An economical model for deviation from collusion with and without make dumping

J. Martins, A.A. Pinto

Abstract The expansion of large companies across frontiers often leads to the phenomena of dumping and not always increases the profit of the companies due to antidumping duties. Here, we consider an economic model in which one firm has the monopoly of a certain market in its own country and divides another market in a foreign country with a firm of the foreign country. Assuming that both firms are cooperating in the foreign market, we study two possible strategies for the firm that is selling in both countries to increase its profit by deviating from collusion: one in which the firm increases the production in both countries and deviates without make dumping and other strategy in which the firm only increases the production in the foreign country and deviates committing dumping. To do our analysis we use an infinitely repeated duopoly model, and we characterize the parameters that define the most profitable strategy.

1 Introduction

Dumping is an unfair practice in international trade that is related to the fact of a firm charging a price for a certain product in the foreign market lower than the price charged by the same product in the domestic market [8]. Usually this phenomena is associated with a deliberate action of large companies to eliminate competition in foreign markets and consolidate them as monopolies. Hence, we consider in this work one firm that have the monopoly of the market of a certain product in its own

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country and divides the market of the same product in other country with a firm of that country. Since the firm has the monopoly in the home market it produces the quantity that leads to the maximum profit in its country. In the foreign market, we consider that the two firms cooperate to maximize the joint profit. This type of cooperation is known as collusion.

We note that trade agreements can demand that the firms compete in the foreign markets using the usual competitive Cournot equilibrium [9]. However, even under the rules of the trade agreements, the firms might prefer to practice, illegally, collusion than Cournot equilibrium because they might have a higher profit if the governments do not take any action. Even the collusion equilibrium being better than the Cournot equilibrium, the foreign firm might prefer to deviate from the collusion equilibrium to the Cournot equilibrium if the gains in the deviation period are higher than the losses by moving from the collusion to the Cournot equilibrium.

The foreign firm can deviate by increasing its production in the home and in the foreign market. By increasing its production, decreases its selling price of the product and might improve its profit

If the foreign firm only increases its production in the foreign market, then the other firm can lobby with the government and the government can action anti-dumping laws against the foreign firm [3, 4, 5, 6]. If the foreign firm prefers to avoid the anti-dumping against her, can also increases its home production decreasing like that its selling home price of the good. However, when the foreign firm increases its home production has a loss in its gain at the home market.

Hence, assuming collusion, we will study two deviation mechanisms from collusion that the foreign firm might have advantage to practice leading to the Cournot equilibrium: one deviation with dumping and other without dumping.

The exogenous economic quantity that immediately show to be relevant for our analyzes is the discount factor: i) for small discount factors the strategy to deviate without losing profit in its home market but facing the anti-dumping measures is the best one; ii) for medium discount factors the strategy to deviate decreasing its profit in the home market but avoiding anti-dumping measures is the best one; iii) for high discount factors the strategy not to deviate and keep in collusion is the best one.

2 Economic model

We consider two different firms F_1 and F_2, of different countries, that compete in quantities of production for a certain product [7]. We assume that F_1 dominates the market of this product in its own country and exports the same product to the country of firm F_2. Hence, F_1 dominates its home market and compete with F_2 in a foreign market. We denote by q_1^h the quantity of the product produced by firm F_1 in its home country and by q_1^f the quantity of the product produced by firm F_1 to the foreign market in the country of firm F_2. The quantity produced by firm F_2 in its own country will be denoted by q_2^h. The correspondent prices of each unit of the product will be denoted by p_1^h, p_1^f and p_2^h.

In the country of firm F_2, the foreign country for F_1, we assume that the utility function for the products produced by firm F_1 and F_2 is quadratic given by

$$U(q_1^f, q_2^h) = \alpha_1 q_1^f + \alpha_2 q_2^h - \frac{1}{2}\left(\beta_1\left(q_1^f\right)^2 + 2\gamma q_1^f q_2^h + \beta_2\left(q_2^h\right)^2\right) \tag{1}$$

with $\alpha_i > 0$, $\beta_i > 0$ and $\beta_1\beta_2 > \gamma^2$. We restrict our analyses to the case of a symmetric model with $\alpha_1 = \alpha_2$ and $\beta_1 = \beta_2$. Hence, the linear inverse demand functions are given by

$$p_1^f = \alpha - \beta q_1^f - \gamma q_2^h \tag{2}$$

$$p_2^h = \alpha - \beta q_2^h - \gamma q_1^f \tag{3}$$

with $\alpha > 0$, $\beta > 0$ and $\beta^2 \geq \gamma^2$. The parameter α represents the maximum price that anyone would pay for the product and β measures the negative relationship between the quantity demanded and the price. We consider only the case of products that are substitutable, i.e. $\gamma > 0$. In the country of firm F_1, we assume that F_1 dominates the market and the competition is negligible. Hence, the demand function is given by

$$p_1^h = \alpha - \beta q_1^h \quad . \tag{4}$$

With these notations and neglecting the marginal costs, in the foreign market the firm F_1 realizes the profit

$$\pi_1^f = p_1^f q_1^f = (\alpha - \beta q_1^f - \gamma q_2^h) q_1^f , \tag{5}$$

whereas the firm F_2 realizes the profit

$$\pi_2^h = p_2^h q_2^h = (\alpha - \beta q_2^h - \gamma q_1^f) q_2^h . \tag{6}$$

In the home market, the firm F_1 realizes the profit

$$\pi_1^h = p_1^h q_1^h = (\alpha - \beta q_1^h) q_1^h \quad . \tag{7}$$

3 Deviation from collusion

We start to assume that firm F_1 have the monopoly in its home market and produces the quantity that maximizes its profit π_1^h. We also assume that firm F_1 cooperates with firm F_2 in the foreign market dividing the production equally and maximizing the joint profit $\left(\pi_1^f + \pi_2^h\right)$. In this case, we say that firms are in collusion. The following Lemma states that, in these conditions, any deviation from collusion is dumping.

Lemma 1. *Let F_1 be a firm that have the monopoly of the home market, and produces the quantity that maximizes its profit, and let F_1 play a collusion strategy with other firm F_2 in a foreign market. If the firm F_1 do not change the quantity produced to the home market, then, any increase in the quantity produced to the foreign market is dumping.*

Proof. By Eq. (7), the quantity produced by firm F_1 that maximizes the profit π_1^h is given by

$$q_1^{h,MON} = \frac{1}{2}\frac{\alpha}{\beta} \tag{8}$$

and, by Eq. (4), the correspondent price is given by

$$p_1^{h,MON} = \frac{1}{2}\alpha \quad . \tag{9}$$

In the foreign market, if both firms cooperate to maximize the joint profit

$$\pi_1^f + \pi_2^h = \alpha(q_1^f + q_2^h) - \beta((q_1^f)^2 - (q_2^h)^2) - 2\gamma q_1^f q_2^h \quad , \tag{10}$$

then, they will produce the quantities

$$q_1^{f,COL} = q_2^{h,COL} = \frac{1}{2}\frac{\alpha}{\beta + \gamma} \quad , \tag{11}$$

and the correspondent prices are given by

$$p_1^{f,COL} = p_2^{h,COL} = \frac{1}{2}\alpha \quad . \tag{12}$$

Hence, $p_1^{h,MON} = p_1^{f,COL}$ and, by Eq. (2), any increase in the quantity q_1^f will result in a decrease in the price p_1^f. Therefore, if $q_1^{f,COL}$ increases to a certain q_1^f, we obtain $p_1^{h,MON} > p_1^f$ which corresponds to dumping.

We observe that the profit of firm F_1 in the home market in monopoly is given by

$$\pi_1^{h,MON} = \frac{1}{4}\frac{\alpha^2}{\beta} \tag{13}$$

and the profit of both firms in the foreign market in collusion is given by

$$\pi_1^{f,COL} = \pi_2^{h,COL} = \frac{1}{4}\frac{\alpha^2}{\gamma+\beta} . \tag{14}$$

The firm F_1 has now two possible strategies to dominate the foreign market and increase the profit: expand making dumping and suffer the penalties or expand and, at the same time, increase the produced quantity to the home market to decrease the price and avoid the dumping.

3.1 Strategy 1 - Deviation from collusion by make dumping

We start to assume that after a period of collusion the firm F_1 deviates from collusion without changing the produced quantity in the home market. This is the deviation period. The deviation will be done to maximize the profit in the foreign market,

$$\frac{\partial \pi_1^f}{\partial q_1^f} = 0 \Leftrightarrow q_1^f = \frac{1}{2}\frac{\alpha - \gamma q_2^h}{\beta} \quad ,$$

and assuming that firm F_2 do not deviates from collusion, $q_2^h = q_2^{h,COL}$, the optimal amount of production is given by

$$q_1^{f,devD} = \frac{1}{4}\frac{\alpha(\gamma^2 - 2\beta^2 + \gamma\beta)}{\beta(\gamma^2 - \beta^2)} \quad . \tag{15}$$

Hence, in the deviation period, the profit $\pi_1^{f,devD}$ realized by the firm F_1 in the foreign market increases, while the profit $\pi_2^{f,devD}$ realized by the firm F_2 decreases.

After the deviation period, the firm F_2 will easily demonstrate that the firm F_1 committed dumping and a following period of punishment will be imposed to F_1. The punishment consists in a prohibitive tariff imposed by the government that ensures a null profit for the firm F_1 in the foreign market

$$\pi_1^{f,PUN} = 0 \tag{16}$$

and a monopoly profit for the firm F_2

$$\pi_2^{h,MON} = \frac{1}{4}\frac{\alpha^2}{\beta} . \tag{17}$$

In both periods of deviation and punishment the firm F_1 produces the quantity in the home market that maximizes the profit and realizes the monopoly profit

$$\pi_1^{h,MON} = \frac{1}{4}\frac{\alpha^2}{\beta} \quad . \tag{18}$$

3.2 Strategy 2 - Deviation from collusion without make dumping

We consider now that the firm F_1 deviates from collusion increasing the produced quantity in the foreign market and also in the home market. These quantities will be chosen in order to maintain the prices equal in both markets and prevent that the firm F_1 become condemned of make dumping. To keep the prices equal

$$p_1^h = p_1^f \Leftrightarrow \alpha - \beta q_1^h = \alpha - \beta q_1^f - \gamma q_2^{h,COL} \quad,$$

the firm F_1 has to produce in the home market the quantity given by

$$q_1^h = q_1^h\left(q_1^f\right) = q_1^f + \frac{\gamma}{\beta} q_2^{h,COL}$$
$$= q_1^f + \frac{1}{2} \frac{\alpha\gamma}{\beta(\beta+\gamma)} \quad. \tag{19}$$

Hence, in the deviation period F_1 realizes a total profit given by

$$\pi_1^{h+f}(q_1^f) = \pi_1^h(q_1^f) + \pi_1^f(q_1^f, q_2^{h,COL}) \quad, \tag{20}$$

and the amount for the optimal deviation is given by

$$\frac{\partial \pi_1^{h+f}}{\partial q_1^f} = 0 \Leftrightarrow q_1^{f,dev\overline{D}} = \frac{\alpha}{8\beta} \frac{\gamma+4\beta}{\gamma+\beta} \quad. \tag{21}$$

Therefore, the profit realized by the firm F_1 in the deviation period is given by

$$\pi_1^{h+f,dev\overline{D}} = \frac{\alpha^2(4\beta+3\gamma)^2}{32\beta(\beta+\gamma)^2} \quad. \tag{22}$$

Assuming that the firm F_1 deviates from collusion in the foreign market by increasing the production in a small amount ε,

$$q_1^f = (1+\varepsilon)q_1^{f,COL} \quad, \tag{23}$$

we observe in Fig. 1 that the profit of firm F_1 increases up to a certain value of ε. Hence, the firm F_1 has an incentive to deviates from collusion by increasing its production up to a certain value.

4 Repeated games

We consider now the following repeated strategies:

- *Repeated collusion* - [*COL*]: when both firms cooperate in every periods maximizing the join profit.
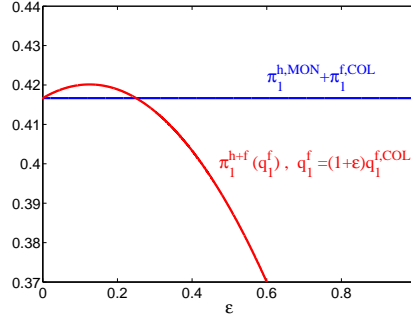
Fig. 1: The total profits of F_1, in the strategies of *collusion* and *deviation from collusion without make dumping* when $q_1^f = (1 + \varepsilon)q_1^{f,COL}$. Parameters: $\beta_i = 1$, $\alpha_i = 1$ and $\gamma = 0.5$.

Hence, the profit realized by the firm F_1 is given by

$$
\begin{aligned}
\pi_1^{[COL]} &= (1 - \delta) \left[\left(\pi_1^{h,MON} + \pi_1^{f,COL} \right) + \delta \left(\pi_1^{h,MON} + \pi_1^{f,COL} \right) + ... \right] \\
&= (1 - \delta) \frac{1}{1 - \delta} \left(\pi_1^{h,MON} + \pi_1^{f,COL} \right) \\
&= \pi_1^{h,MON} + \pi_1^{f,COL} \quad ,
\end{aligned}
\tag{24}
$$

and, similarly, the profit realized by the firm F_2 is given by

$$
\pi_2^{[COL]} = \pi_2^{h,COL} \quad ,
\tag{25}
$$

where $\delta \in (0;1)$ denotes the rate of discount.

- **Deviation-Punishment followed by Cournot** - $DP[CNT]$: When F_1 deviates from collusion by make dumping and suffers a punishment in the following period; After these two periods, the firms do not cooperate any more and adopt a Cournot strategy.

The profit realized by the firm F_1 in the $DP[CNT]$ strategy is given by

$$
\begin{aligned}
\pi_1^{DP[CNT]} &= (1 - \delta) \left[\left(\pi_1^{h,MON} + \pi_1^{f,devD} \right) + \delta \left(\pi_1^{h,MON} + 0 \right) \right. \\
&\quad \left. + \delta^2 \left(\pi_1^{h,MON} + \pi_1^{f,CNT} \right) + \delta^3 \left(\pi_1^{h,MON} + \pi_1^{f,CNT} \right) + ... \right] \\
&= \pi_1^{h,MON} + (1 - \delta)\pi_1^{f,devD} + \delta^2 \pi_1^{f,CNT} \quad ,
\end{aligned}
\tag{26}
$$

and the profit realized by the firm F_2 is given by

$$\pi_2^{DP[CNT]} = (1-\delta)\pi_2^{h,devD} + \delta(1-\delta)\pi_2^{h,MON} + \delta^2\pi_2^{h,CNT} \quad . \tag{27}$$

- **Deviation without dumping followed by Cournot** - $\overline{D}[CNT]$: when F_1 deviates from collusion without make dumping in the first period and there is a competition à la Cournot in the following periods.

  In this $\overline{D}[CNT]$ strategy the profit realized by the firm F_1 is given by

$$\pi_1^{\overline{D}[CNT]} = (1-\delta)\left[\pi_1^{h+f,dev\overline{D}} + \delta\left(\pi_1^{h,MON} + \pi_1^{f,CNT}\right) + \delta^2(...) + ...\right]$$

$$= (1-\delta)\pi_1^{h+f,dev\overline{D}} + \delta\left(\pi_1^{h,MON} + \pi_1^{f,CNT}\right) \tag{28}$$

  and the profit realized by the firm F_2 is given by

$$\pi_2^{\overline{D}[CNT]} = (1-\delta)\pi_2^{h,dev\overline{D}} + \delta\pi_2^{h,CNT} \quad . \tag{29}$$

- **Repeated deviation-punishment** - $[DP]$: when the two periods of deviation-punishment strategy will keep being repeated.

  The profit realized by the firm F_1 in the $[DP]$ strategy is given by

$$\pi_1^{[DP]} = (1-\delta)\left[\left(\pi_1^{h,MON} + \pi_1^{f,devD}\right) + \delta\left(\pi_1^{h,MON} + 0\right)\right.$$
$$\left. + \delta^2\left(\pi_1^{h,MON} + \pi_1^{f,devD}\right) + \delta^3\left(\pi_1^{h,MON} + 0\right) + ... \right]$$

$$= \pi_1^{h,MON} + \frac{1}{1+\delta}\pi_1^{f,devD} \tag{30}$$

  and the profit realized by the firm F_2 is given by

$$\pi_2^{[DP]} = \frac{1}{1+\delta}\pi_2^{h,devD} + \frac{\delta}{1+\delta}\pi_2^{h,MON} \quad . \tag{31}$$

- **Repeated deviation without make dumping** - $[\overline{D}]$: when the strategy of deviation deviation without make dumping is repeated in every periods of the game.

  In this $[\overline{D}]$ strategy the profit realized by the firm F_1 is given by

$$\pi_1^{[\overline{D}]} = (1-\delta)\left[\left(\pi_1^{h+f,dev\overline{D}}\right) + \delta\left(\pi_1^{h+f,dev\overline{D}}\right) + ...\right]$$

$$= \pi_1^{h+f,dev\overline{D}} \tag{32}$$

  and the profit realized by the firm F_2 is given by

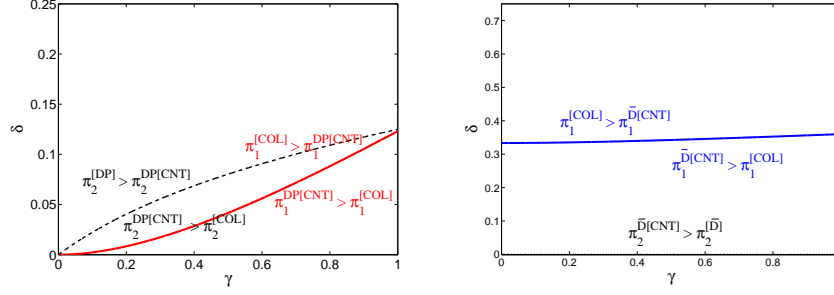$$\pi_2^{[\overline{D}]} = \pi_2^{h,dev\overline{D}} \quad . \tag{33}$$

Fig. 2: (left) The regions where F_1 prefers the $DP[CNT]$ and $[COL]$ strategies and F_2 prefers the $DP[CNT]$ and $[DP]$ strategies. (right) The regions where F_1 prefers the $\overline{D}[CNT]$ and $[COL]$ strategies and F_2 prefers the $\overline{D}[CNT]$ and $[\overline{D}]$ strategies. Parameters: $\alpha_1 = \alpha_2 = \alpha_3$ and $\beta_i = 1$.

To compute the optimal strategy in the infinitely repeated game, we observe that: the firm F_1 makes the decision between maintain the collusion strategy $[COL]$ or choose one deviation strategy DP or $\overline{D}$; the firm F_2 makes the decision between allow the repetition of the deviation strategy or force a Cournot strategy.

Hence, the optimal strategy is $DP[CNT]$ if

$$\pi_1^{DP[CNT]} > \pi_1^{[COL]} \quad and \quad \pi_2^{DP[CNT]} > \pi_2^{[DP]} \quad . \tag{34}$$

We observe on the left hand side of Fig. 2 that the $DP[CNT]$ strategy is the optimal strategy for values of δ below the curve $\delta(\gamma)$ for which $\pi_1^{DP[CNT]} = \pi_1^{[COL]}$.

The optimal strategy is $\overline{D}[CNT]$ if

$$\pi_1^{\overline{D}[CNT]} > \pi_1^{[COL]} \quad and \quad \pi_2^{\overline{D}[CNT]} > \pi_2^{[\overline{D}]} \quad . \tag{35}$$

On the right hand side of Fig. 2 we observe that $\overline{D}[CNT]$ is the optimal strategy for values of δ below the curve $\delta(\gamma)$ for which $\pi_1^{\overline{D}[CNT]} = \pi_1^{[COL]}$. Here, we also observe that the firm F_2 prefers the strategy $\overline{D}[CNT]$ rather than $[\overline{D}]$ for all values of δ.

The repeated strategy of deviation-punishment $[DP]$ is the otimal strategy if

$$\pi_1^{[DP]} > \pi_1^{[COL]} \quad and \quad \pi_2^{[DP]} > \pi_2^{DP[CNT]} \quad . \tag{36}$$

In the symmetric case of $\alpha_1 = \alpha_2 = \alpha_3$ and $\beta_i = 1$ we observe that both conditions are not satisfied because when the firm F_1 prefers the strategy $[DP]$ rather than $[COL]$ the firm F_2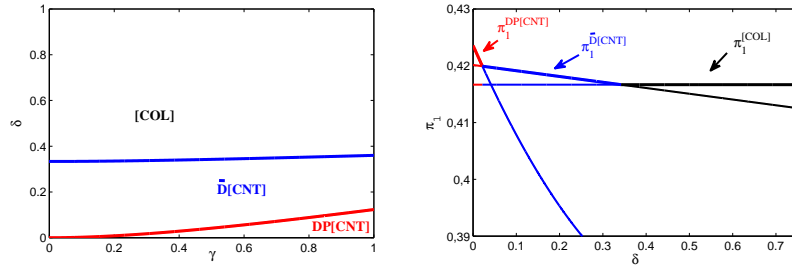 prefers the $DP[CNT]$ strategy rather than $[DP]$. In the same way, we observe that the repeated strategy of deviation without make dumping $[\overline{D}]$ is never the optimal strategy because when the firm F_1 prefers the strategy $[\overline{D}]$ rather than $[COL]$ the firm F_2 prefers the $\overline{D}[CNT]$ strategy rather than $[\overline{D}]$. Indeed, as we

Fig. 3: (left) The three regions in the (γ, δ) region for which the strategies $[COL]$, $\overline{D}[CNT]$ and $DP[CNT]$ are the optimal strategies. (right) The profits of firm F_1 in the strategies $DP[CNT]$, $\overline{D}[CNT]$ and $[COL]$ for $\alpha_i = 1$, $\beta_i = 1$ and $\gamma = 0.5$.

observe in Fig. 2 the firm F_2 always prefers the strategy $\overline{D}[CNT]$ rather than $[D]$ in the symmetric case.

Therefore, joining the previous results we have on the left hand side of Fig. 3 the parameter regions where the repeated strategies of $[COL]$, $\overline{D}[CNT]$ and $DP[CNT]$ are the optimal strategies of the infinitely repeated game. On the right hand side of Fig. 3, we compare the profit of the firm F_1 in the three optimal strategies for a fixed value of γ, here $\gamma = 0.5$, and different values of δ. For small values of the rate of discount δ the optimal strategy is $DP[CNT]$ and the profit of the firm F_1 in this strategy is the higher one. For higher values of the rate of discount δ the optimal strategy is $[COL]$. Here, the profits obtained in the strategies $DP[CNT]$ and $\overline{D}[CNT]$ are smaller than the profit obtained in the strategy $[COL]$. For intermediate values of δ the highest profit is the one obtained in the strategy $\overline{D}[CNT]$ since this is the optimal strategy now.

5 Conclusions

In this work we consider two different strategies of deviation from collusion that can be adopted by a firm that dominates its domestic market and is playing collusion with another firm in a foreign market. One strategy consists in deviating by make dumping and suffer a punishment in the following period. The other strategy consists in increase the produced quantities in both markets, to keep the prices equal and avoid the dumping. We observe that the strategy of deviation with dumping only compensates for a high increase in the quantity of product produced. For a small increase in this quantity, which is the case of a small deviations from collusion, we observe that increasing the production in the home market with the consequent decreasing of the prices to avoid the dumping might be preferable.

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