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Convex costs and profitability of corporate social responsibility in network industries

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Abstract

In a duopoly model with linear costs, Fanti and Buccella (2018, International Review of Economics) show that, for sufficiently intense network externalities, the equilibrium in which both firms have social concerns is more profitable than simple profit-seeking. This note shows that, with convex costs, firms competing non-cooperatively on the level of Corporate social responsibility (CSR) may increase or decrease their social engagement depending on the network effect. However, high costs (for instance due to inefficient technologies or strong input suppliers) tend to favour the appearance of the profitability of the CSR choices.

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1. Introduction

As several consulting firms regularly report (see e.g. the surveys of KPMG and Deloitte), corporate social responsibility (CSR) is nowadays a widespread global business practice. Network industries are characterized by pronounced CSR activities. KPMG reports reveal that the technology, media & telecommunications sector has a 79 percent of the companies surveyed reporting CSR activities, the highest levels among the surveyed industries. In particular, the telecommunication subsector shows the highest rate of CSR reporting, with a 87 percent of the companies (KPMG 2016a,b).

The literature on CSR is vast and studies several aspects of the firms' choice of engaging is social actions, from consumers' positive evaluation of such activities (e.g. Manasakis *et al.* 2013, 2014; Graf and Wirl 2014) to shareholders or other agents social concerns (e.g. Baron and Diermeier 2007; Baron 2008), to strategic reasons (see inter alias Goering 2007; Lambertini and Tampieri 2010, 2012; Kopel and Brand 2012; Fanti and Buccella 2017a, 2017b; Planer-Friedrich and Sahm 2020). However, only few papers analyze the precise relation between CSR activities and the network externality. Exceptions are Fanti and Buccella (2016, 2018). Fanti and Buccella (2016) show that, in a Cournot duopoly with network goods, the equilibrium profits firms obtain if they adopt consumer friendly CSR rules can be larger than those if they were only profit-seeking. Notably, an optimal degree of social care by firms does exist. Fanti and Buccella (2018) develop a Cournot model in which firms can choose, cooperatively or non-cooperatively, the level of CSR, and show that CSR can improve profitability when network effects are high. They abstract from the side of costs because the linear costs does not affect the choice of CSR level. This note extends Fanti and Buccella (2018) and it argues that convex costs, affects the firms' choice of CSR. Under the non-cooperative endogenous choice of CSR, the equilibrium of the game is that both firms engage in CSR; this outcome, in contrast to the common wisdom, is Pareto-superior when both the network effect and the decreasing returns effects are intense. As regards social welfare, the non-cooperative choice of CSR can be Pareto-superior, provided that the intensity of the network externalities is sufficiently high: in fact, both shareholders and consumers yield the largest welfare.

The remainder of this paper is structured as follows. Section 2 introduces the model setup and analyses both the cases of the standard pure profit-seeking by firms and endogenous determination of the social engagement by firms. The last section concludes outlining the future research agenda.

2. The model

We assume a duopoly in which firms produce homogeneous network goods. In the spirit of Katz and Shapiro (1985), the inverse demand function (see Fanti and Buccella 2016) is as follows,

$$p = a - q_i - q_j + n(y_i + y_j), \tag{1}$$

where p is the price of goods, q_i and q_j denote the quantity of the goods produced by the two firms, y_i and y_j denote the consumers' expectation about the firms' sales, the parameter $n \in [0,1)$ indicates the strength of network effects (i.e. the higher the value of the parameter the stronger the network effects), and $a > 0$ is a demand parameter. We assume decreasing returns to scale, that is, convex costs, and in particular quadratic costs. The firm *i*'s profit function is given by:

$$\pi_i = (p - cq_i)q_i, \tag{2}$$

where c is the parameter tuning total, average and marginal cost. It is easy to show that, at the equilibrium of the model, total, average and marginal costs are increasing with the parameter *c*. Following the recent established literature, we incorporate consumer surplus into the firm's objective function (e.g. Goering 2007, 2008; Lambertini and Tampieri 2010, 2012; Kopel and Brand 2012; Kopel *et al.* 2014). This means that the firm wishes to maximize a parameterized

combination of profits and the consumer surplus,[1] where the parameter $k_i \geq 0$ denotes the level of "social concern". Thus, the CSR objective function (W_i) is:

$$W_i = \pi_i + k_i CS = \left[a - q_i - q_j + n(y_i + y_j) - cq_i\right]q_i + k_i\left[\frac{(q_i + q_j)^2 - n(y_i + y_j)^2}{2}\right] \tag{3}$$

In the second stage of the game (the market game), firms decide simultaneously on their output levels $q_i \geq 0$ to maximize their objective functions W_i. Given the CSR firm's objective function (3), from the first order conditions

$$\frac{\partial W_i}{\partial q_i} = \frac{\partial W_j}{\partial q_j} = 0 \tag{4}$$

where $i, j = 1, 2$ and $i \neq j$, we obtain the reaction functions

$$q_i(q_j, y_i, y_j, k_i, k_j) = \frac{a - q_j(1 - k_i) + n(y_i + y_j)}{2(1 + c) - k_i} \tag{5}$$

Note that the reaction functions are 1) as expected, negatively sloped: firms perceive the products as strategic substitutes; and 2) network effects do not affect the inclination of the reaction functions.
As usual, we impose the additional "rational expectations" conditions, i.e. $y_1 = q_1$, and $y_2 = q_2$. Hence, solving the system composed by (5) and its counterpart for firm *j*, we obtain output and profit as a function of the CSR parameters:

$$q_i(k_i, k_j) = \frac{a(1 + 2c + k_i - k_j)}{\left(3 + 2c - 2n - k_i - k_j\right)\left(1 + 2c\right)} \tag{6}$$

$$\pi_i(k_i, k_j) = \frac{a^2\left[(1 + c)(1 + 2c) - k_i(1 + 3c) - k_j(1 + c)\right](1 + 2c + k_i - k_j)}{\left(3 + 2c - 2n - k_i - k_j\right)^2\left(1 + 2c\right)^2} \tag{7}$$

Anticipating the market game equilibrium, firms' owners simultaneously and independently choose the CSR level as strategic competitive variable to gain advantages over the rival firm. The traditional wisdom would predict that, in the first case, the game is a prisoner's dilemma and, at the endogenous equilibrium, firms choose to be CSR-type with the consequence of reducing profits with respect to the profit-seeking behaviour. In the first stage of the game, each firm *i* anticipates quantities (6) and chooses its CSR level $k_i \geq 0$ to maximize its corresponding profit given by (7).[2] By solving the system composed by the first order conditions

$$\frac{\partial \pi_i}{\partial k_i} = \frac{\partial \pi_j}{\partial k_j} = 0 \tag{8}$$

[1] See Fanti and Buccella (2016, footnote 4) for a derivation of the value of consumer surplus.
[2] Alternatively, as in Fanti and Buccella (2018), firms could also cooperate for maximising joint profits through the choice of a uniform level of CSR activities. In that case, however, costs do not affect the choice of CSR and thus the cooperation on the CSR choice would not be of interest in this paper because it focuses on the interaction between externalities on the demand side and convex costs on the technology side in determining the firms' choice to make CSR activities.

the following reaction functions in the CSR parameters space are obtained

$$k_i(k_j) = \frac{\left[(2c+1)(2nc+1) - 2k_j(c(1+n)+1) + {k_j}^2\right]}{3+12c+8c^2-2n(3c+1)-k_j(1+4c)} \tag{9}$$

Analytical inspection of (9) shows that the CSR reaction functions are negatively sloped as well: CSR activities are strategic substitutes. At the equilibrium of the first stage, the CSR level each individual firm chooses is

$$k_i = k_j = k^{NC} = \frac{5}{4} + c - \frac{n}{2} - \frac{H}{4}, \tag{10}$$

where $H = \sqrt{17-20n+4n^2-32nc+16c^2+40c}$, and the superscript *NC* denotes the non-cooperative choice of the CSR level.[3] Differentiation of (10) reveals the following result.

Lemma 1. *The equilibrium level of* k^{NC} *is 1) increasing in the network externality; and 2) hump-shaped in the cost parameter.*

Proof: $\frac{\partial k^{NC}}{\partial n} > 0; \frac{\partial k^{NC}}{\partial c} \gtreqless 0 \Leftrightarrow n \gtreqless 2$.

The rationale for the first comparative statics in Lemma 1 is intuitive: at whichever cost, network externalities tends to expand production (outward shift of the reaction functions), and because of the "consumers friendly" nature of CSR directly linked to output, higher CSR activities follow to catch the additional consumers. The rationale for the second comparative statistics is as follows. On the one hand, network externalities have a positive direct impact on output and prices, and therefore on revenues. On the other hand, the cost parameter impacts directly quantities, and thus total costs. When the network effects are not high, the increase in output affects more the costs side than the revenues side; consequently, owners are not incentivized to expand further production via the engagement in CSR. However, when the network effects are adequately high, the opposite holds true, and owners have an incentive to increase production undertaking CSR activities.
Lemma 1 offers the empirical implication that, in industries with strong (resp. weak or intermediate) network externalities it should be observed that the level of CSR under decreasing returns to scale (involving higher production costs) is larger (resp. smaller) than under constant returns to scale.
By substituting (10) backwards, we obtain output and profits at equilibrium

$$q_i = q_j = q^{NC} = \frac{2a}{H-2n+1} \tag{11}$$

$$\pi_i = \pi_j = \pi^{NC} = \frac{2a^2\left(H+2n-3-2c\right)}{\left(H-2n+1\right)^2} \tag{12}$$

[3] The system composed by the reaction functions in the CSR parametric space in equation (9) leads to two solutions: the one in equation (10) and the root $k_i = k_j = \frac{5}{4} + c - \frac{n}{2} + \frac{H}{4}$. However, the latter does not satisfy the second order condition for the maximization of $\pi_i(k_i, k_j)$.

First, we report here the equilibrium outcomes under profit-seeking behaviours by firms (P), which can be obtained with standard calculations (omitted here for brevity):

$$q^P = \frac{a}{[3-2(n-c)]} \tag{17}$$

$$\pi^P = \frac{a^2(1+c)}{[3-2(n-c)]^2} \tag{18}$$

Now, since both firms endogenously choose to be CSR-type,[4] we are in a position to compare the equilibrium outcomes under the different regimes - profit-seeking and non-cooperative CSR - and investigate whether CSR activities reduce profits. Then, the following results hold:

Result 1. *In contrast to the common wisdom, in network industries the Nash equilibrium of being CSR-type is Pareto-superior when both n and c are sufficiently high. In such a case both firms are more profitable following CSR rules and the Nash equilibrium is Pareto-efficient for firms.*

Proof: Let us define the following profits differential:

$$\Delta\pi = \pi^{NC} - \pi^P = \frac{\left[\begin{array}{l} 2a^2(4Hn^2 - 6Hnc + 4Hc^2 + 8n^3 - 28n^2c + 40nc^2 - 16c^3 - 10Hn + 11Hc - 40n^2 \\ +100nc - 64c^2 + 8H + 66n - 83c - 36) \end{array}\right]}{H^2[3+2(c-n)]^2}$$

It follows that $\Delta\pi \gtrless 0 \Leftrightarrow n \gtrless n^{\circ}(c)$, which is analytically not achievable in closed-form.

Nonetheless, it is possible to obtain a graphical representation of Result 1, depicted in Figure 1.

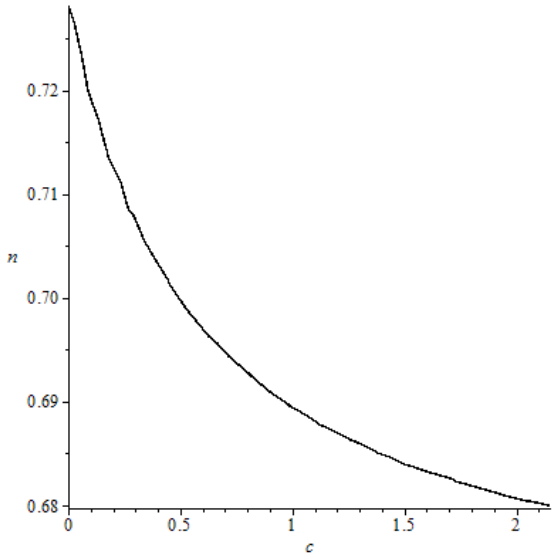

Figure 1. The indifference curve $\Delta\pi = 0$ (which implicitly defines $n^{\circ}(c)$) in the $(c,n)-$plane. Below (resp. beyond) the curve, $\Delta\pi < 0$ (resp. $\Delta\pi > 0$).

[4] It is easy to show (and thus the proof is omitted here for economy of space) that, if firms are allowed to choose endogenously whether to follow CSR rules, the endogenous decisions of following CSR rules would emerge as the SPNE outcome, in line with the result obtained without network (Fanti and Buccella 2017b) as well as with network and without costs (Fanti and Buccella 2018).

One can observe that the higher the costs are, the more likely being a CSR-type firm improves profits. Thus, it is in the interest of shareholders to show social concerns when costs are high, provided that network effects are adequately intense: in such a case, as Lemma 1 shows, the higher costs the higher the level of CSR chosen by owners.

Corollary: By jointly considering Lemma 1 and Result 1, one can remark that: 1) when the engagement in CSR activities is harmful for owners, they reduce (increase) the level of CSR as the production costs raise if $n \leq \frac{2}{3}$ ($\frac{2}{3} < n \leq n^{\circ}(c)$) ; and 2) when the engagement in CSR activities is profitable for owners, they unambiguously increase the level of CSR as production costs raise.

Finally, a consideration on the welfare effects of the choice of the CSR level. Consumer surplus unambiguously increases when firms are of CSR-type because consumers' well-being is directly linked to output levels, and "consumer friendly" CSR leads firms to expand output. Therefore, in the case of a simultaneous presence of sufficiently intense network externalities and high production costs, the non-cooperative choice of CSR is Pareto-superior because both shareholders and consumers yield better outcomes.

3. Conclusions

In a Cournot duopoly with network goods, the present note has investigated the impact of production technology when firms compete non-cooperatively on CSR levels. In fact, provided that network externalities are adequately intense, while with a linear technology the equilibrium in which both firms have social concerns is more profitable than simple profit-seeking, with convex costs firms may increase or decrease their social engagement. However, the presence of high costs (for instance, due to inefficient technologies or strong input suppliers) tend to favour the appearance of the profitability of the CSR choices.

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References

Baron, D.P. (2008) "Managerial contracting and corporate social responsibility" *Journal of Public Economics* **92**, 268–288.

Baron, D.P. and D. Diermeier (2007) "Strategic Activism and Nonmarket Strategy" *Journal of Economics & Management Strategy* **16**, 599–634.

Fanti, L. and D. Buccella (2018) "Profitability of corporate social responsibility in network industries" *International Review of Economics* **65**, 271-289.

Fanti, L. and D. Buccella (2017a) "Corporate Social Responsibility in a game theoretic context" *Economia e Politica Industriale - Journal of Industrial and Business Economics* **44**, 371-390.

Fanti, L. and D. Buccella (2017b) "Corporate social responsibility, profits and welfare with managerial firms" *International Review of Economics* **64**, 341-356.

Fanti, L. and D. Buccella (2016) "Network externalities and corporate social responsibility" *Economics Bulletin* **36**, 2043-2050.

Goering, G.E. (2007) "The strategic use of managerial incentives in a non-profit firm mixed duopoly" *Managerial and Decision Economics* **28**, 83–91.

Goering, G.E. (2008) "Welfare impacts of a non-profit firm in mixed commercial markets" *Economic Systems* **32**, 326–334.

Graf, C. and F. Wirl, F. (2014) "Corporate social responsibility: a strategic and profitable response to entry?" *Journal of Business Economics* **84**, 917– 927.

Katz, M. and C. Shapiro (1985) "Network externalities, competition, and compatibility" *American Economic Review* **75**, 424-440.

Kopel, M. and B. Brand (2012) "Socially responsible firms and endogenous choice of strategic incentives" *Economic Modelling* **29**, 982-989.

Kopel, M., Lamantia, F. and F. Szidarovszky (2014) "Evolutionary competition in a mixed market with socially concerned firms" *Journal of Economic Dynamics and Control* **48**, 394-409.

KPMG (2016a) *Corporate responsibility reporting in the Technology, Media & Telecommunications sector*, Available online at https://assets.kpmg.com/content/dam/kpmg/pdf/2016/06/survey-sector-supplement-tmt.pdf

KPMG (2016b) *Corporate responsibility reporting in the Telecom sector*, Available online at https://assets.kpmg.com/content/dam/kpmg/xx/pdf/2016/08/corporate-responsibility-reporting-telecom-sector.pdf

Lambertini, L. and A. Tampieri (2010) "Corporate Social Responsibility in a Mixed Oligopoly" Department of Economics, University of Bologna, Working paper number 723.

Lambertini, L. and A. Tampieri (2012) "Corporate social responsibility and firms' ability to collude" in *Board Directors and Corporate Social Responsibility* by S. Boubaker and D.K. Nguyen, Eds., Palgrave Macmillan UK: London, 167-178.

Manasakis, C., Mitrokostas, E. and E. Petrakis (2013) "Certification of corporate social responsibility activities in oligopolistic markets" *Canadian Journal of Economics* **46**, 282–309.

Manasakis, C., Mitrokostas, E. and E. Petrakis (2014) "Strategic Corporate Social Responsibility Activities and Corporate Governance in Imperfectly Competitive Markets" *Managerial and Decision Economics* **35**, 460–473.

Planer-Friedrich, L. and M. Sahm (2020) "Strategic corporate social responsibility, imperfect competition, and market concentration" *Journal of Economics* **129**, 79-101.