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What Corporate Social Responsibility Motivations are better for The Environment?

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Abstract

Is it always the case that an environmental friendly CSR firm will be preferred to a consumer caring CSR-firm in terms of the environmental damage generated in the market?. Will always an environmental friendly CSR firm be preferred to a firm which concerns only with profit maximization?. We explore these questions by analyzing a duopoly market setting in which a CSR firm interacts with a profit maximizing firm. Unlike previous literature, we consider different motivations for the CSR firm: (i) the CSR firm acts as a consumer-friendly firm, cares for not only its profits but also consumer surplus, as a proxy of its concern for its "stakeholders" or consumers; (ii) the CSR firm main objective is a combination of its own profit and the environment, caring for the environmental damage produced by the market in which it interacts; and (iii) the CSR firm is both consumer and environmental friendly. As benchmark we also consider the case in which both firms in the duopoly only concern about material profits, evaluating for all cases the environmental damage generated in their market interaction.

Keywords: Corporate social responsibility, consumer-friendly firm, environment-friendly firm, Mixed Duopoly, Emission Taxation

JEL Classification: L13, L31, H23, Q50,

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1 Introduction

There is a current trend in business strategy by which firms are gradually, and increasingly, adopting corporate practices that go beyond profit-maximizing objectives, taking also into account ethical regards, community welfare and environmental sustainability as important business habits.¹ Consequently, the economic literature has started modelling oligopoly markets in which some private firms, that we call here CSR firms, differentiate from others by maximizing its profit as well as a fraction of the market consumer surplus, in order to reflect its consumer-friendly spirit. Among the topics addressed by this literature we can mention: vertical supply chains (Goering, 2014 and Brand and Grothe, 2015); horizontal products differentiation (Matsumura and Ogawa, 2014 and Kopel and Brand, 2012) and strategic tariff policy (Wang et al. 2012, and Liu et al. 2018). There are few works analyzing the environmental problem in this context.²

Nevertheless, one theoretical question that can be put forward is what motivations of CSR firms are more benign towards the environment. For example, is it always the case that an environmental friendly CSR firm will be preferred to a consumer caring CSR-firm in terms of the environmental damage generated in the market?. Similarly, will always an environmental friendly CSR firm be preferred to a firm which concerns only with profit maximization?. While the answers to these questions appear obvious we formally show that this is not always the case. Hence, the main aim of this work is to formally study different potential motivations for a CSR firm and its potential impact on the environment. Particularly, we explore a duopoly market setting in which a CSR firm interacts with a profit maximizing firm. Unlike previous literature, we consider three different scenarios: (i) the CSR firm acts as a consumer-friendly firm, cares for not only its profits but also consumer surplus, as a proxy of its concern for its "stakeholders" or consumers; (ii) the CSR firm main objective is a combination of its own profit and the environment, caring for the environmental damage produced by the market in which it interacts, and (iii) the CSR firm is both consumer and environmental friendly, caring about its profit, a share of consumer surplus and environmental damage. Previous literature typically uses the definition of a CSR firm given by case (i), assuming that it maximizes profits plus a fraction of consumer surplus (see Kopel and Brand, 2012 and Goering, 2014). Adding these additional cases will allow us to evaluate more recent trends in the CSR literature in which environmental concerns have also become a priority for stakeholders and consumers (see, inter alia, Barman, 2018). As benchmark we also consider the case in which both firms in the duopoly, the CSR firm and the other private firm, only concern about material profits, evaluating for all cases the environmental damage generated in their market interactions.

¹ See for instance: https://home.kpmg/content/dam/kpmg/campaigns/csr/pdf/CSR_Reporting_2017.pdf.

² The exception is provided by the recent works of Liu, et al. (2015), Leal et al (2018), García et al (2018), Villena (2019) and Xu and Lee (2018).

2 The Model

Consider a single industry made up of two polluters: one CSR firm labeled 0 and a private firm labeled 1, which competes in quantities with homogeneous products (or perfect substitutes). Both firms have production levels of a single product output q_0 and q_1 , with total output given by $Q = q_0 + q_1$ and an inverse demand function $f(Q) = a - Q = a - (q_0 + q_1)$, where $a > 0$ is the market size, and $f'(Q) < 0$. Both firms discharge pollution into the environment, which we denote by d_0 and d_1 , generating $D(d_0 + d_1)$ in total external environmental damages. Let total resource costs for the pollution-generating firm be represented by: $c_0(q_0, w_0) = \frac{q_0^2 + w_0^2}{2}$ and $c_1(q_1, w_1) = \frac{q_1^2 + w_1^2}{2}$, where w_0 and w_1 represent resources devoted to pollution treatment. Assume that the firm has two ways of reducing its emissions levels d_0 and d_1 . It may either reduce output, q_0 and q_1 , or it may devote more resources w_0 and w_1 to the treatment of pollution once it is produced, which we model as: $d_0(q_0, w_0) = \frac{q_0 - w_0}{2}$ and $d_1(q_1, w_1) = \frac{q_1 - w_1}{2}$. We also consider a tax on emissions, t , which works as a tax rate per unit of pollution discharged. Both firm's profit functions are then given by:

$$\pi_i(q_i, w_i) = f(Q)q_i - c(q_i, w_i) - d(q_i, w_i)t \text{ for } i = 0, 1 \quad (1)$$

As customary in the literature, we assume that the CSR firm, contrary to profit-maximizing private firms, cares for not only its profits but also for a fraction of the consumer surplus, CS , as a proxy of the firm's concern on consumers. We also consider the case in which a the CSR firm also cares for the environmental damage produced by the duopoly, D , as a proxy of the firm's concern for the environment. Hence the objective of the CSR-firm is a combination of consumers surplus, environmental damage and its own profit:

$$v_0 = \pi_0 + \theta CS - \lambda D \quad (2)$$

Let the parameter $\theta \in [0, 1]$ represents the fraction or percentage of total market consumer surplus that is of concern or accrues to the socially concerned firm's stakeholders. When $\theta = 1$, all consumer's welfare is of interest to this firm while, conversely, when $\theta = 0$ the firm is not consumer friendly in our model. Similarly, the parameter $\lambda \in [0, 1]$ measures the degree of concern on environmental damage by the CSR firm. When $\lambda = 1$, all environmental damage is of interest to the CSR firm while, conversely, when $\lambda = 0$ the firm is not environment friendly in our setting. We assume that θ and λ are exogenously given. This definition of CSR implies the CSR firm is willing to accept less profits to act in a more socially and environmentally concerned way. In other words, in our setting CSR is purely a costly activity (see, for instance, Goering, 2014).

We define social welfare as the difference between the sum of producer's and consumer's surplus and any

technological external costs which are not accounted for in producer's surplus.³ Particularly, in this setting we assume that social welfare will be given by the sum of consumer surplus, CS , the profits of both firms, $\pi_0 + \pi_1$, and tax revenue $T = (d_0t + d_1t)$, minus environmental damage, $D(d_0 + d_1)$ (Leal et al. 2018)⁴:

$$SW = CS + f(Q)(q_0 + q_1) - c_0 - c_1 - D(d_0 + d_1) \quad (3)$$

where $CS = \int_0^Q (a - Q) dz - (a - Q)Q = \frac{Q^2}{2}$.

The payoff that the CSR firm maximizes is as follows:

$$v_0(q_0, w_0) = f(Q)q_0 - c(q_0, w_0) - d(q_0, w_0)t + \theta \left(\int_0^Q f(z)dz - f(Q)(Q) \right) - \lambda D(d(q_0, w_0) + d(q_1, w_1)) \quad (4)$$

Throughout the paper, we restrict attention to pure strategies. Our modelling strategy is based on a *sequential two stage game*. In the first stage the regulator chooses the emissions tax (t) that maximizes social welfare, which will be levied on the two firms. In the second stage the two firms choose their levels of production (q) and pollution abatement (w). In this sequential game of perfect information, any stage is a subgame and a strategy vector is a subgame perfect Nash equilibrium (SPNE) only if it induces a Nash equilibrium in the strategic form of every subgame. In this context, SPNE reduces to *backward induction*.

Definition 1 *A strategy for the regulator is a tax amount $t \geq 0$ and a strategy for the firms is $\rho_i(q_i, w_i)$, where $\rho_i(\cdot)$ is a mapping from the domain of t to the domain of (q_i, w_i) . Assuming that the regulator is the first mover, an equilibrium of this duopoly game is then a pair $(t, \rho_i^*(q_i^*, w_i^*))$ for $i = 0, 1$, such that:*

- i. $SW(t^*, \rho_i^*(q_i^*, w_i^*)) \geq SW(t, \rho_i^*(q_i^*, w_i^*)), \forall t \geq 0; i = 0, 1$;
- ii. $\pi_1(\rho_1^*(q_1^*, w_1^*)) \geq \pi_1(\rho_1(q_1, w_1)), \forall q_1 \geq 0, w_1 \geq 0$; and
- iii. $v_0(\rho_0^*(q_0^*, w_0^*)) \geq v_0(\rho_0(q_0, w_0)), \forall q_0 \geq 0, w_0 \geq 0$

In other words, an equilibrium in this game imposes that: (i) the strategy of the firms be a single-valued selection from their best-response correspondences for q_i and w_i given a tax t ; and (ii) the regulator chooses a tax that maximizes the social welfare function given the optimal strategy of the firms (q_i^*, w_i^*) for $i = 0, 1$.

Thus, we start our analysis with stage two, in which the private and CSR firms must choose their production (q_0, q_1) and abatement (w_0, w_1) levels, given a tax, t , defined by the regulator in stage 1. Thus,

³Here, a real income constant measure of consumer's surplus, such as equivalent or compensating variation should be used to be strictly correct. Nevertheless, the area under a money-income constant demand curve is a good estimate of a welfare measure.

⁴Since we define social welfare as. $SW \triangleq CS + (f(Q)q_0 - c_0 - d_0t) + (f(Q)q_1 - c_1 - d_1t) + (d_0t + d_1t) - D(d_0 + d_1)$ we can notice that taxes are merely income transfers from the firms to the government, and therefore, they are canceled out.

the associated optimization problem faced by the private firm in this stage is given by:

$$\max_{q_1, w_1} \pi_1(q_1, w_1) = (a - (q_0 + q_1)) q_1 - \left(\frac{q_1^2 + w_1^2}{2} \right) - \left(\frac{q_1 - w_1}{2} \right) t \quad (5)$$

Similarly, for the CSR firm the problem becomes:

$$\max_{q_0, w_0} v_0(q_0, w_0) = (a - (q_0 + q_1)) q_0 - \left(\frac{q_0^2 + w_0^2}{2} \right) - \left(\frac{q_0 - w_0}{2} \right) t + \frac{\theta Q^2}{2} - \lambda \left(\frac{q_0 - w_0}{2} + \frac{q_1 - w_1}{2} \right) \quad (6)$$

We denote the set of equilibria in this stage by S_2 and its typical element by the strategy profile: $S_2 = \{(q_0^*(t), w_0^*(t)); (q_1^*(t), w_1^*(t))\}$. Now with S_2 the regulator in the first stage chooses the tax rate per unit of emissions discharged, t , that maximizes the social welfare function, see (3):

$$\max_t SW = \left(Q - \frac{Q^2}{2} \right) - \left(\frac{q_0^2 + w_0^2}{2} \right) - \left(\frac{q_1^2 + w_1^2}{2} \right) - \left(\frac{q_0 - w_0}{2} + \frac{q_1 - w_1}{2} \right) t \quad (7)$$

Likewise, S_1 identifies equilibria in this stage given by (t^*) .

3 Results

From solving the Nash Equilibrium of the second stage we obtain the following result:

Lemma 1 *Assuming that in the first stage of the game, the CSR firm and the other private firm view t as a parameter, we get the following first-order conditions for the profit maximization of (6) and (5), which implicitly define the strategy profile $S_2 = \{(q_0^*(t), w_0^*(t)); (q_1^*(t), w_1^*(t))\}$: (i) $q_0^*(t) = \frac{-(2a-t)\theta-4a+2t+3\lambda}{4\theta-16}$; (ii) $q_1^*(t) = \frac{(2a-t)\theta-4a+2t-\lambda}{4\theta-16}$; (iii) $w_0^*(t) = \frac{t+\lambda}{2}$; (iv) $w_1^*(t) = \frac{t}{2}$.*

Differentiating the FOCs of the second stage, presented in Lemma 1, with respect to parameters t , λ and θ (with θ and $\lambda \in [0, 1]$) we obtain the following result.

Lemma 2 *The comparative statics of $S_2 = \{(q_0^*(t), w_0^*(t)); (q_1^*(t), w_1^*(t))\}$ with respect to t , λ and θ is given by: (i) $\frac{\partial q_0^*}{\partial t} = \frac{\theta+2}{4(\theta-4)} < 0$; $\frac{\partial q_0^*}{\partial \lambda} = \frac{3}{4(\theta-4)} < 0$; $\frac{\partial q_1^*}{\partial t} = -\frac{\theta-2}{4(\theta-4)} < 0$; $\frac{\partial q_1^*}{\partial \lambda} = -\frac{1}{4(\theta-4)} > 0$; $\frac{\partial w_0^*}{\partial t} = \frac{1}{2} > 0$; $\frac{\partial w_0^*}{\partial \lambda} = \frac{1}{2} > 0$; $\frac{\partial w_1^*}{\partial t} = \frac{1}{2} > 0$; $\frac{\partial w_1^*}{\partial \lambda} = 0$; $\frac{\partial w_1^*}{\partial \theta} = 0$; (ii) Whenever $4a > 2t + \lambda$ we obtain: $\frac{\partial q_0^*}{\partial \theta} = \frac{3(4a-2t-\lambda)}{4(\theta-4)^2} > 0$; $\frac{\partial q_1^*}{\partial \theta} = -\frac{4a-2t-\lambda}{4(\theta-4)^2} < 0$ (if $4a < 2t + \lambda$ then the opposite holds true: $\frac{\partial q_0^*}{\partial \theta} < 0$; $\frac{\partial q_1^*}{\partial \theta} > 0$)*

From Lemma 2, it transpires that as expected an increase in the equilibrium welfare-maximizing tax reduces the equilibrium level of production for both firms and increases the resources devoted to pollution treatment. Moreover, an increase in the parameter that measures the degree of concern on environmental

damage by the CSR firm, reduces the equilibrium level of production for the CSR firm and increases the production of the private firm. It also increases the pollution abatement resources of the CSR firm, but not those of the private firm. Finally, an increase in the parameter θ that represents the fraction of consumer surplus that is of concern of the CSR firm has no effect on the resources devoted to pollution treatment but it does have an effect on the level of production for both firms, which depend upon the size of the market, the tax rate and the degree of concern on environmental damage by the CSR firm.

Let us now focus on the first stage of the game, in which the regulator faces the problem pointed out in (7). After differentiating SW with respect to t and combining with the FOCs highlighted in Lemma 1, we obtain the following proposition:

Proposition 1 *The equilibrium welfare-maximizing tax in the general setting becomes:*

$$t^* = \frac{(2a - 2\lambda + 4)\theta^2 + (14\lambda - 28)\theta + 24a - 38\lambda + 48}{5\theta^2 - 32\theta + 76} \quad (8)$$

Similarly, environmental damage is now given by $D^* = d_0^*(q_0^*(t^*), w_0^*(t^*)) + d_0^*(q_0^*(t^*), w_0^*(t^*))$. Therefore, using Lemma 1 and (8) we can get the following result:

Proposition 2 *The equilibrium environmental damage is given by:*

$$D^* = -\frac{\theta^2(8 + \lambda + 4a) + \theta(16a - 64 - 5\lambda) - 16a + 120}{20\theta^2 - 128\theta + 304} \quad (9)$$

We can now characterize the equilibrium in order to show some of the main results of the model exploiting some corner solutions.

Proposition 3 *Given (9) and the different potential objectives of the CSR-firm, as a combination of consumers surplus, environmental damage and its own profit, we obtain the optimal levels of environmental damage for the following cases:*

- (i) *Both firms in the duopoly have only a profit maximizing objective, not taking into account the consumers nor the environment in their decisions, namely: $v_0 = \pi_0$ and $\pi_1(\theta = 0$ and $\lambda = 0)$ from which it transpires that: $D^* = \frac{1}{38}(2a - 15)$*
- (ii) *The objective of the CSR-firm is a combination of consumers surplus, and its own profit, that is: $v_0 = \pi_0 + \theta CS$ ($\theta > 0$ and $\lambda = 0$) from which it transpires that: $D^* = -\frac{\theta^2(a+2)+4\theta(a-4)-4a+30}{5\theta^2-32\theta+76}$. As $\theta > 0$, we have in this setting that if $\theta = 1$, that is, all consumer's welfare is of interest to the CSR firm we also obtain: $D^* = -\frac{1}{49}(a + 16)$*

- (iii) *The objective of the CSR-firm is to maximize its material profit minus the environmental damage produced by the duopoly, that is: $v_0 = \pi_0 - \gamma D$ ($\theta = 0$ and $\lambda > 0$) from which it transpires that: $D^* = \frac{2a-15}{38}$. As $\gamma > 0$, we have in this setting that if $\lambda = 1$, that is, all environmental damage is of interest to the CSR firm we obtain: $D^* = \frac{1}{38}(2a - 15)$*
- (iv) *The objective of the CSR-firm is a combination of consumers surplus, environmental damage and its own profit, where $v_0 = \pi_0 + \theta CS - \gamma D$ ($\theta > 0$ and $\lambda > 0$) from which it transpires that: $D^* = -\frac{\theta^2(8+\lambda+4a)+\theta(16a-5\lambda-64)-16a+120}{20\theta^2-128\theta+304}$. Considering the case in which $\theta = 1$ and $\lambda = 1$, that is, all consumer's welfare and all environmental damage is of interest to the CSR firm we obtain: $D^* = -\frac{a+15}{49} = -\frac{1}{49}(a + 15)$*

From Proposition 3, we can further infer the following result.

Corollary 1 *In the context of our duopoly market setting in which a CSR firm interacts with a profit maximizing firm, from the viewpoint of environmental damage, we find that:*

- (i) The consumer friendly CSR-firm is preferred to the environmentally friendly CSR-firm.
- (ii) The consumer friendly CSR-firm is preferred to the consumer-environment friendly CSR-firm .
- (iii) The consumer-environment friendly CSR-firm is preferred to the environmentally friendly CSR-firm.
- (iv) The environmentally friendly CSR-firm produces the same environmental damage than a CSR firm would have obtained ascribing to a profit maximizing objective, that is not taking into account neither consumers nor the environment in its decisions.

The main explanation behind this result is that the consumer friendly CSR-firm is the one that produces a higher quantity of the product, much higher than the private firm, but at the same time it is in this setting in which the tax rate is also the higher since the trade-off between the environmental negative externality and the welfare loss associated with the duopoly restricted output, necessarily requires that the optimal second best tax rate must be very high in this setting. This is not the case with an environmentally friendly CSR-firm, which produces a very low quantity of production, but the private firm produces more and the tax rate is lower than in the case of the consumer friendly CSR-firm. The consumer-environment friendly CSR-firm case is the closest to the one that provokes less damage to the environment. In this case the CSR firm also produces a rather high product quantity, and so the private firm produces a lower quantity and the tax rate in turn is also high. This analysis becomes clear inspecting Table 1, which shows a summary of the individual and total equilibrium levels of production and taxes rates:

Table 1: Equilibrium levels of Production

Profit Maximizing	Consumer friendly	Environmentally friendly	Consumer-Environment friendly
$(\theta = 0 \text{ and } \lambda = 0)$	$(\theta = 1 \text{ and } \lambda = 0)$	$(\theta = 0 \text{ and } \lambda = 1)$	$(\theta = 1 \text{ and } \lambda = 0)$
$t = \frac{6a+12}{19}$	$t = \frac{26a+24}{49}$	$t = \frac{6a}{19} + \frac{5}{38}$	$t = \frac{26a-2}{49}$
$q_0 = \frac{4a}{19} - \frac{3}{38}$	$q_0 = \frac{18a-6}{49}$	$q_0 = \frac{4a}{19} - \frac{31}{152}$	$q_0 = \frac{18a}{49} - \frac{47}{196}$
$q_1 = \frac{4a}{19} - \frac{3}{38}$	$q_1 = \frac{6a-2}{49}$	$q_1 = \frac{4a}{19} - \frac{7}{152}$	$q_1 = \frac{6a}{49} + \frac{17}{196}$
$Q = \frac{8a-3}{19}$	$Q = \frac{24a-8}{49}$	$Q = \frac{8a-3}{19}$	$Q = \frac{24a}{49} - \frac{15}{98}$

4 Concluding Remarks

The results presented in this note are rather counter-intuitive. It is not the environmentally friendly CSR-firm, that cares for all environmental damage, which produces lower environmental damage interacting with a private, profit maximizing firm. In fact, this firm ends up producing the same environmental damage than a CSR firm would have obtained ascribing to a profit maximizing objective, that is not taking into account neither consumers nor the environment in its decisions. The best CSR motivation for the environment is the consumer-friendly CSR firm, which cares for not only its profits but also about all the consumer surplus, as a proxy of its concern for its "stakeholders" or consumers. The second best motivation is the consumer-environment friendly CSR-firm which cares about its profit, all consumer surplus and all environmental damage. In terms of policy recommendations, this analysis is in line with behavioral environmental economics, which encourages the understanding of the drives behind the economic agents actions (Carlsson and Johansson-Stenman, 2012) and calls for discriminatory taxes depending on the motivations of the CSR firms. A potential way to implement this policy would be through the use of reporting and certification of CSR practices. This provides an avenue for future research on the subject.

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