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Corporate social responsibility and the choice of price versus quantities

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Highlights: Price vs. quantity competition in the presence of Corporate Social Responsible firms are compared. - The results contrast the conventional wisdom for profit-seeking firms. – Profits can be larger under Cournot (Bertrand) also when products are complements (substitutes). – Moreover, the firms' dominant strategy can be to choose the price contract with substitute goods. - The dominant Bertrand strategy equilibrium with complement goods may be Pareto-inferior for firms.

Abstract:

This paper revisits the classic issue of the comparison between price and quantity competition in the presence of Corporate Social Responsible (CSR) private firms. The results are in sharp contrast to the conventional wisdom for profit-seeking firms. In fact, profits can be larger under Cournot (resp. Bertrand) also when products are complements (resp. substitutes). Moreover, if the goods are substitutes, then the dominant strategy for each firm may be the choice of the price contract in the subgame perfect Nash equilibrium. Also the dominant Bertrand strategy equilibrium when the goods are complements may be Pareto-inferior from the firms' perspective. Finally, the cornerstone belief that Bertrand competition is more efficient than Cournot competition may be reversed as well.

JEL codes: D21, L13, L14, M14.

Keywords: CSR; Cournot-Bertrand duopoly; Profitability; Social welfare.

1. Introduction

A recent stylised fact regarding the firms' behaviour is their tendency toward an increasing engagement in social activities. The diffusion of the "Corporate Social Responsibility" (CSR) is validated by numerous sources (e.g. McKinsey and Company, 2007; Economist Intelligence Unit, 2007; UN Global Compact and Accenture, 2010; Ernst and Young, 2010; KPMG, 2011, 2013, 2015). In particular, according to KPMG (2015), a remarkable and persistent increasing share of companies adopting CSR reporting has been observed in the last decade: in fact, while in 2005 a mere 41% of the 100 largest national companies in the surveyed countries and 64% of the 250 largest global companies reported CSR activities, those figures climbed in 2015 to 73% and 92%, respectively.

The firms' adoption of CSR behaviours, and its increasing economic relevance, has been a subject more and more frequently discussed also in the academic literature as a special issue appeared in the Journal of Economics and Management Strategy witnesses (Baron and Diermeier, 2007). From a theoretical perspective, the stream of the industrial organization (IO) literature dealing with the firms' social concerns has produced different duopoly models whose main characteristics are the number (asymmetric or symmetric) as well as the typology (consumer surplus or social welfare oriented) of socially concerned firms.[1] However, this IO literature has predominantly investigated Cournot (quantity) competition in product markets. Nonetheless, as known, a classic issue in the IO literature is the comparison between price and quantity competition.

[1] It is worth noting that the consideration of the social welfare instead of the consumer surplus as a proxy of the firm's social concerns leads to a significant difference in the market structure. Indeed, in such a case, each firm decides taking also into account the effects on the profits of the rival firm, and this means that each firm behaves in a more "collusive" way. This may look like the case of mutual cross-ownership, that is, for instance, when the weight attributed to the social welfare in the firm's objective function tends to be unitary (in the terminology of the model of Matsumura and Ogawa, 2016), the firm's behaviour is close to the full collusive one. It follows that the inclusion of the social welfare instead of the consumer surplus reduces the level of competition and, ultimately, strongly modifies the market structure from a duopoly towards a monopoly.

With regard to such an issue the pioneering results obtained in a private duopoly by Singh and Vives (1984) represents the conventional wisdom as regards this subject. Those authors develop a differentiated duopoly – early proposed by Dixit (1979) – with linear demand, goods either substitutes or complements and constant marginal costs of production. Comparing Cournot and Bertrand equilibria, they show that 1) profits are larger, equal, or smaller in Cournot than in Bertrand competition depending on the substitutes, independent, or complements nature of the goods; and 2) Bertrand competition is more efficient than Cournot competition because, in equilibrium, the consumer surplus and total surplus are higher in the former independently of whether the goods are substitutes or complements. Furthermore, they consider a two-stage game in which firms first simultaneously commit themselves to a type of (price or quantity) contract, and afterwards compete contingent on the chosen types of contracts, showing that the in the subgame perfect Nash equilibria (SPNE) of this game, the dominant strategy for each firm is to choose the quantity (resp. price) contract if the goods are substitutes (resp. complements). Finally, combining the result at the point 1) above with the SPNEs of the game, they conclude that the dominant strategy equilibrium is Pareto superior from the point of view of the firms, since Cournot (resp. Bertrand) profits are the highest of all when the goods are substitutes (resp. complements).
However, we note that, so far, it has not been paid specific attention to the choice between price and quantity competition (and the comparison between them) in the presence of CSR–type firms.[2] Exceptions are three papers which all assume substitutes products: Gosh and Mitra (2014), Kopel (2015) and Matsumura and Ogawa (2016).
Kopel (2015) and Matsumura and Ogawa (2016) focus on the endogenous choice of price contracts and quantity contracts, while Ghosh and Mitra (2014) focus on the comparison between exogenously given price and

[2] A vast literature has studied the choice of competition mode in a mixed duopoly, i.e. a duopoly with one social welfare-maximizing public firm that can be reported as a spurious example of socially interested firm (e.g. Ghosh and Mitra, 2010; Matsumura and Ogawa, 2012; Andree, 2013; Chirco et al., 2014; Scrimitore, 2014; Nakamura, 2013; Haraguchi and Matsumura, 2014, 2016). In this context, the results can differ from those of Singh and Vives (1984) in a standard private duopoly. Two recent works deserve mention: 1) in a mixed oligopoly with more than one private firm, the private firms' profit ranking and endogenous competition mode choice depend on their number: when large, Cournot profits overcome Bertrand ones, and Bertrand competition does not occur in equilibrium (Haraguchi and Matsumura, 2016); 2) when the public firm's profits weights relative to consumer surplus and private profits are strategically chosen, all firms may gain higher profits in Cournot than in Bertrand (Scrimitore, 2014), restoring the result of Singh and Vives (1984).

quantity equilibria.[3] Since the aim the aim of this paper is the endogenous choice between price and quantity competition (and the comparison between the corresponding outcomes) with CSR-type firms, we relate the present paper only to the former two papers.

Matsumura and Ogawa (2016) assume that each firm maximizes a weighted average of its own profit and social welfare: thus, in their models, both firms are of CSR-type and their typology of CSR is represented by the social welfare. Kopel (2015) assumes that one firm is a private firm and maximizes its profits while the rival is a socially concerned firm and maximizes a mix of its profits and consumer surplus. Moreover, Matsumura and Ogawa (2016) extend Ghosh and Mitra (2014) assuming that the weight attached to social welfare in the objective function is firm-specific (instead of uniform). Using a game-theoretic approach, their main finding is that both firms endogenously choose the price contract only if the difference in firms' objectives is sufficiently large. In other words, if the firm-specific weights are identical, the quantity contract is always optimal, independent of the degree of substitutability between products. By contrast, Kopel (2015) finds that, differently from the results of Singh and Vives (1984) for private duopoly as well as those above mentioned for mixed duopoly and duopoly with both firms taking into account of the social welfare, if the weight put on consumer surplus is high, then equilibria with price contracts and quantity contracts might co-exist; (ii) welfare under price competition might be lower than under quantity competition; and (iii) the profit of the profit-maximizing firm (the socially concerned firm) might be higher (lower) under price competition than under quantity competition.

Though in a slightly different context, the present paper is also related to the work of Haraguchi and Matsumura (2014). Using the appropriate game-theoretic approach, those authors characterize the endogenous competition structure (prices vs quantities) in a differentiated mixed duopoly in which a pure profit-maximizing (i.e. without any social concern) private firm that can be (partially or totally) owned by foreign investors competes against a public firm that maximizes the overall domestic social welfare (i.e. the sum of the firms' profits and the consumers' welfare). The endogenous choice of the competition mode depends on the kind of market for which the firms compete: domestic market, integrated market, or third-market. In the first case, Bertrand competition (price contracts) always

[3] In particular, Ghosh and Mitra (2014) (assuming that each firm maximises a weighted average of its own profit and social welfare) show that Bertrand competition yields higher profits, and lower consumer surplus and welfare than Cournot when the uniform weight on social welfare is higher than a threshold value, that, in the case of a CES utility function, tends to unity as the number of firms approaches infinity, irrespective of the degree of product substitutability.

emerges endogenously, independent of the ownership share of foreign owners in the private firm. On the other hand, in the second and third case Cournot competition (quantity contracts) can emerge if the fraction of domestic consumers in the integrated market is sufficiently low (zero in the extreme case of third-market).[4]

The present paper, differently from the above-mentioned ones, assumes that both firms are "consumers' friendly" CSR-type, i.e. take into account the consumer surplus in their objective. To the best of the authors' knowledge, this paper is also the first contribution extending the analysis, in a standard private duopoly, the robustness of Singh and Vives' (1984) results on the Cournot-Bertrand comparison when a widespread real markets feature such as CSR is present in all firms under the form of consumer surplus both in the presence of complements and substitutes products. Moreover, this paper gives a twofold contribution to the literature using an IO approach to the analysis of the adoption of CSR: first, it studies the endogenous choice of price vs quantity contracts when "social concerns" are an established industry practice; and second, it describes the Pareto-efficiency properties of the game equilibria, from the firms as well as the society's perspective.

The key results are as follows. In contrast to the conventional wisdom for profit-seeking-firms, profits can be larger under Cournot (resp. Bertrand) also when products are complements (resp. substitutes). Moreover, it is found that, in the presence of substitute goods, the dominant strategy for each firm can be to choose the price contract in the SPNE. Furthermore, in the case of complement goods the dominant Bertrand strategy equilibrium can be Pareto-inferior from the firms' viewpoint. Finally, the conventional belief that Bertrand competition is more efficient than Cournot competition may be reversed as well. Those results, from a qualitative viewpoint, are in sharp contrast to Matsumura and Ogawa (2016), in partial contrast to Kopel (2015), and in line with those of Haraguchi and Matsumura (2014) for substitute goods.[5] However, with respect to the above-mentioned

[4] The special case in which the private firm is completely owned by foreign owners could be considered an "asymmetric" duopoly taking into account the consumer surplus, as in Kopel's (2015) duopoly model. We thank an anonymous referee for having signaled this case.

[5] We argue that the reason for our framework to find the reversal of the Singh and Vives' (1984) model while the Matsumura and Ogawa's (2016) model to find the conventional result is that those authors assume the social welfare, rather than the consumer's surplus, as a proxy of the CSR, and the payoffs in the matrix of the game are the values of the objective functions. As regards the contribution of Kopel (2015), the rationale for that author to find multiple equilibria is the asymmetric nature of the duopoly, in which only one firm is socially concerned. On the other hand, in the presence of substitute

contributions, our paper provides with a complete description of the Pareto-efficiency properties of the game equilibria.
The remainder of the article is organized as follows. Section 2 presents the basic ingredients of the model. Section 3 analyses the game and derives the equilibrium market structures. Section 4 examines the welfare consequences. Section 5 discusses the main results. Finally, section 6 closes the paper suggesting future lines of research.

2. The model

We assume that firms produce heterogeneous goods. As usual, the standard linear inverse market demand is the following

$$p_i = a - q_i - \gamma q_j \tag{1}$$

where p_i denotes price, q_i and q_j are the firms' output levels for $i, j = 1, 2$ and $i \neq j$ and $-1 < \gamma \leq 1$. Note that, if $\gamma < 0$ (> 0) products are complements (substitutes) (if $\gamma = 0$, goods are completely differentiated and each firm is a monopolist for its own product). For tractability, we assume that both firms have zero production costs.[6]
Following the recent established literature (e.g. Lambertini and Tampieri, 2010; Fanti and Buccella, 2016), we consider in our model that all the social concerns can be interpreted as part of consumer surplus; thus, the feature of a CSR firm is to be sensitive to it. Therefore, we suppose that the firm, in its objective, wishes to maximize profits plus a fraction of the market consumer surplus k, the firm's "social concern" or care for consumer outcomes in the market. Therefore, the objective function of the firm following CSR rules can be specified as a simple parameterised combination of profits and consumer surplus. Profits and consumer surplus are, respectively

$$\pi_i = (a - q_i - \gamma q_j) q_i \tag{2}$$

goods, Haraguchi and Matsumura (2014) find the reversal of the Singh and Vives' (1984) as we do. However, in their open economies model, the driving force for this result is different from ours: in fact, in an integrated market in which duopoly firms compete for both domestic and foreign consumers, if the share of the domestic consumers is large, the public firm has a high incentive to reduce prices to improve consumer surplus. Put differently, the public firm acts in a less profit-oriented way and, thus, it has an incentive to adopt price contracts which intensify competition.

[6] This does not imply any loss of generality, in that under symmetric linear costs all the results of the paper are unchanged.

$$CS = \frac{(q_i^{\,2} + q_j^{\,2} + 2\gamma q_i q_j)}{2}. \qquad (3)$$

Thus, the CSR objective function (W) is

$$W_i = \pi_i + kCS = (a - q_i - q_j)q_i + k\frac{(q_i^{\,2} + q_j^{\,2} + 2\gamma q_i q_j)}{2} \qquad (4)$$

where the parameter $k \in [0,1]$ denotes the weight that CSR firm assigns to consumer surplus.[7]

We analyze an industry in which consumers and "socially responsible" producers interact in a non-cooperative two-stage game. In the first stage of the game (i.e., the contract game), each firm simultaneously, and independently, chooses the type of binding contract to offer consumers (i.e., either the quantity contract or the price contract). If a firm prefers the quantity (resp. price) contract, then it is committed to set quantity (resp. price) as the strategy variable in production, irrespective of the competitor's choice. In the second stage (i.e., the market game), each firm takes its optimal production decision to maximize its objective function, including profits and a share of consumer surplus, contingent on the type of contract committed to in the first stage. The model is solved by backward induction.

3. Equilibrium market structure with given CSR rule

In this section, we present the payoffs of the owners in the four games and derive the equilibrium market structure under the pure strategic contract class.

3.1 Firms follow CSR rule under Cournot

The analysis is carried as usual through the maximisation of (4) with respect to the quantity which leads to the two reaction functions

[7] The objective function described in (4) is also typical of the Non-profit organizations (NPOs) competing in commercial markets, as argued by Goering (2007, 2008). As a consequence, commercial NPOs selling output and services which generate revenues can be also considered as CSR firms. Only to mention a few, examples of such commercial NPO's are in sectors such as University bookstores (Schiff and Weisbrod, 1991), water utility, rail track maintenance company, private air-traffic control organization (Bennett et al., 2003) and also in the high-tech markets (Benz, 2005).

$$q_i(q_j) = \frac{a - \gamma q_j(1-k)}{2-k} \tag{5}$$

for $i, j = 1,2$ and $i \neq j$. From the reaction functions in (5), it can be noted that a CSR firm has an incentive to raise the output level more than a profit-maximising firm ($k = 0$). In fact, as k increases, the CSR firm's production increases as well, regardless of the value of γ: differentiation of (5) reveals that $\frac{\partial q_i}{\partial k} > 0$, independently of the substitutability ($\gamma > 0$) or complementarity ($\gamma < 0$) nature of the goods. Therefore, the adoption of CSR behaviours and the increasing weight attached to the consumers' surplus lead the firms to expand output; however, the "relative" expansion for a given level of k is stronger when goods are substitutes than complements (Fanti and Buccella, 2016).

Solving the system in (5), one gets the equilibrium output (where superscript C denotes Cournot)

$$q^C = \frac{a}{2-k+\gamma(1-k)} \tag{6}$$

Substituting (6) backwards, we obtain the equilibrium profits[8]

$$\pi^C = \frac{a^2[1-k(1+\gamma)]}{[2-k+\gamma(1-k)]^2}. \tag{7}$$

Note that the satisfaction of the non-negativity constraints on quantities and profits requires ultimately that $k \leq \frac{1}{1+\gamma} \equiv k^T$ (that is the firm's interest for the consumer's welfare has not to be too high, especially if there is a fierce product competition).[9] This inequality (which is also the most stringent) also holds true for the rest of the paper.

3.2 Firms follow CSR rule under Bertrand

In this case we derive the following direct demand function

[8] From now onwards the first (resp. second) apex denotes the choice of the firm 1 (resp. 2).

[9] Note that the values related to the case of profit maximising firms can be immediately derived by setting $k = 0$ in the expressions of quantity and profits. For economy of space, those are not reported in the main text.

$$q_i = \frac{a(1-\gamma) - p_i + \gamma p_j}{1-\gamma^2} \tag{8}$$

By inserting eq.(8) into the expression for the profit in eq.(2) and then in the objective function in eq. (4) the standard maximization leads to the following reaction function

$$p_i = \frac{(1-k)\left[a(1-\gamma) + \gamma p_j\right]}{2-k} \tag{9}$$

In a similar way we obtain the reaction function for Firm 2. Solving the system of equations in (9) and for its counterpart for j we get the equilibrium prices (where superscript B denotes Bertrand)

$$p^B = \frac{a(1-k)(1-\gamma)}{2-k-\gamma(1-k)}. \tag{10}$$

A direct analytical inspection of the reaction functions in (10), reveals that CSR firms have an incentive to sell products at a price lower than a profit-maximising firm. The differentiation of (10) shows that $\frac{\partial p_i}{\partial k} < 0$ both for substitute ($\gamma > 0$) and complement ($\gamma < 0$) goods: irrespective of the value of γ, an increase of the CSR activities lowers the price of the firms. In both cases, the increasing weight attached to the consumers' surplus by CSR firms drives an aggressive market behaviour through price reduction. Nonetheless, the "relative" aggressiveness (the price reduction for a given level of k) is weaker when goods are substitutes than complements. Thus, the adoption of CSR intensifies competition in the product market also under the Bertrand conjecture (Fanti and Buccella, 2016).
Substitution of (10) into the expressions in (8) yields

$$q^B = \frac{a}{(1+\gamma)[2-k-\gamma(1-k)]}. \tag{11}$$

Consequently the profits are

$$\pi^B = \frac{a^2(1-\gamma)(1-k)}{(1+\gamma)[2-k-\gamma(1-k)]^2}. \tag{12}$$

Note that the satisfaction of the non-negativity constraints on prices and profits boils ultimately down to $k < 1$.

3.3. *The price/quantity choice for given CSR rule*

Now we assume that firm 1 behaves as a Cournot-type firm by competing in output (q_1). Firm 2 behaves as a Bertrand-type firm, competing in price (p_2). Firms make their strategic choices simultaneously under complete information. Firms face symmetric inverse demand and cost functions and differ only in their choice of the strategic variable. Firm 1 (resp. 2) maximizes its profit with respect to q_1 (resp. p_2). The Nash equilibrium of the market stage can be described in terms of the best-reply functions for each firm

$$p_2(q_1) = \frac{a(1-k) - \gamma q_1}{2-k} \tag{13}$$

$$q_1(p_2) = \frac{a(1-\gamma) + \gamma p_2}{(1-\gamma^2)(2-k)}. \tag{14}$$

Standard calculations lead to the firm *i*'s quantities, for given levels of *k*:

$$q_1^{C/B} = \frac{a(\gamma + k - 2)}{[\gamma^2(k^2 - 4k + 3) - (k-2)^2]} \tag{15}$$

$$p_2^{C/B} = \frac{a(\gamma - 1)\left[k(1+\gamma)(k-3) + \gamma + 2\right]}{[\gamma^2(k^2 - 4k + 3) - (k-2)^2]} \tag{16}$$

Finally, substituting back (15) and (16), we get the equilibrium profits

$$\pi_1^{C/B} = \frac{a^2(1-k)(1-\gamma)(1+\gamma)(\gamma + k - 2)^2}{[\gamma^2(k^2 - 4k + 3) - (k-2)^2]^2} \tag{17}$$

$$\pi_2^{C/B} = \frac{a^2(1-\gamma)\left[\gamma^2(k-1) + \gamma(k-1) + 2 - k\right]\left[(1-k)(2-k) + \gamma(1 - 3k + k^2)\right]}{[\gamma^2(k^2 - 4k + 3) - (k-2)^2]^2} \tag{18}$$

3.4 Firms' choice of the price/quantity contract

By combining (7), (12), (17) and (18), we now examine the firms' decisions with regard to the type of contracts, i.e. price or quantity.
Let us define the following profit differentials:

$$\Delta_1 = \pi_1^{C/B} - \pi^B = \frac{a^2\gamma^2(1-k)(1-\gamma)(\gamma k-\gamma+k)}{(1+\gamma)(\gamma^2k^2-4\gamma^2k+3\gamma^2-k^2+4k-4)^2(\gamma k-\gamma-k+2)^2} \underset{<}{>} 0 \Leftrightarrow k \underset{>}{<} k^*(\gamma) \equiv \frac{\gamma}{1+\gamma} \quad (19)$$

$$\Delta_2 = \pi_2^{C/B} - \pi^C = \frac{[a^2\gamma^2(\gamma k-\gamma+k)(\gamma^3k^4-5\gamma^3k^3+\gamma^2k^4+8\gamma^3k^2-6\gamma^2k^3-\gamma k^4-5\gamma^3k^2+14\gamma^2k^2+5\gamma k^3-k^4+\gamma^3-15\gamma^2k-8\gamma k^2+6k^3+6\gamma^2+4\gamma k-14k^2+16k-8)}{[(\gamma^2k^2-4\gamma^2k+3\gamma^2-k^2+4k-4)^2(\gamma k-\gamma+k-2)^2]} \underset{<}{>} 0 \Leftrightarrow k \underset{<}{>} k^*(\gamma) \equiv \frac{\gamma}{1+\gamma} \quad (20)$$

It is easy to see that the threshold value of k, k^*, is the same for both differentials, however with the sign of inequality opposed each other. Particularly, when k is sufficiently low (resp. high), it is convenient to deviate from the Bertrand (resp. Cournot) contract. Therefore, the following result applies.

Result 1. *When products are substitute in the unique SPNE of the game both firms choose Cournot (resp. Bertrand) as their choice variable if* k *is sufficiently low, i.e.* $k < k^*$, *(resp. high, i.e.* $k > k^*$*). When products are complement in the unique SPNE both firms always choose Bertrand.*

Proof: As fig. 1 below exhaustively shows, above (resp. below) the black line $k^*(\gamma) \equiv \frac{\gamma}{1+\gamma}$, $\Delta_1 < 0, \Delta_2 > 0$ *(resp.* $\Delta_1 > 0, \Delta_2 < 0$*), which proves the result.*

Recalling that the traditional result predicts that if the goods are substitutes (complements), it is a dominant strategy for a firm to choose the quantity (price) contract, the presence of firms' social concerns changes dramatically the conventional wisdom when goods are substitute.

3.5 Bertrand/Cournot profitability comparison

We are now in a position to study the relative profitability between the Bertrand/Cournot mode of competitions.

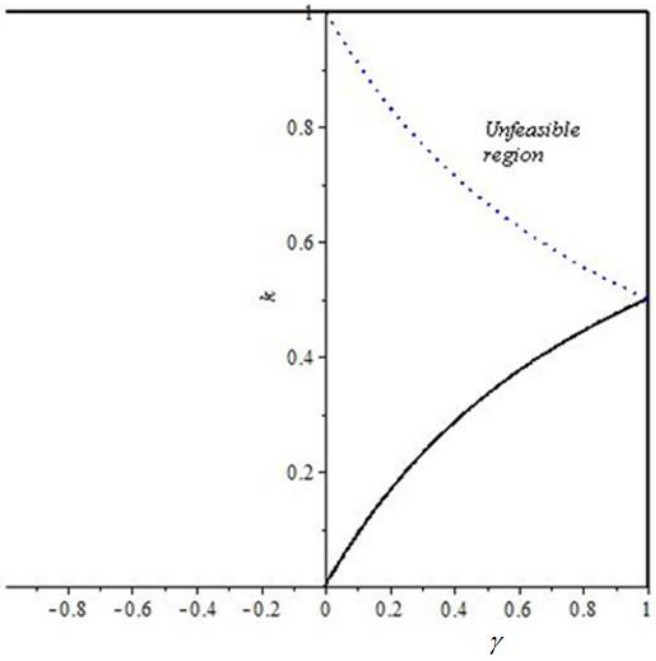

Fig. 1. *Plot of the profit differentials (Eqs. (19) and (20)) and the threshold* $k^T = \frac{1}{1+\gamma}$ *in the* $(\gamma, k)-$ *space. Legend: The graphs are drawn for* $a = 1$, $\Delta_1 = \Delta_2 = 0$ *(solid black line),* $\pi^C = 0$ *(dotted black line). Above (resp. below) the solid black line* $\Delta_1 < 0, \Delta_2 > 0$ *(resp.* $\Delta_1 > 0, \Delta_2 < 0$*). Above the dotted black line Cournot profits would be negative and thus this parametric region is economically unfeasible.*

The Bertrand-Cournot profit differential is given by the following expression

$$\Delta_3 = \pi^B - \pi^C = \frac{a^2(1-\gamma)(1-k)}{(1+\gamma)[2-k-\gamma(1-k)]^2} - \frac{a^2[1-k(1+\gamma)]}{[2-k+\gamma(1-k)]^2} \tag{21}$$

Recalling that the traditional result is that profits are larger, equal, or smaller in Cournot than in Bertrand competition, according to whether the goods are substitutes, independent, or complements, we shall see that when firms care for all consumers a novel rich set of results emerges. Indeed a deeper analytical investigation reveals the following result.

Result 2. *When products are substitute profits are larger (resp. smaller) in Cournot than in Bertrand competition if the level of CSR parameter is sufficiently low, i.e.* $k < k_a = k^*(\gamma)$*, (resp. high, i.e.* $k > k_a = k^*(\gamma)$*) and products are sufficiently substitute (resp. differentiated). When products are complements, profits are larger (resp. smaller) in Bertrand than in Cournot*

competition if the level of CSR parameter is sufficiently low, i.e. $k < k_b$ *) (resp. high, i.e.* $k > k_b$ *) and products are sufficiently complements (resp. low complements).*

Proof: By using Result 1 and Fig. 1 and 2 (below), the following parametric regions are identified: Region A: $\Delta_1 > 0, \Delta_2 < 0, \Delta_3 < 0$ *; Region B:* $\Delta_1 < 0, \Delta_2 > 0, \Delta_3 > 0$ *; Region C:* $\Delta_1 < 0, \Delta_2 > 0, \Delta_3 < 0$ *;. Region D:* $\Delta_1 < 0, \Delta_2 > 0, \Delta_3 > 0$ *. For each parametric region the following SPNEs with the corresponding properties in terms of pay-off emerges: i) Region A: the SPNE is Cournot which is also Pareto-superior for firms because it pay-off dominates the Bertrand outcome. ii) Region B: the SPNE is Bertrand which is Pareto-superior for firms because it pay-off dominates the Cournot outcome; iii) Region C: the SPNE is Bertrand which is Pareto-inferior for firms because it is pay-off dominated by the Cournot outcome, that is, in this area the game presents the structure of the prisoner's dilemma; iv) Region D: the SPNE is Bertrand which is Pareto-superior for firms because it pay-off dominates the Cournot outcome.*

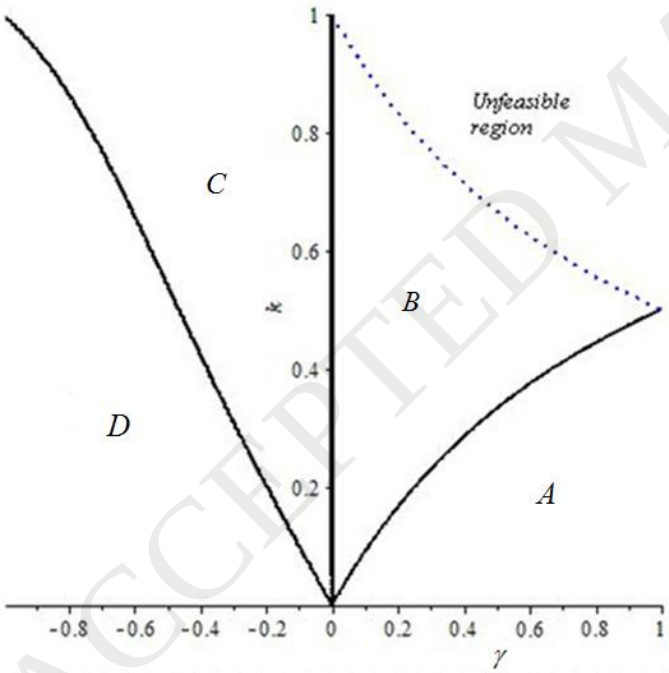

Fig. 2 *Plot of the indifference curve for firms* $\Delta_3 = 0,$ *given in the non-negative quadrant by* $k = k_a(\gamma) = k^*(\gamma) \equiv \frac{\gamma}{1+\gamma}$*, and in the negative quadrant by* $k = k_b(\gamma) = \frac{2-\gamma-\gamma^2-\sqrt{\gamma^4-6\gamma^3-3\gamma^2+4\gamma+4}}{2(1-\gamma^2)}$*. In the non-negative quadrant, for values of* $k < (resp.\ >)\, k_a(\gamma) \Rightarrow \Delta_3 < (resp.\ >)\, 0$ *. In the negative quadrant for values of* $k < (resp.\ >)\, k_b(\gamma) \Rightarrow \Delta_3 > (resp.\ <)\, 0$ *.*

Finally, combining Result 1 and 2, we can state the following result with regard to the properties of the SPNEs of the game in terms of achieved profits by firms.

Result 3. *While in the traditional frame the SPNEs are always Pareto superior from the point of view of the firms, in the presence of CSR the prisoner's dilemma structure occur when products are complements and CSR activities tend to be large.*

Proof: by inspection of Region C in Fig. 2.

4. Welfare analysis with given CSR rule

We show that also the benchmark result for profit-seeking firms of Singh and Vives (1984) in terms of efficiency, according to which consumer surplus and total surplus are always higher under Bertrand competition does no longer hold in the presence of CSR-type firms. In fact, for sufficiently high levels of social concerns consumer surplus and total surplus are larger under Cournot, provided that products are substitutes (and the more substitute products are, the more likely the conventional wisdom is reversed).
Given (6) and (11), direct substitutions in (3) allow to derive the following Bertrand-Cournot consumer surplus differential

$$\Delta_4 = CS^B - CS^C = \frac{a^2}{(1+\gamma)[2-k-\gamma(1-k)]^2} - \frac{a^2(1+\gamma)}{\left[2-k+\gamma(1-k)\right]^2} \tag{22}$$

An analytical and graphical inspection reveals the next result.

Result 4. *While the conventional wisdom states that the consumer surplus is always higher under Bertrand competition, in the presence of CSR rules the consumer surplus under Cournot is larger than under Bertrand competition for* $k > k_a(\gamma) = k^*(\gamma) \equiv \frac{\gamma}{1+\gamma}$*, that is, when products are substitutes and CSR activities tend to be relatively large. On the other hand, when goods are complements, the conventional result is re-established.*

Proof: by inspection of Region B in Fig. 3 below.

It is worth to note that Regions A ($\Delta_4 > 0$) and B ($\Delta_4 < 0$) in Fig. 3 perfectly overlap Regions A ($\Delta_3 < 0$) and B ($\Delta_3 > 0$) in Fig. 2. In other words, when

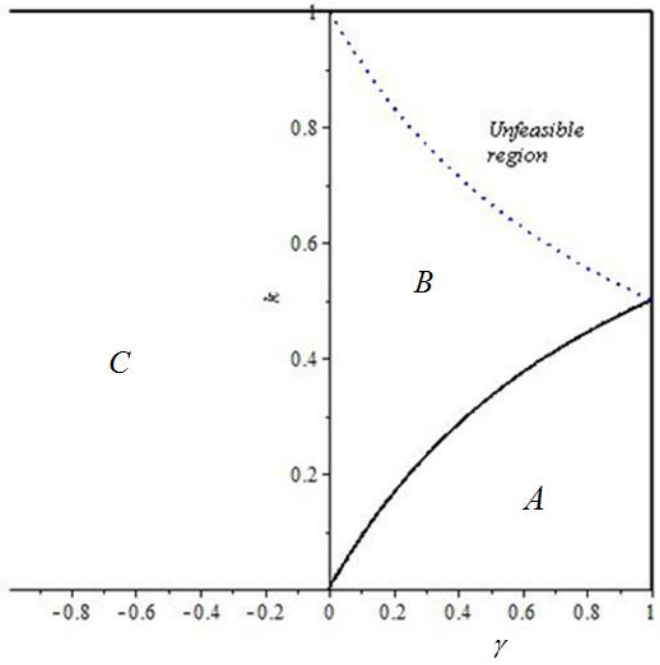

Fig. 3 *Plot of the indifference curve with regard to consumer surplus* $\Delta_4 = 0$, *given by* $k = k_a(\gamma) = k^*(\gamma) \equiv \frac{\gamma}{1+\gamma}$. *In the non-negative quadrant, for values of* $k < (resp.\ >)\ k_a(\gamma) \Rightarrow \Delta_4 > (resp.\ <)\ 0$. *In the negative quadrant* $\Delta_4 > 0,\ \forall k \in [0,1]$.

goods are substitutes, there is an overall conflict of interest between consumers and firms because they have completely opposite preferences over the mode of competition in the product market. Therefore, given that firms strategically choose the contract to offer consumers, in equilibrium those are always prevented to achieve their most desirable outcome.
Finally, defining the social welfare as

$$SW = \pi_1 + \pi_2 + CS\,, \tag{23}$$

we obtain the following differential

$$\Delta_5 = SW^B - SW^C = \frac{a^2[3-2k-2\gamma(1-k)]}{(1+\gamma)[2-k-\gamma(1-k)]^2} - \frac{a^2[3-2k+\gamma(1-2k)]}{\left[2-k+\gamma(1-k)\right]^2} \tag{24}$$

An analytical and graphical investigation shows the following result.

Result 5. *While the conventional result affirms that the social welfare is always higher under Bertrand competition, when firms are engaged in CSR activities the social welfare under Cournot is larger than under Bertrand competition for* $k > k^*(\gamma)$*, that is, when products are substitutes and the CSR level not extremely low. On the other hand, when goods are complements, the conventional result is confirmed.*

Proof: by inspection of Region B in Fig. 4.

Therefore, there is a large area of the relevant parameter $(\gamma, k)-$space when goods are substitutes (Region B in Fig. 4) in which the reversal of the Bertrand-Cournot ranking takes place. Moreover, considering the endogenous equilibria with regard to the mode of competition in the product market, the following result directly applies.

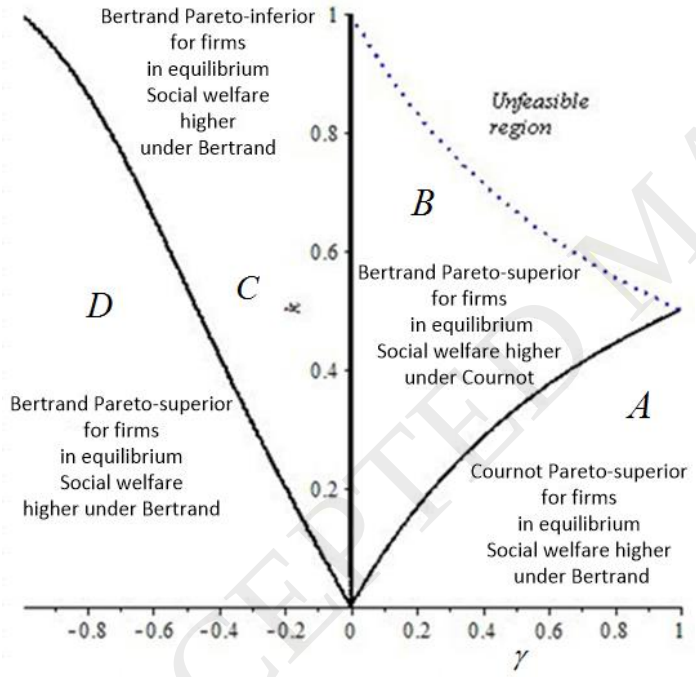

Fig. 4 *Plot of the indifference curve with regard to social welfare* $\Delta_5 = 0$*, given by* $k = k_a(\gamma) = k^*(\gamma) \equiv \frac{\gamma}{1+\gamma}$*, and endogenous selection of the contract type in equilibrium. In the non-negative quadrant, for values of* $k < (resp.\ >)\, k^*(\gamma) \Rightarrow \Delta_5 > (resp.\ <)\, 0$*. In the negative quadrant* $\Delta_5 > 0 \quad \forall k \in [0,1]$*. As regards the contract-type in equilibrium, the thresholds are: 1) in the non-*

negative quadrant $k = k_a(\gamma) = k^*(\gamma) \equiv \frac{\gamma}{1+\gamma}$, *and 2) in the negative quadrant* $k = k_b(\gamma) = \frac{2-\gamma-\gamma^2-\sqrt{\gamma^4-6\gamma^3-3\gamma^2+4\gamma+4}}{2(1-\gamma^2)}$.

Result 6. *In the presence of substitute goods, the firms' endogenous choice of the quantity contract never leads to the most desirable social welfare. On the other hand, in the presence of complement goods, the endogenous selection of the price contract leads to the most desirable social welfare outcome. However, this coincide with the Pareto-efficient contract for both firms only in the parametric set delimited by* $\{k = 0 \cup k \leq k_b(\gamma)\}$. *As a consequence, we may conclude that only in the latter parametric set a Pareto-superior (i.e. for both firms and consumers and thus for society as a whole) welfare is achieved.*

Proof: by inspection of Region D in Fig. 4.

Result 6 reveals that, when goods are substitutes, the firms' endogenous choice of the contract is always in contrast to the governments' preferences. Nonetheless, it is worth to note that when goods are complements, the firms' Pareto-superior endogenous choice of the price contract leads to the most desirable welfare outcome, which is also universally Pareto-superior in Region D of Fig. 4 because preferred both by firms and consumers.

5. Discussion of the results

The economic intuition behind the results of Sections 3 and 4, in particular those emerged when products are substitutes (i.e. Regions A and B in all Figures), is as follows. While with the standard profit-seeking firms quantities are lower and prices higher in Cournot than in Bertrand competition, regardless of whether the goods are substitutes or complements, with CSR-type firms this do not occur. The reason why Bertrand competition may become more "monopolistic" than Cournot competition is that the presence of the CSR parameter changes the perceived elasticity of demand of a firm in Cournot relative to Bertrand competition as below remarked.

Lemma 1. The perceived elasticity of demand of a firm when taking the quantity of the rival as given is larger than that which the same firm perceives when taking the price of the rival as given when $k > k^*$.

Proof: by denoting the price elasticity under Cournot and Bertrand as $\eta^C = -\frac{[1-k(1+\gamma)]}{1-\gamma^2}$ *and* $\eta^B = k-1$ *, respectively, it is easy to show that* $\eta^C \underset{<}{\overset{>}{-}} \eta^B \Leftrightarrow k \underset{<}{\overset{>}{-}} k^*(\gamma) = \frac{\gamma}{1+\gamma}$.

Therefore when CSR is sufficiently intense (however, it suffices even a small CSR parameter if products are extremely differentiated) firms are, rather unexpectedly, more able to raise the mark-up, and therefore prices, in Bertrand competition. The result is that in Bertrand competition firms may set prices higher than those in Cournot, as the following Lemma shows.

Lemma 2. The final price is higher (resp. lower) in Bertrand (compared to Cournot) when $k > (resp. <)\, k^*$.

Proof: because $p^C = \frac{a[1-k(1+\gamma)]}{2-k+\gamma(1-k)}$ *, and* p^B *is given by eq. (10), then* $(p^C - p^B) \underset{<}{\overset{>}{-}} 0 \Leftrightarrow k \underset{>}{\overset{<}{-}} k^*$.

By contrast, the ordering in terms of quantity is symmetrically reversed: for instance, in Bertrand (resp. Cournot) competition if firms set prices higher than those in Cournot (resp. Bertrand) then they choose quantities lower than those in Cournot (resp. Bertrand).

Lemma 3. Output is higher (resp. lower) in Bertrand (compared to Cournot) when $k < (resp. >)\, k^*$.

Proof: by recalling eqs. (11) and (14), then $(q^C - q^B) \underset{<}{\overset{>}{-}} 0 \Leftrightarrow k \underset{<}{\overset{>}{-}} k^*$.

Therefore, since "lower prices and higher quantities are always better in welfare terms" and "for firms, if the goods are substitutes,[10] low prices mean low profits" (Singh and Vives, 1984, 549), then the economic mechanisms leading to unconventional outcomes of the Regions A and B in the figures are intuitively explained. Furthermore, the difference in prices (or quantities) depends on the degree of product differentiation. However, in contrast to the standard case in which "the more differentiated the

[10] "When the goods are complements low prices do no longer imply low profits, because if the goods are complements since then to increase profits firms have to lower prices from the Cournot levels to gain market share." (Singh and Vives, 1984, 549).

products are, the smaller is the difference between the Cournot and Bertrand prices" (Singh and Vives, 1984, 549), in the presence of CSR-type firms the following Lemma holds.

Lemma 4: If the CSR parameter is neither too high nor too low, i.e. if $k^*(\gamma) \le k \le k^{**}(\gamma)$, the difference between the Cournot and Bertrand prices (and, therefore, profits) is larger the more differentiated the products are.[11]

Proof: This is easily shown by investigating the price differential in Lemma 2 with respect to the parameter γ, as shown in Figure 5.

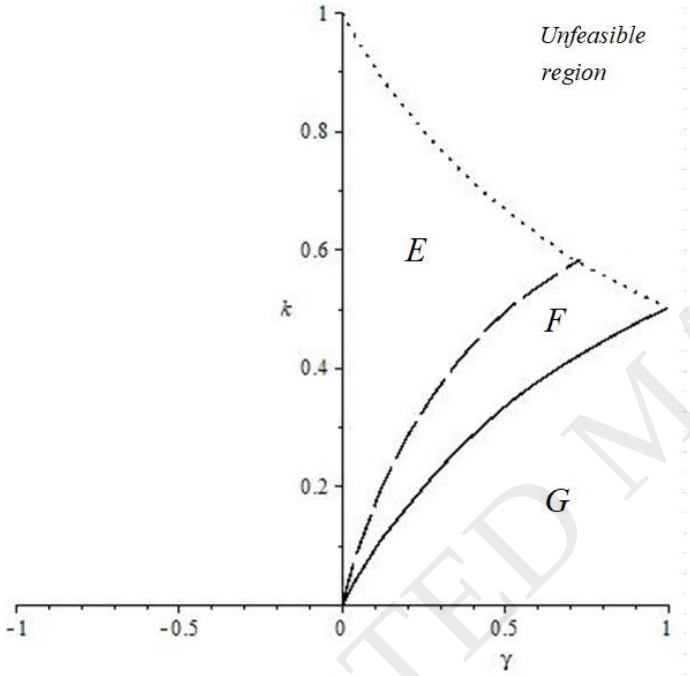

Fig. 5 *Plot of the price differential $p^C - p^B = 0$, given by $k = k^*(\gamma) \equiv \frac{\gamma}{1+\gamma}$ (solid line), and of $\frac{\partial(p^C - p^B)}{\partial\gamma} = 0$, given by $k = k^{**}(\gamma)$ (long dashed line). In Region E, $p^C > p^B$ and $\frac{\partial(p^C - p^B)}{\partial\gamma} > 0$. In Region F, $p^C > p^B$ and $\frac{\partial(p^C - p^B)}{\partial\gamma} < 0$: as γ increases, i.e. as the degree of market competitiveness increases, the prices under Bertrand lowers less than the those under Cournot, causing a widening of the price, and profits, differential due to the highly non-linear*

[11] The analytical expression of $k^{**}(\gamma)$ is extremely long and algebraically not elegant; therefore, for economy of space, it is not here reported. However, it can be obtained upon request from the authors.

impact of k *in the expression of the derivative. In Region G,* $p^C < p^B$ *and* $\frac{\partial(p^C - p^B)}{\partial\gamma} > 0$.

A peculiar and noteworthy feature of this model is that, in the presence of complement goods, in Region C of Fig. 4 although the SPNE is the choice of the price contract, it leads to an outcome which is Pareto-inferior for firms because the outcome under the quantity contract is pay-off dominant. This result contrasts that of the classical model of Singh and Vives (1984), according to whom, with complement goods, the price contract always Pareto-dominates the quantity contract. The rationale for this finding is as follows.

Irrespective of CSR behaviours, Cournot prices are always higher than Bertrand prices when goods are complements. However, the adoption of CSR under Cournot lowers the price and, at the same time, expands output with respect to the standard case. The impact of k on the Cournot price and quantity is to increase them. However, for small negative values of γ, the Cournot price does not increase to such a level to undermine the profitability of the quantity contract because the positive output expansion effect of the CSR behaviours more than offset the negative impact of a price increase in the firm's revenues. On the other hand, when the parameter γ takes more negative values, the price Cournot-Bertrand price differential tends to increase and, remarkably, more than in the standard case, as shown in Figure 6, left box. Therefore, for γ sufficiently negative, p^C becomes relatively high with respect to p^B, and through this mechanism firms are able to capture a market share (i.e. to sell an amount of goods) adequately large that Bertrand profits exceed those under Cournot, restoring the conventional result of Singh and Vives (1984). Thus, the conclusion of Singh and Vives (1984, 549) according to whom "the type of competition becomes less important, the less related the goods are" does not completely hold true in the presence of firms' social concerns.

Finally, the economic intuition behind Result 1, i.e. the price contract endogenously emerges as the game equilibrium in the case of substitute products, is exactly driven by the above considerations, reported in the various Lemmata, and Figures 4 and 5. In fact, for substitute products, the value of the price elasticity of demand becomes larger under Cournot than Bertrand (see Lemma 1); consequently, each firm always finds

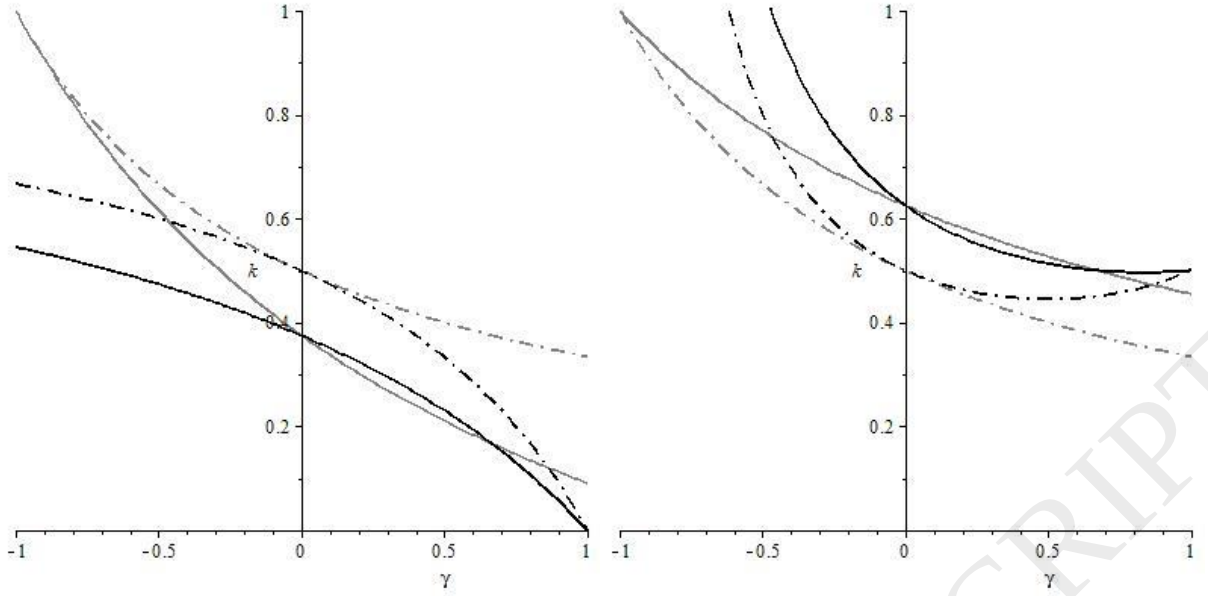

Fig. 6 *Plot of the prices (left box) and quantities (right box) under Cournot and Bertrand competition. Legend: grey lines, Cournot variables; black lines, Bertrand variables; dotted lines, no CSR (*$k = 0$*); solid lines, CSR (*$k = .4$*). The figures are drawn for a value of* $a = 1$*.*

advantageous to deviate from the Cournot equilibrium and never convenient to deviate from the Bertrand one. Moreover, when the products are complements, the price elasticity of demand under Cournot is constantly higher than in Bertrand; then, though it is still possible that profits in the Cournot equilibrium are larger than those in the Bertrand equilibrium (see Region C, Figure 4), it is always convenient to deviate from the Cournot equilibrium towards the Bertrand one, and not vice versa. That is, the equilibrium which endogenously emerges is confirmed to be Bertrand and, as a consequence, the prisoner's dilemma appears.

6. Conclusions

This paper has revisited the classic issue of the comparison between price and quantity competition in an industry characterized by the presence of private firms engaged in Corporate Social Responsible (CSR) activities, where, in line with most literature, taking into account the consumer surplus in the market decisions is a proxy of the firms' CSR activity. The presence of CSR behaviours leads to results which are in sharp contrast to the conventional wisdom applying for standard profit-seeking-firms. [12] In fact, firms' profits can be larger under Cournot (resp. Bertrand) also when

[12] Our results are also contrasting to those applying for: 1) mixed duopoly; 2) private duopoly with social welfare as proxy of CSR activities; 3) asymmetric private duopoly as regards the social concerns, previously analysed in the literature.

products are complements (resp. substitutes). Moreover, if products are substitutes, then the choice of the price contract arises as the dominant strategy for each firm in the subgame perfect Nash equilibria. In addition, the dominant Bertrand strategy equilibrium when the goods are complements may be Pareto-inferior from the firms' perspective. Finally, the paper has shown that also cornerstone belief that the consumer surplus as well as the overall social welfare under Bertrand competition is always higher than under Cournot competition does not holds. In fact, it has been shown that the consumer surplus can be higher under Cournot in the presence of substitute goods, and noteworthy in the precise parametric space in which firms prefer Bertrand competition. Therefore, when goods are substitutes, there is always conflict of interest between consumers and firms. As regards social welfare, the endogenous selection of the competition mode leads to Pareto-efficient welfare outcomes when goods are complements. However, when goods are substitutes, the endogenous selection of the quantity contract never leads to the most desirable welfare outcome precisely because of the overall conflict of interest between firms and consumers.

The current results are based on a set of precise assumptions. As future lines of research, the robustness of these findings is called to checked under different model specifications such as the presence of network externalities, endogenous costs of production, for instance wage negotiated between firms and unions, and the presence of managerial delegation.

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