

Welfare-Improving Mixed Collusion

Filipa Mota* João Correia-da-Silva† Joana Pinho‡

18th April 2020

Abstract. We study collusion between a public firm and a private firm, focusing on the impact of the public firm's preference for consumer surplus. We characterize the collusive outcome (market shares, profits, consumer surplus and welfare) that results from Nash bargaining between the two firms, compare it with the competitive outcome, and study sustainability of collusion. If the public firm's preference for consumer surplus is mild, collusive outcomes are qualitatively similar to those of a private duopoly (both firms reduce output) although distorted by the public firm's bias towards high output. If the public firm's preference for consumer surplus is strong, the collusive outcome is qualitatively different. While the public firm reduces output, the private firm expands output to such an extent that total output increases (as long as the public firm's preference for consumer surplus is not excessive). Output is transferred from the public firm to the private firm so that productive efficiency increases, resulting in higher profits and welfare.

Keywords: Collusion, Public firms, Mixed oligopoly.

JEL Classification Numbers: L44, L41, L21, H44, D43.

We are grateful to Duarte Brito and Joana Resende for valuable comments and suggestions. We also thank audiences at PEJ 2018, EARIE 2018 and EBES 2019. This research was financed by Portuguese public funds through Fundação para a Ciência e a Tecnologia (SFRH/BD/100022/2014, UID/GES/00731/2016, UID/ECO/04105/2019 and UIDB/04105/2020).

*CEF.UP and Faculty of Economics, University of Porto, and Católica Porto Business School. Email: fcmota@porto.ucp.pt.

†CEF.UP and Faculty of Economics, University of Porto. Email: joao@fep.up.pt.

‡CEGE and Católica Porto Business School. Email: jpinho@porto.ucp.pt.

1 Introduction

There are many markets where state-owned firms compete with private ones, giving rise to specific concerns and challenges to competition policy and cartel prosecution. Examples of cartel cases where public firms were convicted can be traced back to 1997, when the Spanish Competition Authority fined a price-fixing cartel in the dairy industry led by a state-owned firm.¹ In 2005, the OECD Competition Directorate recommended penalties on all Tunisian banks, some of them state-owned, found to be on a price-fixing cartel (OECD, 2013). In 2008, the Egyptian National Company of Cement was found to be part of a price-fixing cartel in the cement market (OECD, 2013), and the Hungarian Competition Authority fined the parties in a rail freight transport industry cartel, for price-fixing and market sharing.² In 2010, the European Commission imposed fines on 11 air cargo carriers, three of which partially state-owned, for participating in a price fixing cartel. In 2015, the European Commission fined three big logistics providers for operating a price-fixing cartel on the provision of rail cargo transport services from 2004 to 2012,³ and the French Competition Authority fined 20 logistics firms and their trade association for a price-fixing cartel that lasted from 2004 to 2010.⁴ In 2019, the Portuguese Competition Authority imposed a fine of 225 M€ to fourteen banks, the biggest of them state-owned, for exchanging commercial data between 2002 and 2013.⁵

Despite all this evidence of cartels involving public and private firms, there are very few contributions to the economic literature on this type of cooperation. We contribute to fill this gap by studying collusion between a state-owned firm and a private firm. We consider a mixed duopoly where a public and a private firm play an infinitely repeated Cournot game. Firms are symmetric in every respect except their objective functions: while the private firm is a profit-maximizer, the public firm maximizes a weighted sum of consumer surplus and own profit. Increasing marginal costs play an important role for our results.

The collusive agreement, reached through Nash bargaining, qualitatively depends on whether the public firm's preference for consumer surplus is mild or strong. If it is mild, both firms restrict output as in private cartels. If it is strong, while the public firm restricts output, the private firm expands output! Both firms are, of course, better off under collusion than under competition (otherwise they would reject the agreement).

In terms of welfare, if the public firm's preference for consumer surplus is strong: collusion increases producer surplus and total surplus. More surprisingly, if the public firm's preference for consumer surplus is intermediate, collusion also increases consumer surplus! In the light of these results, competition authorities should be careful when analyzing cartel cases involving

¹Case 352/94, Industrias Lácteas.

²Case Vj-3/2008/363.

³Case AT.40098 - Blocktrains. ÖBB Group, Austria's largest mobility services provider and state-owned, and two of its subsidiaries were undertakings involved.

⁴Décision n. 15-D-19 du 15 décembre 2015. Geodis, the logistics arm of France's state-owned railway SNCF, faced the biggest fine. Royal Mail, another of the firms involved, was public at the time.

⁵Case PRC/2012/9.

public firms, since, depending on the public firm’s objective, collusion may increase or decrease both consumer surplus and total surplus.

Related Literature

Since the pioneer contributions of Merrill and Schneider (1966) and Sertel (1988), a strand of literature emerged on cooperation between private firms in mixed oligopolies. Colombo (2016) and Correia-da-Silva and Pinho (2018) contributed to this literature by analyzing how the presence of a public firm affects sustainability of collusion among private firms.

Wen and Sasaki (2001) were the first to study collusion between a welfare-maximizing public firm and a profit-maximizing private firm. They found that the public firm may hold excess capacity as a commitment device to sustain a welfare-improving agreement. The recent contribution of Haraguchi and Matsumura (2018) is the closest to ours, but they assume the public firm makes a take-it-or-leave-it offer of a collusive agreement to the private firm, while we assume the collusive agreement is the outcome of Nash bargaining.⁶ This means Haraguchi and Matsumura (2018) place all the bargaining power on the public firm, while we assume that bargaining power is equally distributed. In addition, they assume constant marginal costs, while we assume increasing marginal costs.

Our contribution also relates to the literature on sustainability of collusion among heterogeneous firms. Existing contributions assume asymmetries in costs (Donsimoni, 1985; Bae, 1987; Harrington, 1991; Verboven, 1997; Rothschild, 1999; Vasconcelos, 2005; Ganslandt *et al.*, 2012; Correia-da-Silva and Pinho, 2016), production capacities (Compte *et al.*, 2002; Bos and Harrington, 2010) or discount factors (Harrington, 1989; Gerson, 1989). The asymmetry in our model is in the objective functions.

2 Model

Consider an industry with one public firm, g , and one private firm, p , producing homogeneous goods along an infinite number of periods. In each period, firms simultaneously set quantities, q_g and q_p . Demand is linear and given by $p = 1 - Q$, where $Q = q_p + q_g$ is total output.

Following De Fraja and Delbono (1989) and Correia-da-Silva and Pinho (2018), we assume the total cost of producing q units of the good is the same for the public and the private firm, given by $C(q) = \frac{q^2}{2}$.⁷ Thus, the profit function of firm $i = \{p, g\}$ is given by:

$$\pi_i(q_g, q_p) = (1 - q_g - q_p)q_i - \frac{q_i^2}{2}.$$

⁶The adoption of Nash bargaining for selecting the collusive agreement between heterogeneous firms was proposed by Harrington (1991).

⁷With constant and symmetric marginal costs, $C(q) = cq$, the competitive output of a pure public firm would be such that price equals marginal cost, driving profits to zero and maximizing total surplus.

Firms are symmetric in every dimension but one: their objective functions. The private firm maximizes individual profit, while the public firm maximizes a weighted sum of consumer surplus (CS) and individual profit, as follows:

$$\Omega(q_g, q_p) = \mu CS + (1 - \mu)\pi_g = \mu \frac{(q_g + q_p)^2}{2} + (1 - \mu) \left[(1 - q_g - q_p)q_g - \frac{q_g^2}{2} \right],$$

where $\mu \in [0, \frac{2}{3}]$ is the weight the public firm attaches to consumer surplus.⁸ Parameter μ can also be interpreted as the degree of nationalisation of a firm that is semi-public. If the public firm is a pure profit-maximizer, then $\mu = 0$. If the public firm is a pure consumer welfare maximizer and distributes its profit among consumers, then $\mu = \frac{1}{2}$. The assumed neglect of private firm's profit in the objective of the public firm may be justified if the private firm distributes its profits among foreigners or a very small group of individuals (negligible in terms of number of votes in an election).

Total surplus is the sum of consumer surplus and industry profit: $TS = CS + \pi_g + \pi_p$.

Nash equilibrium

In the Nash equilibrium of the stage game, the private firm chooses the quantity q_p^N that solves $\max_{q_p} \{\pi_p(q_g, q_p)\}$, while the public firm chooses the quantity q_g^N that solves $\max_{q_g} \{\Omega(q_g, q_p)\}$.⁹ The first-order condition (FOC) for the private firm yields:

$$\frac{\partial \pi_p}{\partial q_p} = 0 \Leftrightarrow q_p = \frac{1 - q_g}{3}, \quad (1)$$

which means that the higher is the public output, the lower is private output (downward-sloping reaction function). The FOC for the public firm yields:¹⁰

$$\frac{\partial \Omega}{\partial q_g} = 0 \Leftrightarrow q_g = \frac{1 - \mu - (1 - 2\mu)q_p}{3 - 4\mu}. \quad (2)$$

If $\mu < \frac{1}{2}$, the greater is private output, the lower is public output. In this case, the model exhibits strategic substitutability, as is usual in quantity competition models. By contrast, if $\mu > \frac{1}{2}$, the higher is private output, the greater is public output. If the public firm weights more consumer surplus than own profit, its reaction function is upward sloping.

Combining (1) and (2), we obtain:

$$q_p^N = \frac{2 - 3\mu}{8 - 10\mu}, \quad q_g^N = \frac{2 - \mu}{8 - 10\mu} \quad \text{and} \quad Q^N = \frac{2 - 2\mu}{4 - 5\mu}.$$

⁸It will be shown that the private firm is active if and only if $\mu < \frac{2}{3}$.

⁹The public firm is allowed to have negative profit. This assumption is realistic for many industries, as government spending is frequently used to finance hospitals, schools and urban transportation systems.

¹⁰Both second-order conditions are satisfied for $\mu \in [0, \frac{2}{3}]$.

The more the public firm cares about consumer surplus, the higher is its output and the lower is the output of the private firm. As q_g^N increases more than q_p^N decreases in μ , total output, and thus consumer surplus, increases in μ .

The corresponding profits and payoff of the public firm are:

$$\pi_p^N = \frac{3(2-3\mu)^2}{8(4-5\mu)^2}, \quad \pi_g^N = \frac{(2-\mu)(6-11\mu)}{8(4-5\mu)^2} \quad \text{and} \quad \Omega^N = \frac{(1-\mu)(12-12\mu-5\mu^2)}{8(4-5\mu)^2}. \quad (3)$$

Both profits are decreasing in μ . This is the result of fiercer competition by the public firm. Since $\mu \leq \frac{2}{3}$, the private firm always has non-negative profit. However, this is not true for the public firm. If $\mu > \frac{6}{11}$, the public firm has losses (Figure 1). Interestingly, we conclude that the public firm has higher profit than its rival if $\mu \in (0, \frac{1}{2})$.¹¹

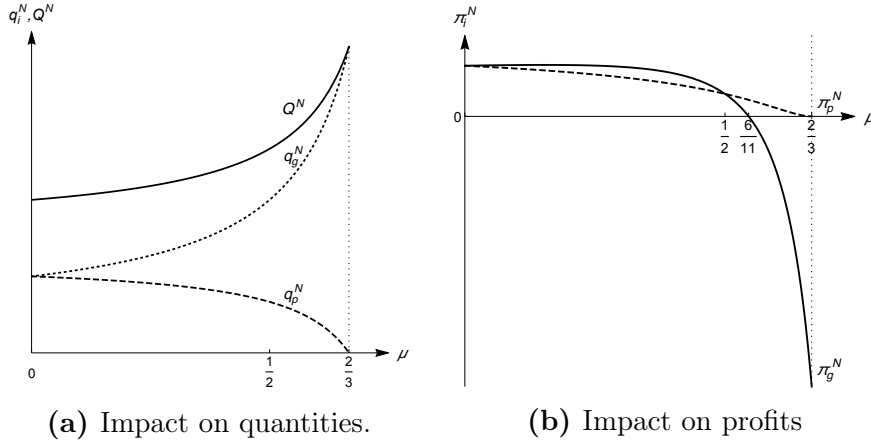


Figure 1. Impact of public firm's preference for CS on the non-cooperative outcome.

Collusive agreement

When asymmetric firms collude, it is not straightforward to find the agreement they should establish. Following Harrington (1991), we assume firms negotiate the collusive agreement in a way that leads to the Nash (1950) bargaining solution. For simplicity, we assume firms have the same bargaining power, so that collusive quantities solve:

$$\max_{(q_g, q_p)} [\pi_p(q_g, q_p) - \pi_p^N] [\Omega(q_g, q_p) - \Omega^N],$$

where the disagreement payoffs of the private firm, π_p^N , and the public firm, Ω^N , are the non-cooperative payoffs, given by (3).

¹¹These results relate to the literature on strategic delegation, according to which it is profitable for an owner to unilaterally provide incentives for her manager to choose high output. Becoming a fiercer competitor turns the rival into a milder competitor (Fershtman and Judd, 1987; Sklivas, 1987), as long as the rival's reaction function is downward sloping. In our model, valuing CS works as a commitment device to choose higher output, leading the private firm to choose lower output and thus have lower profit.

The case in which the public firm maximizes the sum of consumer surplus and own profit ($\mu = \frac{1}{2}$) has particular interest if we expect the public firm's profit/loss to directly translate into a tax reduction/increase. This case can be solved analytically.

Proposition 1. *If $\mu = \frac{1}{2}$, collusion increases private output, decreases public output and keeps total output constant. Both firms' profits and total surplus increase.¹²*

$$\begin{aligned} q_p^C &= \frac{1}{3}, & q_g^C &= \frac{1}{3}, & Q^C &= \frac{2}{3}, & \pi_p^C &= \frac{1}{18}, & \pi_g^C &= \frac{1}{18}, & \Omega^C &= \frac{5}{36}, \\ q_p^N &= \frac{1}{6}, & q_g^N &= \frac{1}{2}, & Q^N &= \frac{2}{3}, & \pi_p^N &= \frac{1}{24}, & \pi_g^N &= \frac{1}{24}, & \Omega^N &= \frac{19}{144}. \end{aligned}$$

If $\mu = \frac{1}{2}$, total output is the same under collusion and under competition. While public output is much lower under collusion than under competition, private output is much higher under collusion than under competition! Collusion transfers output from the public firm to the private firm, keeping total output constant. Since marginal cost is increasing, output symmetry implies productive efficiency. As a result, profits and total surplus are higher. Consumer surplus is unaffected, but consumers are likely to benefit from through lower taxes.

For general values of μ , we cannot find closed-form expressions for collusive quantities. Therefore, we proceed numerically. Figure 2 shows output levels as a function of the weight the public firm attaches to consumer surplus.

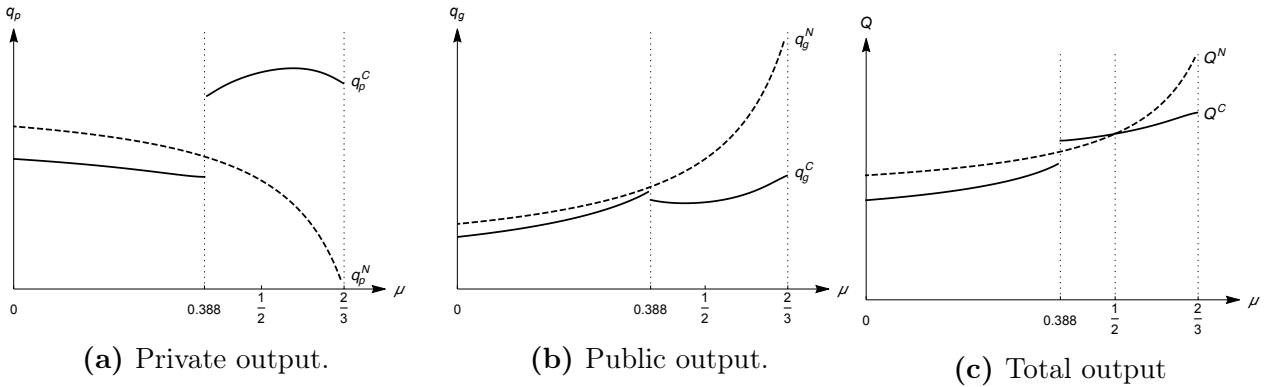


Figure 2. Output levels under collusion (solid lines) and competition (dashed lines).

As shown previously, if firms behave non-cooperatively, private output is strictly decreasing in μ , while public output and total output are strictly increasing in μ . If firms collude, private output and public output become non-monotonic. Nevertheless, total output and thus consumer surplus remain increasing in μ .

Note the qualitative change of behavior at $\mu^* \approx 0.388$. For $\mu < \mu^*$, private output and public output are lower under collusion than under competition. Private output is decreasing

¹²Calculations are available upon request.

in μ while public output is increasing in μ . In this region, collusion between the public and the private firm appears to be a distorted version of collusion between private firms: output reduction (greater at the private firm) to increase price and profit.

At $\mu = \mu^*$, private output jumps upward while public output jumps downward. For $\mu > \mu^*$, collusion reduces public output ($q_g^C < q_g^N$) and increases private output ($q_p^C > q_p^N$). Total output remains relatively high, but with greater productive efficiency because output asymmetry decreases. Importantly, collusion increases total output and thus consumer surplus for intermediate values of μ . More precisely, if and only if $\mu \in (\mu^*, \frac{1}{2})$.¹³

Let us explain why there is a “jump” in collusive quantities at $\mu^* \approx 0.388$. For firms to be willing to collude, payoffs under collusion must be greater than under competition. In Figure 3, the public firm is willing to collude for pairs of collusive quantities, (q_g^C, q_p^C) , in the light grey areas, while the private firm accepts to collude for pairs (q_g^C, q_p^C) in the dark grey area. Thus, the agreements that are individually rational for both firms are those in the intersection of the shaded regions. The point marked in each plot represents the collusive outcome.

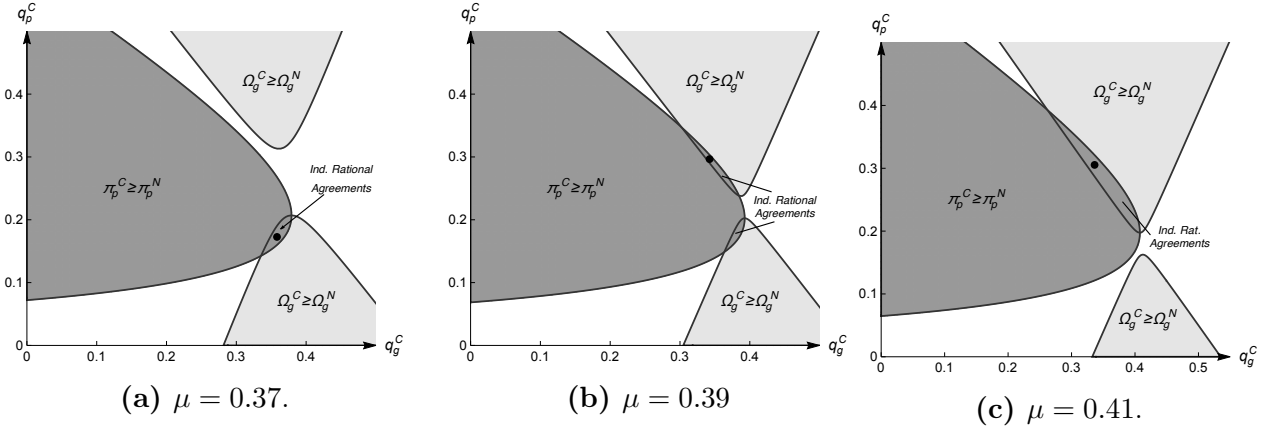


Figure 3. Individually rational collusive agreements for different values of μ .

Total surplus is higher under competition for low levels of μ , but is higher under collusion for high levels of μ (see Figure 4c). For low levels of μ , the public firm is mostly concerned with own profit, and thus it is not surprising that the traditional effect of collusion prevails: both firms restrict output, decreasing welfare. For high levels of μ , the public firm is highly concerned with consumer surplus, and thus the three components of total surplus (consumer surplus, public firm’s profit and private firm’s profit) are taken into account by the colluding firms. Therefore, it is not surprising that collusion increases total surplus. In fact, if $\mu = \frac{1}{2}$, increase of total surplus is an immediate consequence of individual rationality. Collusion increases private firm’s profit (otherwise, the private firm would not accept the agreement), and the sum of public firm’s profit and consumer surplus (otherwise, the public firm would not accept the agreement). Hence, collusion increases total surplus.

Note that the collusive profit of the public firm, despite being decreasing for sufficiently high

¹³As firms sell homogeneous goods, the greater is total output, the greater is consumer surplus.

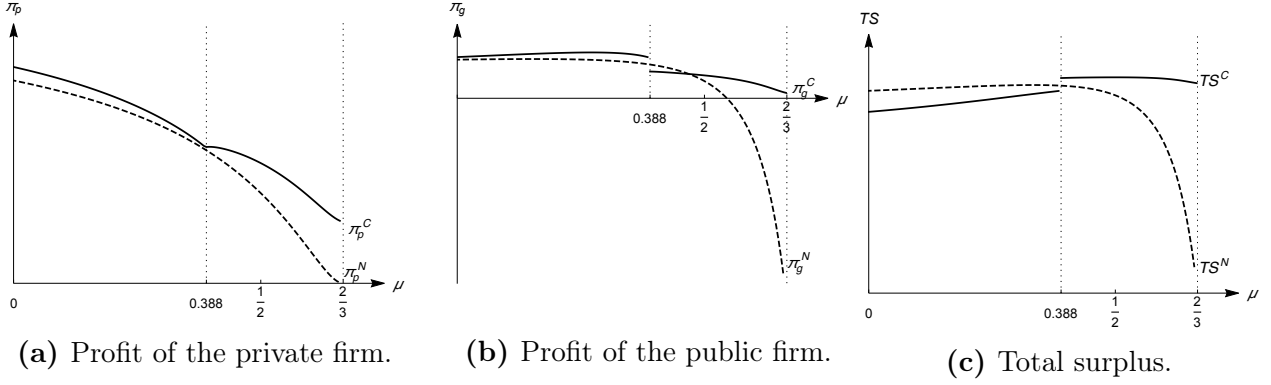


Figure 4. Payoffs and total surplus under collusion (solid line) and competition (dashed line).

values of μ , is always positive (Figure 4b), while its competitive profit is negative for $\mu > \frac{6}{11}$. However, for intermediate levels of μ , the public firm has lower profit under collusion than under competition. The public firm gains from collusion through the increase in consumer surplus, which more than compensates the decrease in profit.

Sustainability of collusion

Firms may have incentives to unilaterally deviate from the collusive agreement, i.e., to produce the output that maximizes individual payoff even though this triggers a punishment. Firms are assumed to use grim trigger punishments, permanently reverting to the static Nash outcome after a deviation (Friedman, 1971).

If the private firm deviates, it chooses the output that solves $\max_{q_p} \{\pi_p(q_g^C, q_p)\}$. If the public firm deviates, it chooses the output that solves $\max_{q_g} \{\Omega(q_g, q_p^C)\}$. From Figure 5, it is clear that, while the private firm deviates from the collusive agreement by reducing output ($q_p^D < q_p^C$), the public firm deviates by expanding output ($q_g^D > q_g^C$).

The private firm is willing to comply with the collusive agreement if and only if the following incentive compatibility constraint (ICC) is satisfied:

$$\sum_{s=t}^{\infty} \delta^{s-t} \pi_p^C \geq \pi_p^D + \sum_{s=t+1}^{\infty} \delta^{s-t} \pi_p^N \Leftrightarrow \delta \geq \frac{\pi_p^D - \pi_p^C}{\pi_p^D - \pi_p^N} \equiv \delta_p^*,$$

where δ_p^* is the critical discount factor for the private firm. Likewise, the public firm will abide by the agreement if and only if:

$$\delta \geq \frac{\Omega_g^D - \Omega_g^C}{\Omega_g^D - \Omega_g^N} \equiv \delta_g^*,$$

where δ_g^* is the critical discount factor for the public firm. The agreement is sustainable if no firm is better off deviating. The critical discount factor for collusion sustainability is thus $\delta^* = \max \{\delta_p^*, \delta_g^*\}$.

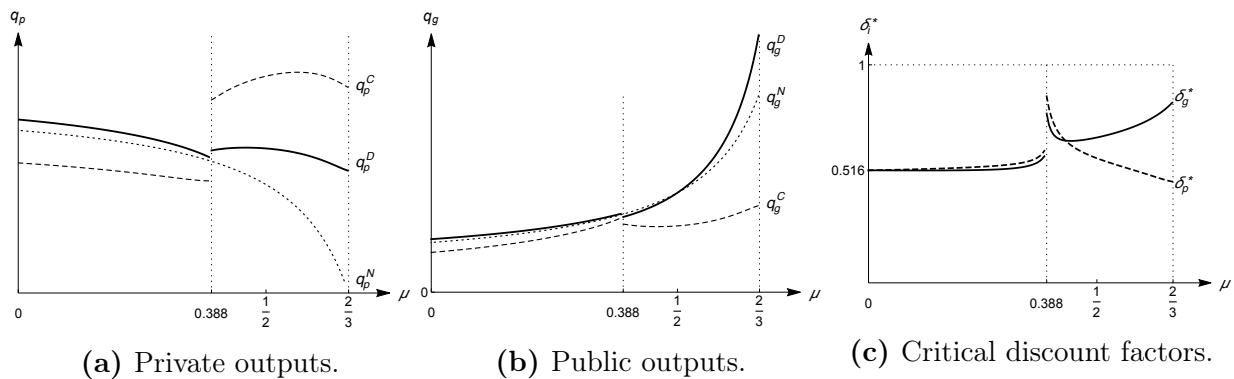


Figure 5. Outputs and critical discount factors.

Collusion is easiest to sustain if $\mu = 0$, i.e., if the public maximizes own profit disregarding consumer surplus (Figure 5c).¹⁴ Incentives to collude are non-monotonic in the public firm's preference for consumer surplus. In fact, for sufficiently high levels of μ , the critical discount factor of the public firm is not only increasing in this parameter, but it is also binding (i.e., higher than the critical discount factor of the private firm). Note also that after the threshold $\mu^* \approx 0.388$ is reached, while the public firm is tempted to deviate by expanding output, the private firm is tempted to deviate by reducing output!

3 Conclusion

Motivated by several cartel cases involving public firms, we studied collusion between a public and a private firm. Without collusion, as the result of its preference for consumer surplus, the public firm produces more than the private firm. This originates productive inefficiency, because marginal cost is increasing. Collusion reduces (or even eliminates) this inefficiency, as the public firm transfers output to the private firm. The private firm agrees to increase total output as long as its profit increases (due to greater market share). This result contrasts with the traditional idea that colluding firms restrict total output to increase market price.

The incentives for both firms to collude are non-monotonic in the weight the public firm attaches to consumer surplus. It is interesting to note that while the public firm deviates by increasing output (as usual), the private firm does so by restricting output. Anyway, collusion is easiest to sustain when both firms maximize profits. This corroborates the result in the literature that firm asymmetry hinders collusion sustainability.

Finally, the most important policy implication of this paper is that collusion may increase total surplus and even also consumer surplus. Competition authorities should be aware of this when making decisions on cartel cases involving state-owned firms.

¹⁴The finding that symmetry favours collusion sustainability is in line with most literature (Ivaldi et al., 2007; Escrihuela-Villar, 2008), but there are exceptions (Correia-da-Silva and Pinho, 2016).

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