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# Abuse of Competitive Fringe

Carlo Capuano

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Carlo Capuano, *University of Naples FEDERICO II*

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**Summary**

The purpose of this article is to analyze how the presence of a competitive fringe, composed by price taker firms, can affect the sustainability of collusive equilibria. Our starting point is that there exists a diffused misunderstanding about its strategical role as collusive minus factor. We deny that. In fact, if it is true that in single dominance cases the presence of a competitive fringe significantly reduces the price increasing profitability and the leader market power, when we consider collective dominance cases the deviation profitability and the punishment mechanism become crucial. In this paper after introducing a minimal structural and strategical framework needed for describing this kind of competition, we prove that not only the presence of a competitive fringe is a collusive plus factor, but also that there exists a critical dimension of the fringe such that collusion is a Nash equilibrium of the static game.

**Keywords:** Collusion, Oligopoly, Competitive fringe, Bertrand, Nash

**JEL Classification:** D43, L1, L13

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*Address for correspondence:*

Carlo Capuano
Dipartimento di Teoria e Storia dell'Economia Pubblica
Complesso Universitario di Monte S.Angelo
80124, Naples
Italy
Phone: +39 081675366
Fax: +39 0817663540
E-mail: carcapua@unina.it

# 1 Introduction.

The purpose of this article is to analyze how the presence of a competitive fringe, composed by price taker firms, can affect the sustainability of collusive equilibria. Our starting point is that there exists a diffused misunderstanding about its strategical role as collusive minus factor. In fact, if we agree that when we deal with single dominance the presence of a competitive fringe is a collusive minus factor, we deny it when we consider collective dominance and collusion sustainability. Here we are why we talk about an abuse of competitive fringe, an abuse that we have also found in some recent European Commission sentences[1].

In presence of a competitive fringe composed by price taker firms, the topic literature, developed on single dominance issues, considers that the dominant firm market power is constrained, as its profits. In fact, when the leader increases its price, the competitive fringe responds increasing its supply, the effect is a significant reduction of the dominant firm residual demand and of its extra profits. This is the main result that we find, for example, in Landes e Posner (1981), Utton (1995), Carlton e Perloff (1990), Scherer e Ross (1990), and Del Monte (2002). In particular, in Del Monte, it is clear how the competitive fringe supply elasticity, directly correlated with the number of competitive fringe members, its also positively correlated with the absolute value of the dominant firm residual demand: the bigger is the fringe, the higher is the residual demand elasticity, the lower is the leader mark up[2].

Unfortunately, the same theoretical structure cannot be easily switched to collective dominance analysis. In fact, when we deal with tacit collusion as a Subgame Perfect Equilibrium, it is known that it is not crucial the price increasing profitability but the unilateral incentive to deviate from the collusive price. It is essential to analyze the feasibility of an undercutting strategy and the strengthen of the punishment mechanism implemented. Nevertheless, there exists a broad literature about cartel stability in presence of a competitive fringe. The main problem is that in order to explain the competition, in many papers collateral assumptions are introduced, assumptions not always necessary for isolating the strategical role of the mere presence of a competitive fringe: capacity constraints, incomplete information, multivariable competition as R&D or advertisement, product differentiation and so on.

Indeed, this paper starts discussing the minimal structural and strategical framework needed for describing a market where a cartel faces a competitive fringe. Then, after proposing a simple model setting, we analyze the role of the competitive fringe in a Supergames framework. We prove not only that when

[1] The Merger Task Force of the European Commission has accepted the presence of a competitive fringe as a defence referring to the risk of a post merger collective dominance. For example see the case CVC/Danone. Moreover, in some seminal cases as Nestlè/Perrier, Kali und Salz and, the last but not the least, the case Airtours/ First Choice, the absence of a competitive fringe is mentioned as a collusive plus *factor*. See also the Enterprise Papers n.6/2001, *" Assessment criteria for distinguishing between competitive and dominant oligopolies in merger control"* published by the European Commission.

[2] On the residual demand, the inverse elasticity rule holds.

collusion is sustained as a Subgame Perfect Equilibrium, the competitive fringe is a collusive plus factor, but also that there exists a critical dimension of the fringe such that collusion is a Nash Equilibrium of the static game.

# 2 Minimal structural and strategical assumptions.

## 2.1 Characterization of a competitive fringe.

We start properly defining the structural and strategical assessment of the firms belonging to a competitive fringe.

The first question involves their technology. The competitive fringe member cannot be characterized by constant returns to scale. Otherwise, defining a supply function of the fringe would be impossible. For the same reason, we cannot assume increasing returns to scale. This means that the competitive fringe members ought to be characterized by decreasing returns to scale, maybe by a U shaped cost function. Moreover, in some models a capacity constraint is assumed. But, this could not be time consistent in a repeated game framework. Otherwise, it would be not clear why constrained firms don't invest in capacity if profitable.

A second question involves the strategical behavior of the competitive fringe. If we assume that the competitive fringe member operates as a *Cournot Stackelberg follower*, this would not cohere with the idea that price taker firms observe a price, the equilibrium one, and choose a quantity as control variable. In fact, Cournot assumptions require the firms to operate as monopolist on a residual demand but this makes them price makers[3]. Similarly, a competitive fringe member cannot operate as *Bertrand-Stackelberg follower:* price taker firms never decides a price[4]!

## 2.2 Characterization of the leader firms.

The competitive fringe observes and responds to the cartel behavior: the latter cannot operate as *Cournot-Stackelberg Leader* for the same reason that the former, the competitive fringe, is not composed by *Cournot-Stackelberg Followers*. Moreover, if the cartel members, the leaders, decide their quantity, the observed price cannot be the equilibrium one. This is because when the competitive fringe responds, the price will change and it can happen that payoffs will be negative for all the firms: in some cases an equilibrium does not exist at all. Indeed, we assume that in any contest, the leaders choose a price. The lowest price among leaders' ones will be the equilibrium price.

A second hypothesis is required about technology. Assuming that the leaders are characterized by a different technology with respect to the competitive fringe

[3] Anyway, many author study cartel stability with a Cournot fringe. See, for example, Shaffer (1995), or de Roos (2004).

[4] Our assumption, then, is different from the ones we find in Rothschild (1992) and Ross (1992), in Posada (2000) and (2001), where cartel stability is considered in a market with a Bertrand differentiated fringe.

is risky because it would be difficult to isolate the strategical impact of this asymmetry on the implemented equilibrium. Anyway, if we assume constant returns to scale we have a trivial result.

**Proposition 1** *In a linear demand market where a competitive fringe, characterized by an increasing and continuous supply function, competes with some leader firms characterized by constant returns to scale, the presence of the competitive fringe is not relevant with respect to the sustainability of tacit collusion as a Subgame Perfect Equilibrium.*

**Proof.** We assume that the firms belonging to the competitive fringe operate as price taker. Under the assumption of decreasing returns to scale, without capacity constraints, the profit maximizer problem surely admits a solution, an increasing, continuous supply function. The leaders serve the residual demand. Directly from the seminal paper of Friedman (1971), we know that when colluders are characterized by constant returns to scale, the demand parameters do not affect the critical discount factor needed for sustaining collusion as a non cooperative equilibrium in a infinitely repeated game. This is true when the leaders choose either quantities or prices as control variables. ■

Again, we cannot assume increasing returns to scale for any leader firms because of the natural monopoly result.

At last, we can assume that leaders are characterized by decreasing returns scale as the competitive fringe. It is easier but not necessary assume symmetry. In this case, there exist some problems about the definition of a Bertrand Nash equilibrium for the leaders firms, but also before figuring it out we prove some relevant results .

### 2.3 A proposed model setting.

We assume good homogeneity and we consider a linear demand market where two leader firms compete with a $n$ firm competitive fringe.

$$P = A - \beta Q \tag{1}$$

with

$$A, \beta > 0$$

where

$$Q = q_1^L + q_2^L + q_1^F + ... + q_n^F \tag{2}$$

is the total amount produced by the two leaders, indexed by the apex $L$,added to the total amount produced by the $n$ firms belonging to the competitive fringe, indexed by the apex $F$.

The technology is symmetric and characterized by decreasing returns to scale. We assume a quadratic cost function for all the firms, the leaders and the competitive fringe.

$$C_i(q) = \frac{1}{2}q^2 \tag{3}$$

Neither structural nor strategical capacity constraints are considered. We have complete but not perfect information because of the following time setting. First, the leaders simultaneously choose their prices. Then, the lowest one is considered as the equilibrium one by any firms belonging to the competitive fringe. They operate as price takers that solve the own profit maximization problem. This two-stage game is infinitely repeated. If tacit collusion among the leaders is implemented, then it would be as a Subgame Perfect Equilibrium.

#### 2.3.1 The competitive fringe supply and the leaders residual demand

Given the 3, from the first order condition of the standard profit maximization problem we derive the firm supply function $s_i(p)$, and, adding for all the firms belonging to, we obtain the competitive fringe supply function, $S^F(p)$.

$$C'(q_i) = q_i = p = s_i(p) \tag{4}$$
$$S^F(p) = ns_i(p) = np \tag{5}$$

where the equilibrium price $p$ is the lowest price between the leaders ones.

$$p = \min(p_1, p_2) \tag{6}$$

The leaders residual demand is now a function of the number $n$ of firms belonging to the competitive fringe.

$$D^L(.) = D(p) - S^F(p) \tag{7}$$

$$\begin{aligned} D^L(.) &= A - (n+\beta)p \\ &= A - bp \end{aligned} \tag{8}$$

where

$$b = n + \beta > 0 \tag{9}$$

The number $n$ of firms belonging to the competitive fringe affects the elasticity of the leaders residual demand function: the more are the firms, the flatter is the inverse demand function, i.e. the higher is the absolute value of the price elasticity.

$$\left|\eta^L\right| = -\frac{\partial D^L}{\partial p}\frac{p}{D^L} = \frac{bp}{A - bp} \tag{10}$$

where

$$\frac{d\left|\eta^L\right|}{dn} = \frac{\partial\left|\eta^L\right|}{\partial b}\frac{\partial b}{\partial n} = \frac{p}{(A-bp)^2} > 0 \tag{11}$$

In the following we examine how demand elasticity affect collusion sustainability. We have already had a first result when leaders are characterized by constant returns to scale[5]. A second result involves decreasing returns to scale and it is the main contribute of our analysis.

[5] See Proposition 1.

# 3 Collusion among leaders.

Referring to the seminal contribute of Friedman (1971), we characterized the level of collusion sustainability in a market by the critical discount factor $\delta^*$ needed for letting firms be indifferent between colluding and deviating in an infinitely repeated game.

$$\delta^* : \frac{\Pi^{Coll}}{1-\delta^*} = \Pi^{dev} + \delta^* \frac{\Pi^{Nash}}{1-\delta^*} \tag{12}$$

$$\delta^* = \frac{\Pi^{dev} - \Pi^{Coll}}{\Pi^{dev} - \Pi^{BN}} \tag{13}$$

where $\Pi^{Coll}, \Pi^{dev}$ and $\Pi^{Nash}$ respectively are the static collusive profits, the deviation and Nash ones. As standard, we assume trigger strategies and a for ever Nash reversion punishment.

## 3.1 Static collusive profits.

In order to derive the static collusive profits, the problem to solve is the same faced by a multiplane monopolist. With symmetry and decreasing returns to scale the production will be equally shared until the firm marginal cost is equal to the marginal revenue. When price is the control variable we have the following.

$$\begin{aligned}
\underset{p}{MAX} 2\Pi^{Coll} &= p\left(A-bp\right) - 2\left[\frac{1}{2}\left(\frac{A-bp}{2}\right)^2\right] \\
\frac{\partial 2\Pi^{Coll}}{\partial p} &= A - 2bp + \frac{A}{2}b - \frac{1}{2}b^2 p = 0 \\
p^{Coll} &= A\frac{2+b}{b\left(4+b\right)} && (14) \\
q_1^{Coll} &= q_2^{Coll} = \frac{A}{4+b} && (15) \\
\Pi_1^{Coll} &= \Pi_2^{Coll} = \frac{A^2}{2b\left(4+b\right)} && (16)
\end{aligned}$$

The leaders output, $q_1^{Coll} = q_2^{Coll}$, the collusive price, $p^{Coll}$, and the collusive profits, $\Pi_1^{Coll} = \Pi_2^{Coll}$, are negatively correlated with the number of firms belonging to the competitive fringe: the bigger is the competitive fringe, the less profitable is collusion. But, this result only affects a part of our problem. Differently from single dominance cases, with a cartel the unilateral incentive to deviate from collusion would be the crucial issue.

## 3.2 Deviation profits.

In a supergame framework collusion is sustainable in a no cooperative way only if the short period gains by deviation are not higher than the expected losses by Nash Reversion for ever[6]. This kind of trade-off, that often depends on the agent intertemporal discount factor, needs that the deviation is profitable, i.e. the collusion is not a static Nash equilibrium. Otherwise, for any discount factor, collusion is part of a Subgame Perfect Equilibrium. This consideration helps us to introduce the second result of our paper.

**Proposition 2** *When we consider decreasing returns to scale, if the demand elasticity is sufficiently high, oligopolistic firms have not incentive to deviate from collusive agreement by undercutting, i.e. collusion is a Nash equilibrium of the static game.*

**Proof.** The proof of this proposition requires to compute the price and the profits by deviation from the collusive scheme. We can anticipate the intuition that underlies these results: without any structural or strategical capacity constraints of the served demand, when a firm tries to undercut rivals, it has to serve all the generated demand. If we consider a infinitesimal price deviation the effect on marginal revenue is not significant; at the same time, because of the decreasing returns to scale, we have a relevant increasing in the marginal cost of the firm that now has to serve all the generated demand. The net effect can decreases the deviator profit with respect the collusive level.

Analytically, we start computing the deviation price. If the first leader decides to deviate from the collusive price, it is going to play as a monopolist on the leaders residual demand $D^L$.

$$if \;\; p_1^{dev} < p_2 \Rightarrow q_1\left(p^{dev}\right) = D^L\left(p^{dev}\right) \tag{17}$$

A first candidate as deviation price is the monopoly price $p^M$,computed as the following.

$$\begin{aligned}
\underset{p}{MAX}\Pi^M &= p\left(A - bp\right) - \frac{1}{2}\left(A - bp\right)^2 \\
\frac{\partial \Pi^M}{\partial p} &= A - 2bp + Ab - b^2 p = 0 \\
p^M &= A\frac{1+b}{b\left(2+b\right)}
\end{aligned} \tag{18}$$

where

$$\forall b > 0, \;\; p^M = A\frac{1+b}{b\left(2+b\right)} > p^{Coll} = A\frac{2+b}{b\left(4+b\right)} \tag{19}$$

The monopoly price is always higher than the collusive one: this is because of the decreasing returns to scale assumption. Indeed, the profit function is a quadratic form of the implemented price, this implies that the deviation price will be the higher one that the firm can offer, i.e. an infinitesimal deviation

[6] Gains and losses are computed with respect to the collusive profits as benchmark.

from the collusive one.

$$\begin{aligned} p^{dev} &= p^{Coll} - \varepsilon \qquad\qquad con\ \varepsilon \to 0 & (20) \\ \Pi^{dev} &\simeq \Pi^{M}\left(p^{Coll}\right) \\ &\simeq A^2 \frac{4}{b\,(4+b)^2} & (21) \end{aligned}$$

Comparing 21 to 10,

$$\forall b = (n+\beta) \geq 4 \Leftrightarrow n \geq n^* = 4 - \beta,$$
$$\Pi^{dev} \simeq A^2 \frac{4}{b\,(4+b)^2} \leq \Pi^{Coll} = A^2 \frac{1}{2b\,(4+b)} \qquad (22)$$

It is shown that if the coefficient $b$ of the demand function is high enough, deviation is not profitable, i.e. collusion is a Nash equilibrium of the static game. ■

Moreover,

**Proposition 3** *Because of the demand elasticity is positively correlated with the number of firms belonging to the competitive fringe, there exists a critical mass $n^*$for the competitive fringe such that collusion is a Nash equilibrium of the static game.*

**Proof.** Because of the 11, this is directly derived from the previous proposition. ■

The figures 1 and 2 show that both collusive both monopoly profits are quadratic functions of the implemented price. As verified with the**??**, the monopoly price is always higher than the collusive one. A deviation from collusion shifts the deviator onto the monopoly profit function, in the neighborhood of the collusive price. We have two cases. In the first one, shown in figure 2, deviation profits are higher than collusive ones, i.e. the unilateral deviation is profitable. In the second case, deviation profits are lower than collusive ones, i.e. the unilateral deviation is not profitable: collusion is a Nash equilibrium.

## 3.3 A Bertrand-Nash Equilibrium.

The propositions 1 and 3 already deny the idea that the presence of a competitive fringe play the role of a *collusive minus factor.* The last step is to analyze what happens when the condition 22 is not verified, i.e. the number of firms belonging to the competitive fringe is smaller than the critical value $n^*$[7]. In

[7] This is tha case shown in figure 2.

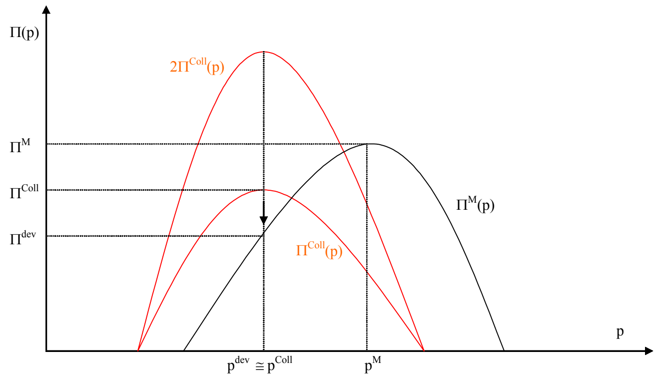


Figure 1: Case of non profitable unilateral deviation from collusive price.

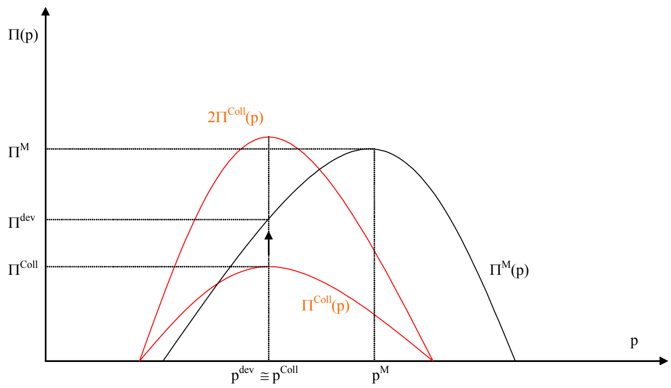


Figure 2: Case of profitable unilateral deviation from collusive price.

order to compute the critical discount factor 13, we have to derive a non collusive Bertrand Nash equilibrium of the model. In particular, we look for a symmetric one.

We consider the problem of a leader firm that maximizes its own profits and faces a residual demand that now assumes as given not only the competitive fringe supply but also the in equilibrium served demand of the other leader.

$$\begin{aligned}
\underset{p_1}{MAX}\Pi_1 &= p_1\left(D^L - q_2\right) - \frac{1}{2}\left(D^L - q_2\right)^2 \\
&= p_1\left(A - bp_1 - q_2\right) - \frac{1}{2}\left(A - bp_1 - q_2\right)^2 \\
\frac{\partial \Pi_1}{\partial p} &= A - q_2 + Ab - 2bp_1 - bq_2 - b^2 p_1 = 0 \\
p_1 &= \frac{(A - q_2)(b+1)}{(b+2)\, b} \\
q_1\left(p_1, q_2\right) &= A - q_2 - \frac{b+1}{b+2}\left(A - q_2\right)
\end{aligned}$$

Under symmetry, we impose

$$q_1 = q_2 = q^{BN} = A - q^{BN} - \frac{b+1}{b+2}\left(A - q^{BN}\right)$$

then

$$q^{BN} = \frac{A}{b+3} \tag{23}$$

and

$$p_1^{BN} = p_2^{BN} = \frac{A}{b}\frac{b+1}{b+3} \tag{24}$$

$$\Pi_1^{BN} = \Pi_2^{BN} = A^2 \frac{(b+2)}{2\,(b+3)^2\, b} \tag{25}$$

where, $\forall b > 0$,

$$p^{BN} = \frac{A}{b}\frac{b+1}{b+3} < A\frac{2+b}{b\,(4+b)} = p^{Coll} \tag{26}$$

$$\Pi^{BN} = A^2 \frac{(b+2)}{2\,(b+3)^2\, b} < A^2 \frac{1}{2b\,(4+b)} = \Pi^{Coll} \tag{27}$$

In order to verify that the price vector $\left\{p_1^{BN}, p_2^{BN}\right\}$ is a Nash equilibrium we have to prove that there not exist any profitable unilateral deviations. Given the 26 and the 19, the price of monopoly $p^M$ is higher that the price $p_1^{BN}$. Again, because of the quadratic form of the profit function with respect to the implemented price, we analyze a infinitesimal deviation from the price $p_1^{BN}$.

$$\Pi_1^{dev}\left(p_1 = \frac{A}{b}\frac{b+1}{b+3} - \varepsilon\right) \simeq p_1^{BN}\left(A - bp_1^{BN}\right) - \frac{1}{2}\left(A - bp_1^{BN}\right)^2$$

$$\Pi_1^{dev} \simeq \frac{A^2}{2\left(b+3\right)^2 b} < A^2 \frac{(b+2)}{2\left(b+3\right)^2 b} = \Pi_1^{BN}, \forall b \tag{28}$$

Indeed, the condition 28 proves that there not exist any profitable unilateral deviations.

The model admits infinite Nash equilibrium of the static game. The derived one is sustainable for all $b$, it is symmetric and characterized by lower profits than the collusive ones; moreover, it has been computed starting from an own profit maximization problem.

### 3.4 The collusive critical discount factor.

When the condition 22 does not hold, derived a non collusive Nash equilibrium of the static game, we can compute the critical discount factor needed for sustaining collusion as a Subgame Perfect Equilibrium.

$$\begin{aligned} \delta^* &= \frac{\Pi^{dev} - \Pi^{Coll}}{\Pi^{dev} - \Pi^{BN}} \\ &= \frac{\frac{4}{b(4+b)^2} - \frac{1}{2b(4+b)}}{\frac{4}{b(4+b)^2} - \frac{(b+2)}{2(b+3)^2 b}} \\ &= \frac{\left(b+3\right)^2 (b-4)}{(2b^2 - 16b + b^3 - 40)} \end{aligned} \tag{29}$$

where

$$\left.\frac{\partial \delta^*}{\partial b}\right|_{b\in[1,4[} = (-2)\frac{\left(4b+b^2-4\right)(b+3)}{\left(2b^2-16b+b^3-40\right)^2} \leq 0 \tag{30}$$

**Proposition 4** *When (i) the leader firms are characterized by decreasing returns to scale, (ii) a deviation from collusive equilibria is profitable, then the critical discount factor $\delta^*$ needed for sustaining collusion as a Subgame Perfect Equilibrium, is a decreasing function of the number of firms belonging to the competitive fringe.*

**Proof.** Given the 9, there exists a positive correlation between the number $n$ of firms belonging to the competitive fringe and the demand coefficient $b$. The derivative of the discount factor 29 with respect to $b$, as shown by the 30, is always negative. Then, the derivative of the discount factor $\delta^*$ with respect the number of firms $n$ is always negative.

$$\left.\frac{d\delta^*}{dn}\right|_{b\in[1,4[} = \left.\left[\frac{\partial \delta^*}{\partial b}\ \frac{\partial b}{\partial n}\right]\right|_{b\in[1,4[} \leq 0 \tag{31}$$

■

Indeed, we have shown an other case where the presence of competitive fringe is not a *collusive minus factor.*

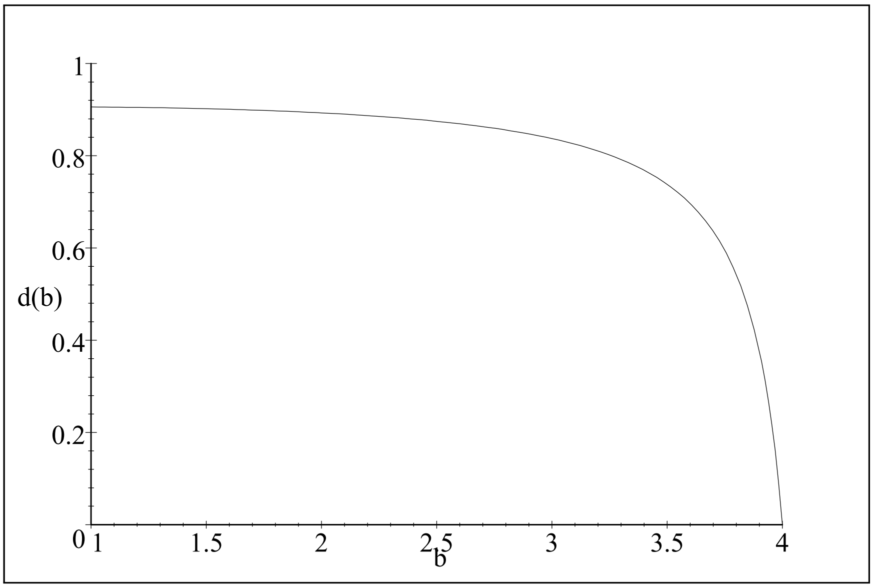


Figure 3: The critical discount factor $\delta(b)$ as a decreasing function of the demand coefficient $b$.

# 4 Conclusions.

In this paper we have proved that, under a structurally and strategically consistent model setting, the presence of a competitive fringe is a *collusive plus factor*. The assumptions of decreasing returns to scale, absence of structural or strategical capacity constraints, are crucial to derive a contest where the firm that deviate from collusion by undercutting the rivals, faces losses with respect the collusive payoff. The main intuition is the following. If an infinitesimal price deviation does not affect marginal revenue, when we impose the deviator to serve all the generated demand, we see a relevant increasing of marginal cost and a consequent decreasing of the marginal profit. It can happens that deviation from collusive price is not profitable, i.e. collusion is a Nash equilibrium of the static game. In particular, we prove that the bigger is the competitive fringe, the more likely is that collusive equilibrium is implemented.

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