eccles et al., 2014).

3 The Model

We consider competition between $2 \leq n \in \mathbb{N}$ profit-maximizing firms on the market for some homogeneous good with (normalized) linear inverse demand[7]

$$p = 1 - \sum_{i=1}^{n} q_i, \tag{1}$$

where p denotes the price of the good and q_i denotes the output of firm $i \in \{1, \ldots, n\}$. Marginal costs of production are assumed to be constant and identical for all firms. For simplicity, we normalize them to zero.[8]

Competition between firms is modeled as a two-stage game. In the first stage of the game, each firm $i \in \{1, \ldots, n\}$ publicly commits to a certain objective function V_i. In particular, firm i chooses its level of CSR, i.e., the weight $\theta_i \geq 0$

[7]Section 6.2 illustrates that, under rather mild conditions, the strategic incentives remain unchanged for a general inverse demand function $p(q)$ with $dp/dq < 0$.

[8]In fact, constant marginal costs do not influence the equilibrium level of CSR as long as they are symmetric. Section 6.1 discusses the case of asymmetric costs.

it puts on consumer surplus CS in addition to profits π_i[9]:

$$V_i = \pi_i + \theta_i \cdot CS = (1 - \sum_{j=1}^{n} q_j)q_i + \frac{1}{2} \cdot \theta_i \cdot (\sum_{j=1}^{n} q_j)^2. \tag{2}$$

Such a commitment to an objective function can be thought of as signing an appropriate corporate charter or hiring a manager known to have appropriate preferences. The latter approach corresponds to strategic delegation. Models of strategic delegation show that firms may profit from employing a manager with a personal motivation or a working contract that differs from the firm's own objective (profit-maximization); see, e.g., the seminal papers by Vickers (1985), Fershtman and Judd (1987) and Sklivas (1987).[10]

In the second stage of the game, firms decide simultaneously on their output levels $q_i \geq 0$ in order to maximize their objective functions V_i. Below we consider two different scenarios and solve each specification of the game for its subgame perfect equilibrium (SPE).

Following an alternative interpretation, our framework may be understood as an indirect evolutionary game with the choices $q_i \geq 0$, the utility functions V_i, the preference types $\theta_i \geq 0$, and the evolutionary success functions π_i (Güth and Yaari, 1992, Königstein and Müller, 2001). In this respect, the SPE entails the evolutionary stable levels of CSR, i.e., nature shapes the firms' preferences such that they are, in the long run, associated with the most profitable levels of CSR.

4 Strategic CSR in Cournot Competition

In the first scenario we consider, $2 \leq n \in \mathbb{N}$ symmetric firms simultaneously choose their level of CSR at the first stage of the game.

4.1 Short-run effects

We first consider a time horizon in which the number of active firms is fixed. Solving the game by backward induction, we start examining the second stage decisions. For any given vector of CSR levels $(\theta_j)_{j=1}^n$, firm $i \in \{1, \ldots, n\}$ chooses its output q_i in order to maximize its objective function V_i as given by (2). From the first-order condition

$$\frac{\partial V_i}{\partial q_i} = 1 - \sum_{j=1}^{n} q_j - q_i + \theta_i \cdot \sum_{j=1}^{n} q_j = 0 \tag{3}$$

[9]Incorporating consumer surplus into the firm's objective function is a standard way of modeling CSR (Goering, 2008a, 2012, 2014, Kopel and Brand, 2012, Kopel et al., 2014, Kopel, 2015).

[10]For the use of strategic delegation in models of manipulation of a firm's objective function, see, e.g., Schaffer (1989), Chirco et al. (2013) or Benassi et al. (2014) and, particularly, for the use as a commitment to CSR, see, e.g., Baron (2008), Kopel and Brand (2012), Manasakis et al. (2014) and Kopel and Lamantia (2016).

we can derive firm i's best response:

$$q_i = \frac{1 - (1-\theta_i) \cdot \sum_{j \neq i} q_j}{(2-\theta_i)}. \tag{4}$$

Summing up over all n first order conditions (3) and using (1), we can derive the total quantity $Q := \sum_{i=1}^n q_i$ and the price p:

$$\begin{aligned} Q &= \frac{n}{n+1-\sum_{i=1}^n \theta_i}, \\ p &= \frac{1-\sum_{i=1}^n \theta_i}{n+1-\sum_{i=1}^n \theta_i}. \end{aligned} \tag{5}$$

Inserting Q into (4) and rearranging terms yields:

$$q_i = \frac{1-\sum_{j=1}^n \theta_j + n \cdot \theta_i}{n+1-\sum_{j=1}^n \theta_j}. \tag{6}$$

In the first stage of the game, each firm i anticipates this price and quantities and chooses the CSR level θ_i in order to maximize its corresponding profit which, by (5) and (6), equals

$$\begin{aligned} \pi_i = p \cdot q_i &= \frac{(1-\sum_{j=1}^n \theta_j)(1-\sum_{j=1}^n \theta_j + n\theta_i)}{(n+1-\sum_{j=1}^n \theta_j)^2}, \\ &= \frac{(1-\theta_{-i})^2 + (1-\theta_{-i})(n-2)\theta_i - (n-1)\theta_i^2}{(n+1-\theta_{-i}-\theta_i)^2}, \end{aligned} \tag{7}$$

where $\theta_{-i} := \sum_{j \neq i} \theta_j$. The first order condition $\frac{\partial \pi_i}{\partial \theta_i} = 0$ yields

$$\begin{aligned} &[(1-\theta_{-i})(n-2) - 2(n-1)\theta_i](n+1-\theta_{-i}-\theta_i) \\ &+2[(1-\theta_{-i})^2 + (1-\theta_{-i})(n-2)\theta_i - (n-1)\theta_i^2] = 0. \end{aligned} \tag{8}$$

Symmetry implies that in equilibrium $\theta_i = \theta_j = \theta^*$ for all $i, j \in \{1, \ldots, n\}$, and thus $\theta_{-i} = (n-1)\theta^*$. Using this relation in equation (8) and solving for θ^* yields

$$\theta^* = \frac{n^2+n-1}{2n(n-1)} - \sqrt{\left(\frac{n^2+n-1}{2n(n-1)}\right)^2 - \frac{1}{n}}. \tag{9}$$

Proposition 1 *In the SPE of the two-stage game between $n \geq 2$ symmetric firms, the CSR level θ^* that is chosen by each individual firm*

(a) is positive for any given number n of active firms,

(b) decreases in the number n of active firms,

(c) converges to zero as the number n of active firms tends to infinity.

Proof. Part (a) follows immediately from equation (9). In order to show part (b), consider θ^* as a function of n. First note that $\theta^*(2) > \theta^*(3)$. Moreover, treating n as a continuous variable, straightforward calculations show that $\partial\theta/\partial n < 0$ for all $n \geq 3$. Using equation (9), it is straightforward to compute $\lim_{n\to\infty} \theta^* = 0$ which proves part (c).

□

Parts (b) and (c) of the proposition show that an increasing competitive pressure decreases the strategic incentives to engage in CSR. In particular, under perfect competition, there is no room for CSR.[11] The intuition for positive equilibrium levels of CSR is essentially the same as in (other) models of strategic delegation (Fershtman and Judd, 1987) or in models of consumer orientation (Königstein and Müller, 2001). Firms engage in CSR in order to commit to higher output levels which, ceteris paribus, reduces the output chosen by their rivals because quantities are strategic substitutes in Cournot competition. As a result, however, they end up in a situation that is similar to a prisoner's dilemma. In fact, inserting (9) into equations (5), (6), and (7) yields the following

Corollary 1 *In the SPE of the two-stage game between $n \geq 2$ symmetric firms,*

(a) the output of each firm $q_i^* = \dfrac{1}{1+n(1-\theta^*)} > \dfrac{1}{1+n}$ *is higher,*

(b) the market price $p^* = \dfrac{1-n\theta^*}{1+n(1-\theta^*)} < \dfrac{1}{1+n}$ *is lower,*

(c) the profit of each firm $\pi_i^* = \dfrac{1-n\theta^*}{[1+n(1-\theta^*)]^2} < \dfrac{1}{(1+n)^2}$ *is lower*

than it would be if all firms abstained from CSR.

4.2 Long-run effects

So far, all considerations have been short-term taking the number of active firms n as given and neglecting any fixed cost. However, the fact that strategic CSR decreases equilibrium profits in the short run may lead to some market consolidation and increase market concentration in the long run because firms with negative profits will leave the market. To be more specific, suppose that there is free market entry and all firms have identical quasi-fixed costs F. Then, Corollary 1 immediately implies

[11] Similar results have been found in (other) models of strategic delegation, see, e.g., Fershtman and Judd (1987).

Corollary 2 *In the long run with free market entry and positive fixed costs $F > 0$, the number of firms that are active in the SPE of the two-stage game does not exceed the number of firms that would be active if all firms abstained from CSR.*

A number of empirical studies suggest a positive relationship between market competition and CSR (Fernández-Kranz and Santaló, 2010, Zhang et al., 2010, Kemper et al., 2013, Flammer, 2015). While this finding is not compatible with our short run findings, it can be better explained by our result that firms may use CSR in highly competitive environments hoping to decrease competition and increase market concentration in the long run.

In order to explore the implications of the long run effect on welfare notice that, on the one hand, the increase in market concentration induced by CSR ceteris paribus reduces aggregate output and thus countervails the direct quantity-augmenting effect of CSR. On the other hand, the lower number of active firms also reduces aggregate fixed costs. In general, the impact of CSR on welfare is thus ambiguous. The following example illustrates the anticompetitive potential of CSR. To this end we refer to the long-run SPE of the two-stage game between $n \geq 2$ symmetric firms as CSR-equilibrium and asterisk the corresponding equilibrium values. By contrast, the situation in which all firms abstain from CSR is equivalent to the regular Cournot equilibrium with pure profit maximizers, and we indicate the corresponding equilibrium values by superscript C.

Example 1 *Compared to the regular Cournot equilibrium, for fixed costs $0.034 \leq F < 0.04$ the CSR equilibrium is characterized by*

(a) higher market concentration: $n^* = 2 < 4 = n^C$,

(b) higher individual and aggregate profits: $2(\pi_i^*(2) - F) \approx 2 \cdot (0.0856 - F) > 4 \cdot (0.0400 - F) \approx 4(\pi_i^C(4) - F)$,

(c) lower aggregate output: $2q_i^*(2) \approx 0.7806 < 0.8000 = 4q_i^C(4)$,

(d) lower consumer surplus and lower (gross) total surplus,

(e) higher total surplus net of aggregate fixed costs.

Proof. The results follow from straightforward calculations using equation (9) and Corollary 1.

□

The example also illustrates that CSR may serve as a substitute for second best regulation of markets with pure profit maximizers. Suppose that the regulator wants to maximize welfare, i.e., total surplus net of aggregate fixed costs, but cannot control production directly. He can only control the number of active firms, e.g., by issuing a restricted number of production licences. As straightforward calculations show, for $0.034 \leq F < 0.04$ the regulator would then optimally limit the number of pure profit maximizers to $n = 2 < 4 = n^C$ in order to reduce aggregate fixed costs.[12] Under this kind of forced market consolidation, however, output and thus total surplus would still be lower than under the CSR equilibrium consolidation which leads to the same number $n = 2 = n^*$ of active firms.

There is a further insight provided by this example: While CSR decreases profits in the short run, it may well increase profits in the long run due to the associated market consolidation. This gives rise to the idea that (large) solvent firms may use CSR also as a strategy to induce exit and deter entry of (small) firms with tighter financial constraints.[13] In the next section, we elaborate on this idea examining the strategic use of CSR as an entry deterrent.

5 CSR as an Entry Deterrent

In this second scenario, we consider a market with an incumbent monopolist (firm 1) and one potential entrant (firm 2). Here, the first stage of the game is split into two sequences: First the incumbent chooses its CSR level θ_1. Given this decision, the potential entrant then decides whether to incur entry costs $e > 0$ and, if so, which CSR level θ_2 to enter with. In the case of entry, the second stage of the game again consists in Cournot competition with each of the two firms $i \in \{1, 2\}$ choosing its output q_i in order to maximize its objective function

$$V_i = (1 - q_i - q_j)q_i + \frac{1}{2}\theta_i(q_i + q_j)^2.$$

If firm 2 does not enter, the monopoly will persist and firm 1 will choose q_1 in order to maximize its objective function

$$V_1^M = (1 - q_1)q_1 + \frac{1}{2}\theta_1 q_1^2.$$

In order to find out whether firm 1 can indeed deter entry by means of CSR and, if so, under which conditions deterrence is profitable, we proceed in three steps. First, we characterize the conditions for which entry is blockaded in the sense that the incumbent can behave as an unconstrained monopolist who is not threatened by entry. Second, we determine the SPE for the case in which firm 1 accommodates entry of firm 2 and compute the firms' respective profits.

[12] The following table contains the respective values of total surplus net of aggregate fixed costs in a market without CSR:

	$F = 0.040$	$F = 0.034$
$n = 1$	0.335	0.341
$n = 2$	0.364	0.376
$n = 3$	0.349	0.367

[13] This leads to the testable hypothesis that large firms engage more in CSR than small ones.

Finally, this allows us to determine the minimum CSR level firm 1 must choose to deter entry as a function of entry costs. Comparing firm 1's profit made under entry deterrence with its profit made under entry accommodation, we can then determine the range of entry costs for which entry deterrence is profitable and discuss its impact on welfare.

5.1 Blockaded entry

It is straightforward to show that an unconstrained monopolist who is not threatened by entry will not engage in CSR, i.e., will choose $\theta_1^u = 0$. Entry will be blockaded if, given this choice, the firm 2 will not find it profitable to enter the market. If firm 2 enters, there will be Cournot competition between the two firms. Solving the game by backward induction, the analysis of the second stage is identical to the second stage analysis in Section 4 with $n = 2$. We can therefore use equation (8) with $n = 2$, $\theta_{-i} = \theta_1$, and $\theta_i = \theta_2$ to compute firm 2's best response to firm 1's CSR level θ_1:

$$\theta_2 = \frac{(1-\theta_1)^2}{3-\theta_1}. \tag{10}$$

Thus for $\theta_1^u = 0$, the entrant chooses the CSR level $\theta_2 = 1/3$. Moreover, we can use equation (7) with $n = 2$, $\theta_{-i} = \theta_1 = 0$, and $\theta_i = \theta_2 = 1/3$ to compute the equilibrium profit of firm 2 conditional on entry:

$$\pi_2 = \frac{(1-\theta_1)^2 - \theta_2^2}{(3-\theta_1-\theta_2)^2} - e = \frac{1}{8} - e. \tag{11}$$

If firm 2's resulting profit is still negative, it will be better not to enter the market in the first place. Consequently, entry will be blockaded for all entry costs $e > e^+ := \frac{1}{8}$.

5.2 Entry accommodation

Now suppose that firm 1 will choose a CSR level θ_1 such that firm 2 finds it profitable to enter. Solving the game by backward induction, the analysis of the second stage is again identical to the second stage analysis in Section 4 with $n = 2$, and firm 2's best response to firm 1's CSR level θ_1 is given by equation (10). Moreover, we can use equation (7) with $n = 2$, $\theta_{-i} = \theta_2$, and $\theta_i = \theta_1$ to compute the equilibrium profit of firm 1 anticipating the entrant's best response as given by (10):

$$\pi_1 = \frac{\left[1 - \dfrac{(1-\theta_1)^2}{3-\theta_1}\right]^2 - \theta_1^2}{\left[3 - \left(\theta_1 + \dfrac{(1-\theta_1)^2}{3-\theta_1}\right)\right]^2} = \frac{1+\theta_1-3\theta_1^2+\theta_1^3}{(4-2\theta_1)^2}.$$

Firm 1 initially chooses θ_1 in order to maximize these profits. The first order condition for a maximum

$$\frac{\partial \pi_1}{\partial \theta_1} = \frac{(1-6\theta_1+3\theta_1^2)(4-2\theta_1)+4(1+\theta_1-3\theta_1^2+\theta_1^3)}{(4-2\theta_1)^3} = 0$$

yields $\theta_1^A \approx 0.479$ as the optimal level of CSR for the purpose of entry accommodation. Further, this implies $\theta_2^A \approx 0.108$ as well as $\pi_1^A \approx 0.0972$ and $\pi_2^A \approx 0.0446 - e$ in the SPE with accommodated entry.

5.3 Entry deterrence

Using equations (11) and (10), the equilibrium profit of firm 2 conditional on entry equals

$$\pi_2 = \frac{(1-\theta_1)^2 - \left[\dfrac{(1-\theta_1)^2}{3-\theta_1}\right]^2}{\left[3-\left(\theta_1+\dfrac{(1-\theta_1)^2}{3-\theta_1}\right)\right]^2} - e. \tag{12}$$

Since firm 2 enters only for positive profits, firm 1 is able to deter entry by choosing a CSR level of at least

$$\theta_1^D := 1 - 2e - 2\sqrt{e(1+e)}$$

for which $\pi_2 = 0$ by equation (12). If firm 2 does not enter, firm 1 will stay a monopolist and choose q_1 in order to maximize V_1^M. The first order condition yields

$$\frac{\partial V_1}{\partial q_1} = 1 - 2q_1 + \theta_1^D q_1 = 0 \quad \Leftrightarrow \quad q_1 = \frac{1}{2-\theta_1^D}. \tag{13}$$

The related profit equals

$$\pi_1^D = \frac{1-\theta_1^D}{(2-\theta_1^D)^2} = \frac{2e+2\sqrt{e(1+e)}}{\left(1+2e+2\sqrt{e(1+e)}\right)^2}.$$

5.4 Comparison

Entry deterrence will be more profitable than entry accommodation if $\pi_1^D \geq \pi_1^A$. This condition is equivalent to $e \geq e^*$, where the critical value of entry costs e^* is implicitly defined by[14]

$$2e^* + 2\sqrt{e^*(1+e^*)} = \left(1+2e^*+2\sqrt{e^*(1+e^*)}\right)^2 \pi_1^A.$$

Our results yield a pattern that is well-known from other models of market entry (Dixit, 1980, Maskin, 1999), and are summarized in

[14] $e^* \approx 0.0034$

Proposition 2 *The SPE of the two-stage game between one monopolistic incumbent and one potential entrant depends on the level of entry costs.*

(a) For high entry costs $e > e^+$, entry is blockaded and the monopolist does not engage into CSR.

(b) For intermediate entry costs $e^* \leq e \leq e^+$, the incumbent deters entry by means of the positive CSR level $\theta_1^D = 1-2e-2\sqrt{e(1+e)}$ which is decreasing in e.

(c) For low entry costs $e < e^*$, the incumbent accommodates entry and both firms choose positive CSR levels with $\theta_1^A > \theta_2^A$.

Note that in the case of entry accommodation the incumbent chooses its CSR level first. Since CSR levels are strategic substitutes, as implied by (10), this redounds to a first-mover advantage which results in a larger market share and higher profits for the incumbent. The case of entry deterrence reinforces the validity of Corollary 2 characterizing situations for which the strategic use of CSR increases the market concentration compared to the case in which firms abstain from CSR.

5.5 Welfare analysis

The results from our model of entry deterrence imply the same opposing welfare effects of strategic CSR as in the model of Cournot competition. We must trade off the negative output effect of higher market concentration against the positive output effect of positive CSR levels and, with respect to total surplus, the positive effect of saved entry costs.

We first compare consumer surplus in the equilibria with and without entry deterrence by means of CSR. Since consumer surplus increases in total output, it suffices to compare the corresponding output levels. In the regular Cournot model without CSR, the output level of each firm equals 1/3 yielding gross profits of 1/9. Firm 2 will thus be active if entry costs do not exceed 1/9. In this case, total output equals 2/3. Otherwise, firm 1 produces the monopoly output 1/2.

For entry costs below e^* for which entry is accommodated in the model of entry deterrence by means of CSR, both firms apply positive levels of CSR which increases total output beyond the regular Cournot output 2/3. For entry costs between e^* and 1/9, entry is deterred and we have to confront the incumbent's output q_1^D given by equation (13) with the regular Cournot output 2/3. We compute that $q_1^D > 2/3$ for entry costs $e^* < e < \hat{e} := \frac{1}{24}$ and vice versa for entry costs $\hat{e} := \frac{1}{24} < e < \frac{1}{9}$. Intuitively, in order to deter entry, CSR levels must be the higher, the lower the entry costs. Thus the positive output effect of positive CSR levels outweighs the negative output effect of higher market concentration for low entry costs, and vice versa for intermediate entry costs. For entry costs between 1/9 and 1/8 entry would be blockaded if there was not the threat of firm 2 to enter with some positive level of CSR. This threat forces the incumbent to adopt positive CSR levels in order to deter entry even in this range of high entry costs, which induces some output above the regular monopoly level 1/2. For entry costs above 1/8, entry is blockaded and the regular monopoly output 1/2 is produced. We summarize these results in

Corollary 3 *In the SPE of the two-stage game between one monopolistic incumbent and one potential entrant, the strategic use of CSR influences consumer surplus*

(a) positively for low entry costs $e < \hat{e}$*,*

(b) negatively for intermediate entry costs $\hat{e} \leq e \leq 1/9$*,*

(c) positively for high entry costs $1/9 < e < e^+$*,*

(d) not at all for prohibitive entry costs $e \geq e^+$

compared to a situation in which both firms abstain from CSR.

The finding that entry deterrence may increase consumer surplus even for high entry costs is particular for the strategic use of CSR as a commitment to larger quantities and a distinguishing feature of our model.

Unlike for consumer surplus, total surplus net of entry costs is always higher in the equilibrium with than without entry deterrence by means of CSR. To see this, notice that gross total surplus increases in total output, just as consumer surplus does. Since the saving of entry costs represents an additional surplus, we only have to check whether this additional surplus outweighs the reduction of gross total surplus in the range of entry costs for which $\hat{e} \leq e \leq 1/9$. In the absence of CSR, total welfare in the regular Cournot equilibrium equals $4/9 - e$. If entry is deterred by means of CSR, total welfare in the SPE equals $(1 - \frac{1}{2}q_1^D)q_1^D$, where q_1^D is given by equation (13). Simple calculations show that the former is always smaller than the latter.

Corollary 4 *In the SPE of the two-stage game between one monopolistic incumbent and one potential entrant, the strategic use of CSR increases net total surplus compared to a situation in which both firms abstain from CSR for all non-prohibitive entry costs* $e < e^+$*.*

6 Extensions

In this section, we extend our baseline model of section 3 to heterogeneous firms and general demand functions.

6.1 CSR in Cournot competition with heterogeneous firms

In this paragraph, we examine the case of firms with heterogeneous productivities, i.e., asymmetric costs. For simplicity, we consider strategic CSR in a Cournot duopoly in which firm 1 has constant marginal costs normalized to zero and firm 2 has constant marginal costs of c with $0 < c < 1$. We focus on potential SPE in which $\theta_i \in [0,1]$ for $i \in \{1,2\}$, i.e., no firm puts more weight on consumer surplus than on profits.

At the second stage of the game, the two firms simultaneously choose their output levels in order to maximize their objective functions which are then given by

$$V_1 = (1 - q_1 - q_2)q_1 + \frac{1}{2}\theta_1(q_1 + q_2)^2,$$
$$V_2 = (1 - q_1 - q_2 - c)q_2 + \frac{1}{2}\theta_2(q_1 + q_2)^2.$$

The first-order conditions $\partial V_1/\partial q_1 = 0 = \partial V_2/\partial q_2$ imply the reaction functions

$$q_1(q_2) = \frac{1 - (1-\theta_1)q_2}{2 - \theta_1},$$
$$q_2(q_1) = \frac{1 - c - (1-\theta_2)q_1}{2 - \theta_2},$$

and thus the second stage quantity choices as functions of the CSR levels:

$$q_1 = \frac{1 - \theta_2 + \theta_1 + c(1-\theta_1)}{3 - \theta_1 - \theta_2}, \tag{14}$$
$$q_2 = \frac{1 - \theta_1 + \theta_2 - c(2-\theta_1)}{3 - \theta_1 - \theta_2}. \tag{15}$$

At the first stage, the firms anticipate these choices and maximize their respective profits

$$\pi_1 = \frac{(1 - \theta_2 + c - \theta_1)(1 - \theta_2 + c - (1-c)\theta_1)}{(3 - \theta_1 - \theta_2)^2},$$
$$\pi_2 = \frac{(1 - 2c - (1-c)\theta_1 - (1-c)\theta_2)(1 - 2c - (1-c)\theta_1 + \theta_2)}{(3 - \theta_1 - \theta_2)^2},$$

by the choice of their CSR levels. The first-order conditions $\partial\pi_1/\partial\theta_1 = 0 = \partial\pi_2/\partial\theta_2$ imply

$$\theta_1(\theta_2) = \frac{(1-\theta_2)^2 + (1-\theta_2)c}{3 - \theta_2 - c}, \tag{16}$$
$$\theta_2(\theta_1) = \frac{(1-\theta_1)^2 - (1-\theta_1)(2-\theta_1)c}{3 - \theta_1 - (2-\theta_1)c}. \tag{17}$$

It is straightforward to show that $0 \leq \theta_1(\theta_2) < 1$ for all $0 < c < 1$ and all $\theta_2 \in [0,1]$ as well as $\theta_2(\theta_1) < 1$ for all $0 < c < 1$ and all $\theta_1 \in [0,1]$. Moreover, $0 < \theta_2(\theta_1)$ for $0 < c < 1$ and $\theta_1 \in [0,1]$ if and only if

$$\theta_1 < \frac{1-2c}{1-c}. \tag{18}$$

Consequently, for all $0 < c < 1$ and $\theta_1, \theta_2 \in [0,1]$, the first stage best responses of the firms are given by the reaction functions $r_1(\theta_2) := \theta_1(\theta_2)$ and $r_2(\theta_1) := \max\{\theta_2(\theta_1), 0\}$, where $\theta_1(\theta_2)$ and $\theta_2(\theta_1)$ are defined by equations (16) and (17), respectively. The intersection of these reaction functions constitute an SPE. As above, we asterisk the corresponding equilibrium values.

Proposition 3 *For all $c \in (0,1)$, the two-stage game with strategic CSR and Cournot competition between two asymmetric firms has an SPE in which $\theta_i^* \in [0,1]$ for $i \in \{1,2\}$ and*

(a) the firm with the lower marginal costs chooses a higher CSR level, produces more output, and earns higher profits, i.e., $\theta_1^* > \theta_2^*$, $q_1^* > q_2^*$, and $\pi_1^* > \pi_2^*$ for all $0 < c < 1$;

(b) an increase in the cost advantage of a firm increases its CSR level but (weakly) decreases the CSR level and profit of its competitor, more precisely: $d\theta_1^*/dc > 0$ for all $c \in (0,1)$ and $d\theta_2^*/dc < 0$ for all $c \in (0,1/3)$ as well as $\theta_2^* = 0$ for all $c \in [1/3,1)$.

The proof can be found in Appendix A. Figure 1 illustrates the equilibrium CSR levels depicting the reaction functions r_1 and r_2 for the cost differentials $c = 0$, $c = 1/4$, and $c = 1/3$, respectively. We have run a number of further simulations suggesting that the SPE is unique. Proposition 3 provides an explanation for the coexistence of (highly profitable) firms that engage in CSR and (less profitable) firms that abstain from CSR in the short-run market equilibrium. The results demonstrate that the strategic use of CSR complements cost advantages and reinforces differences in profitabilities.[15] In the long-run, strategic CSR may thus foster market consolidation and accelerate the adoption of superior technologies.

6.2 CSR in Cournot competition with general demand functions

In this paragraph, we consider the more general set-up of an ordinary good, i.e., a general inverse demand function $p(q)$, with $\partial p/\partial q < 0$. We characterize a sufficient condition under which, in Cournot competition, CSR has the same

[15] This complementarity suggests that the empirical observation of a positive correlation between the profitability of a firm and its engagement in CSR (Jo and Harjoto, 2011, Eccles et al., 2014, Flammer, 2015) may be due to mutual causality.

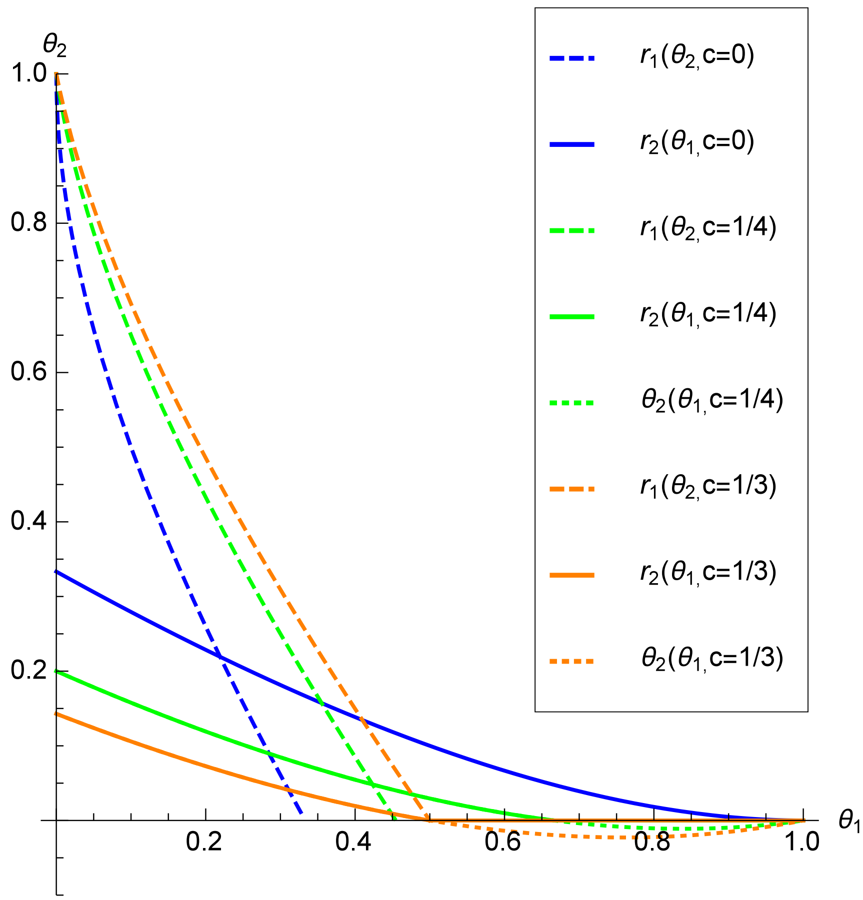

Figure 1: CSR levels in the SPE with asymmetric marginal costs

strategic impact as in the linear case, i.e., serves the firm as a commitment to increase its own output ($dq_i/d\theta_i > 0$) and induces rivals to reduce their output ($dq_j/d\theta_i < 0$).

For simplicity, consider a duopoly and suppose that a symmetric SPE in pure strategies exists. At the second stage, the objective functions of the two firms are given by

$$V_1 = p(q_1 + q_2)q_1 + \theta_1 CS(q_1 + q_2),$$
$$V_2 = p(q_1 + q_2)q_2 + \theta_2 CS(q_1 + q_2).$$

The maximizing quantities satisfy the first-order conditions

$$\frac{\partial V_1}{\partial q_1} = p'(q_1 + q_2)q_1 + p(q_1 + q_2) + \theta_1 CS'(q_1 + q_2) = 0, \tag{19}$$
$$\frac{\partial V_2}{\partial q_2} = p'(q_1 + q_2)q_2 + p(q_1 + q_2) + \theta_2 CS'(q_1 + q_2) = 0. \tag{20}$$

as well as the second order conditions $\dfrac{\partial^2 V_i}{\partial q_i^2} < 0$. Using $CS(q_1+q_2) = \int_0^{q_1+q_2}[p(q)-p(q_1+q_2)]dq$ and thus $CS'(q_1+q_2) = -(q_1+q_2)p'(q_1+q_2)$, we rewrite equations (19) and (20):

$$[(1-\theta_1)q_1 - \theta_1 q_2]p'(q_1+q_2) + p(q_1+q_2) = 0, \tag{21}$$
$$[(1-\theta_2)q_2 - \theta_2 q_1]p'(q_1+q_2) + p(q_1+q_2) = 0. \tag{22}$$

Denote the left-hand side of equations (21) and (22) by $F_1(\theta_1,\theta_2,q_1,q_2)$ and $F_2(\theta_1,\theta_2,q_1,q_2)$, respectively.

First, we compute the sign of $dq_1/d\theta_1$. Treating θ_2 as fixed and applying the implicit function theorem yields

$$\frac{dq_1}{d\theta_1} = \frac{-\dfrac{\partial F_1}{\partial \theta_1}\dfrac{\partial F_2}{\partial q_2}}{\dfrac{\partial F_1}{\partial q_1}\dfrac{\partial F_2}{\partial q_2} - \dfrac{\partial F_1}{\partial q_2}\dfrac{\partial F_2}{\partial q_1}}. \tag{23}$$

Notice that $\partial F_1/\partial\theta_1 = -(q_1+q_2)p'(q_1+q_2) > 0$. Moreover, $\partial F_i/\partial q_i = \partial^2 V_i/\partial q_i^2 < 0$ for $i \in \{1,2\}$, as implied by the second order conditions on the solution of the maximization problem. Thus the numerator of (23) is positive. Taking the respective derivatives, using the symmetry $\theta_1 = \theta_2 = \theta$ in equilibrium, writing $q_1 + q_2 = Q$, and simplifying terms, we compute the denominator

$$\frac{\partial F_1}{\partial q_1}\frac{\partial F_2}{\partial q_2} - \frac{\partial F_1}{\partial q_2}\frac{\partial F_2}{\partial q_1} = p'(Q)[(3-2\theta)p'(Q) + (1-2\theta)Qp''(Q)]. \tag{24}$$

Since $p'(Q) < 0$, an increase in a firm's CSR level increases its output, i.e., $dq_1/d\theta_1 > 0$, if and only if

$$(3-2\theta)p'(Q) + (1-2\theta)Qp''(Q) < 0 \tag{25}$$

Next, we compute the sign of $dq_1/d\theta_2$. Treating θ_1 as fixed now and applying the implicit function theorem yields

$$\frac{dq_1}{d\theta_2} = \frac{\dfrac{\partial F_2}{\partial \theta_2}\dfrac{\partial F_1}{\partial q_2}}{\dfrac{\partial F_1}{\partial q_1}\dfrac{\partial F_2}{\partial q_2} - \dfrac{\partial F_1}{\partial q_2}\dfrac{\partial F_2}{\partial q_1}}. \tag{26}$$

The denominator of (26) equals the denominator of (23). Again due to the symmetry in equilibrium, the numerator simplifies to

$$\frac{\partial F_2}{\partial \theta_2}\frac{\partial F_1}{\partial q_2} = -Qp'(Q)[(1-\theta)p'(Q) + (1-2\theta)Qp''(Q)]. \tag{27}$$

As $-Qp'(Q) > 0$, an increase in a firm's CSR level decreases its rival's output, $dq_1/d\theta_2 < 0$, if and only if

$$(3 - 2\theta)p'(Q) + (1 - 2\theta)Qp''(Q) \tag{28}$$

and

$$(1 - \theta)p'(Q) + (1 - 2\theta)Qp''(Q) \tag{29}$$

are either both positive or both negative, such that either the numerator of (26) is positive and the denominator of (26) is negative or vice versa. Note that (28)<(29) and thus we obtain the condition that $dq_1/d\theta_2 < 0$ if and only if either

$$(3 - 2\theta)p'(Q) + (1 - 2\theta)Qp''(Q) > 0 \tag{30}$$

or

$$(1 - \theta)p'(Q) + (1 - 2\theta)Qp''(Q) < 0. \tag{31}$$

Further notice that (30) and (25) can never both be fulfilled at the same time and that (31) already implies (25).

Proposition 4 *In the SPE of the two-stage game with Cournot competition between two symmetric firms facing a general inverse demand function $p(Q)$, an increase in the CSR level of a firm imposes a commitment to a higher quantity and simultaneously induces a quantity reduction by the competitor, i.e., $dq_i/d\theta_i > 0$ and $dq_j/d\theta_i < 0$, if and only if $(1 - \theta)p'(Q) + (1 - 2\theta)Qp''(Q) < 0$.*

For equilibrium CSR levels $\theta \leq 1/2$, the relevant condition (31) is weaker than what Cornes and Itaya (2016) call Hahn's condition: $p'(Q) + Qp''(Q) < 0$ (Hahn, 1962).[16] Thus under rather mild conditions on a general demand function, in a Cournot duopoly the use of CSR underlies the same strategic incentives as with linear demand. Due to the fact that we consider an aggregative game, we conjecture that this is also true for $n > 2$ (cf. Cornes and Itaya, 2016).

7 Conclusion

We have examined the strategic use of Corporate Social Responsibility (CSR) in oligopolistic markets using a two-stage model, in which the level of CSR determines the weight a firm puts on consumer surplus in its objective function before it decides upon supply. First, we have shown that the endogenous level of CSR is positive for any given number of firms active in symmetric Cournot competition. Since positive CSR levels imply smaller equilibrium profits, however, market concentration may increase. Second, we have demonstrated that an incumbent

[16] Hahn's condition is known to be a sufficient condition for the strategic success of various kinds of manipulations of a firm's objective function, while often it imposes a stricter condition than necessary (Cornes and Itaya, 2016).

monopolist can profitably use CSR as an entry deterrent. Both results indicate that CSR can be anticompetitive. Indeed we have identified circumstances in which CSR decreases consumer surplus, but mitigates the problem of excessive entry thereby increasing total welfare. Third, we have shown that asymmetric costs imply asymmetric CSR levels because strategic CSR complements cost advantages.

Our analysis has focused on quantity competition where the strategic use of CSR serves as a commitment to increase output. In Appendix B we show that such a commitment is of no avail on markets with price competition. The intuition is that a commitment to higher outputs will be understood as a commitment to lower prices where instead some commitment to higher prices would be needed (Fershtman and Judd, 1987). As a consequence, both prices and profits decrease in the level of CSR and firms will not choose to engage in it if faced with price competition. Notice, however, that this negative result hinges on our assumption of homogeneous goods. If consumers have preference for socially responsibly produced goods, CSR may be used strategically as a means of product differentiation and possibly reduce competition this way (Conrad, 2005, Liu et al., 2015).

Acknowledgements

We thank the participants of the following conferences, workshops, and seminars for their helpful comments and suggestions: Oligo Workshop 2015 (Madrid), 6th Bavarian Micro Day 2015 (Bamberg), Public Economics Research Seminar 2015 (Munich), Annual Meeting of the European Economic Association 2015 (Mannheim), Economic Research Seminar at TUM 2015 (Munich), CESifo Area Conference on Applied Microeconomics 2016 (Munich), Joint Annual Meeting of the Slovak Economic Association and the Austrian Economic Association (NOeG-SEA) 2016 (Bratislava), 22nd BGPE Research Workshop 2016 (Munich), 5th World Congress of the Game Theory Society (GAMES) 2016 (Maastricht), 43rd Annual Conference of the European Association for Research in Industrial Economics (EARIE) 2016 (Lisbon).

Appendix

A Proof of Proposition 3

In order to prove part (a) of Proposition 3, first notice that for $c = 0$, a (unique) SPE exists and is symmetric with $\theta_1^* = \theta_2^* = (5 - \sqrt{17})/4$ according to equation (9). Now, suppose that an SPE with $\theta_i^* \in [0, 1]$ for $i \in \{1, 2\}$ exists for all $0 < c < 1$ and has the properties stated in part (b) of Proposition 3. Then these properties imply $\theta_1^* > \theta_2^*$ for all $0 < c < 1$, which, in turn, implies $q_1^* > q_2^*$ according to equations (14) and (15), and, consequently, $\pi_1^* > \pi_2^*$.

It remains to show that an SPE with $\theta_i^* \in [0,1]$ for $i \in \{1,2\}$ exists for all $0 < c < 1$ and has the properties stated in part (b). Notice that $r_1(1) = r_2(1) = 0$ and $r_1(0) > 0$ for all $0 < c < 1$. For $c = 1/3$, we have $r_1(0) = \theta_1(0) = 1/2$ and $r_2(1/2) = \theta_2(1/2) = 0$ according to equations (16) and (17), and thus $\theta_1^* = 1/2$ and $\theta_2^* = 0$ constitute an SPE. The existence of an SPE for all $0 < c < 1$ in which $\theta_i^* \in [0,1]$ for $i \in \{1,2\}$ and the respective comparative statics $d\theta_1^*/dc > 0$ for all $c \in (0,1)$ and $d\theta_2^*/dc < 0$ for all $c \in (0,1/3)$ as well as $\theta_2^* = 0$ for all $c \in [1/3,1)$ now result from the following

Lemma 1 *For all $0 < c < 1$ and $\theta_1, \theta_2 \in [0,1]$, the reaction function*

(a) r_1 strictly decreases in θ_2, i.e., $\partial r_1/\partial \theta_2 < 0$,

(b) r_2 strictly decreases in θ_1, i.e., $\partial r_2/\partial \theta_1 < 0$, wherever positive.

(c) r_1 shifts strictly upward in c, i.e., $\partial r_1/\partial c > 0$, for all $\theta_2 \in [0,1)$

(d) r_2 shifts strictly downward in c, i.e., $\partial r_2/\partial c < 0$, for all $\theta_1 \in [0,1)$ wherever positive.

Proof.

(a) Using equation (16), it is straightforward to show that $\partial r_1/\partial \theta_2 = \partial \theta_1(\theta_2)/\partial \theta_2 < 0$ is equivalent to

$$-5 + c^2 - 2c\theta_2 + 6\theta_2 - \theta_2^2 < 0.$$

For $\theta_2 = 1$, the expression on the left-hand side (LHS) of this inequality is obviously negative for all $0 \leq c \leq 1$. As a function of c, the LHS is convex and takes its minimum at $c = \theta_2 \in [0,1]$. Consequently, depending on θ_2, the LHS takes its maximum either at $c = 0$ or at $c = 1$. For $0 \leq \theta_2 \leq 1/2$ the LHS has a maximum of $-4 + 4\theta_2 - \theta_2^2 < 0$ at $c = 1$, and for $1/2 < \theta_2 < 1$ the LHS has a maximum of $-5 + 6\theta_2 - \theta_2^2 < 0$ at $c = 0$. The maximum of the LHS is thus always negative and, a fortiori, the inequality is correct for all $0 < c < 1$ and $\theta_2 \in [0,1]$.

(b) Wherever r_2 is positive, $r_2(\theta_1) = \theta_2(\theta_1)$. Using equation (17), it is straightforward to show that $\partial \theta_2(\theta_1)/\partial \theta_1 < 0$ is equivalent to

$$(6 - 10c + 4c^2)\theta_1 - (1-c)^2\theta_1^2 < 5 - 10c + 4c^2. \tag{32}$$

The expression on the left-hand side (LHS) of inequality (32) strictly increases in θ_1, because straightforward calculations show that

$$\frac{6 - 10c + 4c^2}{2(1-c)} > 1 \geq \theta_1$$

for all $0 < c < 1$ and $\theta_1 \in [0,1]$. According to inequality (18), $\theta_1 < (1-2c)/(1-c)$ wherever r_2 positive. Consequently, wherever r_2 positive, the LHS of inequality (32) is smaller than

$$(6 - 10c^2 + 4c^2) \cdot \frac{1-2c}{1-c} - (1-c)^2 \cdot \left(\frac{1-2c}{1-c}\right)^2 = 5 - 12c + 4c^2$$

and thus obviously smaller than the right-hand side of inequality (32) for all $0 < c < 1$.

(c) Using equation (16), it is straightforward to show that $\partial r_1/\partial c = \partial\theta_1(\theta_2)/\partial c > 0$ is equivalent to

$$2 - 3\theta_2 + \theta_2^2 > 0,$$

which is obviously true for all $\theta_2 \in [0,1)$ as the expression on the left-hand side of this inequality strictly decreases for all $\theta_2 \in [0,1]$ and thus takes its minimum 0 at the corner $\theta_2 = 1$.

(d) Wherever r_2 is positive, $r_2(\theta_1) = \theta_2(\theta_1)$. Using equation (17), straightforward calculations show that $\partial\theta_2(\theta_1)/\partial c < 0$ for all $\theta_1 \in [0,1)$.

□

B Strategic CSR in Bertrand Competition

The analysis of strategic CSR in Bertrand Competition requires some minor changes to the set-up introduced in Section 3. We now assume product differentiation and thus there no longer exists a single demand function for the goods of both firms. Instead, the (normalized) linear demand function for each of the goods is now given by

$$q_i = 1 - p_i + \gamma p_j \quad \text{with} \quad 0 < \gamma < 1,$$

where $i, j \in \{1,2\}$, $i \neq j$.
Accordingly, also the objective function of each firm has to be adjusted, though the general form is the same as before:

$$V_i = \pi_i + \theta_i \cdot CS = (1 - p_i + \gamma p_j)p_i + \theta_i[2 - (1-\gamma)(p_i + p_j)]^2.$$

Some transformations yield

$$\begin{aligned} V_i =& 4\theta_i - 4\theta_i(1-\gamma)p_j + (1-\gamma)^2\theta_i p_j^2 \\ &+ [\gamma p_j - 4\theta_i(1-\gamma) + 2\theta_i(1-\gamma)^2 p_j + 1]p_i - [1 - (1-\gamma)^2\theta_i]p_i^2. \end{aligned}$$

Competition, again, is modeled as a two-stage game. As before, firms simultaneously choose their respective levels of social concern by maximizing profits in the

first stage. In the second stage, firms maximize their resulting objective functions V_i, now, by the choice of their prices p_i.
We solve the game by backward induction. In the second stage, the firms maximize their objective functions V_i by choosing their optimal price levels p_i for any given CSR level θ_i. The first-order condition

$$\frac{\partial V_i}{\partial p_i} = [2\theta_i(1-\gamma)^2 + \gamma]p_j + 1 - 4\theta_i(1-\gamma) - 2[1-(1-\gamma)^2\theta_i]p_i = 0$$

yields firm i's best response:

$$p_i = \frac{[2\theta_i(1-\gamma)^2 + \gamma]p_j + 1 - 4\theta_i(1-\gamma)}{2[1-\theta_i(1-\gamma)^2]}. \tag{33}$$

Inserting the two firms' best responses into each other yields

$$p_i = \frac{2+\gamma-2(1-\gamma)(3+\gamma)\theta_i - 2(1-\gamma)(1+\gamma)\theta_j}{(2-\gamma)(2+\gamma) - 2(1-\gamma)^2(2+\gamma)\theta_i - 2(1-\gamma)^2(2+\gamma)\theta_j}. \tag{34}$$

In the first stage, the firms maximize their profits by the choice of their respective CSR levels θ_i. Because

$$\frac{\partial \pi_i}{\partial \theta_i} = \frac{\partial p_i}{\partial \theta_i} - 2 - p_i\frac{\partial p_i}{\partial \theta_i} + \gamma\left[p_j\frac{\partial p_i}{\partial \theta_i} + \frac{\partial p_j}{\partial \theta_i}p_i\right], \tag{35}$$

the first-order condition for a maximum $\partial\pi_i/\partial\theta_i = 0$ is never fulfilled. Rather, we show below that always $\partial\pi_i/\partial\theta_i < 0$. Consequently, each firm will choose the lowest CSR level possible.

Proposition 5 *In the SPE of the two-stage game with Bertrand competition between 2 symmetric firms, both firms choose a CSR level of $\theta^* = 0$, irrespective of the degree of product differentiation.*

Proof. Note that in equilibrium $\theta_i = \theta_j = \theta$ and $p_i = p_j = p$. Some transformations of (35) yield

$$\frac{\partial \pi_i}{\partial \theta_i} = \frac{\partial p_i}{\partial \theta_i} - \frac{\gamma p}{(2-\gamma)p-1}\frac{\partial p_j}{\partial \theta_i}.$$

Using (34) it can be shown that $\frac{\partial p_i}{\partial \theta_i} < 0$ and $\frac{\partial p_j}{\partial \theta_i} < 0$. In equilibrium, (34) implies

$$p = \frac{2+\gamma-4(1-\gamma)(2+\gamma)\theta}{(2+\gamma)(2-\gamma)-4(1-\gamma)^2(2+\gamma)\theta}$$

and thus

$$(2-\gamma)p = \frac{2-\gamma-4(1-\gamma)(2-\gamma)\theta}{2-\gamma-4(1-\gamma)(1-\gamma)\theta} < 1.$$

Consequently, $\frac{\gamma p}{(2-\gamma)p-1} < 0$. We conclude that the firms' profits decrease in their CSR level θ_i for all possible values of γ and the only subgame-perfect outcome is to choose $\theta_i = \theta_j = \theta = 0$.

□

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