# Hawks and doves in segmented markets : a formal approach to competitive aggressiveness

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# Hawks and doves in segmented markets:

# A formal approach to competitive aggressiveness


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**Abstract**

Competitive aggressiveness is analyzed in a simple spatial oligopolistic competition model, where each one of two firms supplies two connected market segments, one captive the other contested. To begin with, firms are simply assumed to maximize profit subject to two constraints, one related to competitiveness, the other to market feasibility. The competitive aggressiveness of each firm, measured by the relative implicit price of the former constraint, is then endogenous and may be taken as a parameter to characterize the set of equilibria. A further step consists in supposing that competitive aggressiveness is controlled by each firm through its manager hiring decision, in a preliminary stage of a delegation game. When compe-



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tition is exogenously intensified, through higher product substitutability or through larger relative size of the contested market segment, competitive aggressiveness is decreased at the subgame perfect equilibrium. This decrease partially compensates for the negative effect on profitability of more intense competition.

# 1 Introduction

It is widely recognized, both by practitioners and academics, that the entrepreneurial style of the manager crucially determines the performance of the firm. Entrepreneurial style is related to a subtle combination of personality traits and attitudes sustaining the leadership of the manager within the organization. However, from an external point of view, the entrepreneurial style of the manager does also matter, although the underlying traits and attitudes can only be assessed according to whether the firm is consumer- or competitor-centered (Kotler, 2003). Indeed, *customer orientation* requires building confident relationships with the consumers, sticking with their needs, and developing negotiation skills, whereas *competitor orientation* implies vigilance, responsiveness and aggressiveness. Balancing these orientations is a strategic choice implying human resource decisions based on the identification of the portfolio of executives' personal profiles and values which best fit the desired orientation of the firm. *Competitive aggressiveness* can consequently be viewed, not as a mere individual psychological characteristic of its members, but rather as a constructed feature of the organization itself, as a "general managerial disposition reflected

In dealing with its competitors, my business unit…

| | | |
|---|---|---|
| Is very seldom the first business to introduce new products/services, operating technologies,... | 1 to 7 | Is very often the first business to introduce new products/services, operating technologies,... |
| Typically responds to actions which competitors initiate | 1 to 7 | Typically initiates actions which competitors then respond to |

Figure 1: Proactiveness in the entrepreneurial style scale of Covin and Slevin

in a firm's willingness to take on and desire to dominate competitors through a combination of proactive moves and innovative efforts" (Covin and Covin, 1990, p.36). For a firm, competitive aggressiveness can be viewed as a chosen characteristic. It may become a strategic variable. Our objective is accordingly to analyze, in a simple oligopolistic model, the strategic choice of managerial competitive aggressiveness.

If we look at the empirical literature, competitive aggressiveness is measured by mixing items resorting to two dimensions:

($i$) A *temporal dimension* in terms of first mover advantages (Lieberman and Montgomery, 1988, 1998) and commitment to react to competitors' moves. This dimension refers to a proactive attitude of the manager who seeks to anticipate the events and not to stay quietly in a procrastinated posture. It is quite explicit, for instance, in the entrepreneurial style scale proposed by Covin and Slevin (1988) on the basis of the questionnaire given in the following table: This dimension is recognized as a key determinant of firm performance in hostile environments (Covin and Covin, 1990), or as a specific asset in entry deterrence strategies (Clark and Montgomery, 1998a, 1998b).

(*ii*) A *spatial dimension* associated with the quest of a market share advantage. Venkatraman (1989), for instance, uses four indicators of aggressiveness identifying various actions designed to gain market share at the expense of profitability. This dimension measures the pugnacity of the manager, namely his propensity to conceive his action within a "warfare context" (Kotler and Singh, 1981) where he has to decide either to launch a frontal attack on the rivals' positions or to elude the struggle. As emphasized by Lumpkin and Dess (1996, 2001), the two (temporal and spatial) dimensions should be kept apart, and the respective concepts of proactiveness and competitive aggressiveness carefully distinguished: "proactiveness refers to how firms relate to market opportunities by seizing initiative in the marketplace; competitive aggressiveness refers to how firms react to competitive trends and demands that already exist in the marketplace" (Lumpkin and Dess, 2001, p.429). Without mobilizing dynamic arguments and information structure considerations, competitive aggressiveness identifies a specific behavioral component of any firm facing a competitive environment, a component which can be represented along a metaphoric scale whose extremes oppose hawkish and dovish attitudes.

The spatial dimension of competitive aggressiveness becomes particularly significant when the market for each firm products can be divided into a *captive segment* and a *contested segment*, calling in principle for two distinct orientations, a customer orientation in the former against a competitor orientation in the latter. These orientations must however be balanced within a single competitive posture whenever the firm is unable or reluctant to price discriminate, so that the segments fail to fall completely apart. This posture, responding to the trade-off between gaining new customers, in particular in the captive segment, and picking up those of the rivals, reflects in practice the manager's more or less aggressive attitude.

In order to formalize the strategic choice of competitive aggressiveness, both along its temporal and its spatial dimensions, we adapt the popular Hotelling (1929) model of a spatial duopoly, where each firm has its own *hinterland* and both compete actively in the middle segment between their locations. Of course, as already pointed out by Hotelling, space is not necessarily geographic and may account for product differentiation in terms of any characteristic which is relevant from the consumers' viewpoint. We assume that each firm keeps its *hinterland* captive by adopting a best price policy and thus making price undercutting unprofitable for its rival, and also that it gives up any price discrimination by introducing a most-favored-customer clause in its sales contracts.

A distinctive feature of our approach is that we suppose each firm to make a *price-quantity* choice based on a feasibility analysis oriented towards both consumers and competitors. It takes into account *market feasibility* (given the consumers' preferences and the anticipated decision taken simultaneously by its rival) as well as *competitive feasibility* (the impact of its decision on its comparative price advantage). This approach, in terms of simultaneous price and quantity decisions, has been introduced by d'Aspremont, Dos Santos Ferreira and Gérard-Varet (2007). It may be claimed to be more realistic than the standard dichotomic price or quantity formulations. At the business unit level of a company, for instance, production and pricing decisions appear as aggregate data. They are elaborated at different stages of the organization through interrelated decision processes which lead to a coordinated set of marketing and logistic actions over a longer horizon. In this context, considering that these decisions are made simultaneously is a reasonable point of view. Nobody can imagine that a worldwide car maker like BMW or Renault might launch a new car without letting know the (average) price and the global number of vehicles he intends to sell per year.

This way of modeling oligopolistic competition has the advantage of generating a set of equilibria that can be parameterized by the degree of competitive aggressiveness displayed by each one of the two competitors, the determination of which immediately results in equilibrium selection. In this setting, the degrees of competitive aggressiveness can be either taken as exogenously given or considered as strategic variables to be chosen at a previous stage. In the latter case, such a choice refers to a human resource decision made at the top management level, which might take the classical form of hiring the executive in charge of the business unit. The hiring committee may then try to evaluate the aggressiveness of the candidates on the basis of their previous experience, personality traits and/or through indicators inspired, for instance, by Venkatraman's questionnaire (cf. table 1). It remains to the top management to match this evaluation with the desired aggressiveness level required for the job.

Another interpretation can be found in the management of the salesforce: the aggressiveness factor is related to the proportion of time and effort the sales representatives have to devote to prospecting and attracting rival's consumers. This proportion is under the responsibility of the salesforce manager and reflects the desired trade-off between customer and competitor orientations, expressing how long the salesperson has to behave as a hawk or as a dove. Since the competitors are both involved in the prior choice of their respective degrees of aggressiveness, this leads to a two-stage game where the equilibrium pair of degrees of aggressiveness determines the outcome. The question is to find out how aggressiveness competition confronts hawks, doves or some hybrid birds.

We introduce in section 2 the model of price-quantity competition, and characterize the set of equilibria, showing that it includes the equilibrium outcomes of several standard competition regimes, including Stackelberg equilibria. The last point allows to link competitive aggressiveness to the temporal dimension of the entrepreneurial orientation, and to exhibit the first mover (dis)advantage. In section 3, we analyze the strategic choice of managerial aggressiveness, and discuss the implications of changes in the relative weight of the two market segments. We conclude in section 4.

## 2 Price-quantity competition

We study a market where two firms compete to sell a homogeneous good, supposed to be produced (or purchased) by both at the same constant unit cost. The product is differentiated by its location in space, as in Hotelling (1929). Here, we assume that firm locations are fixed and cannot be strategically changed, and that firms compete simultaneously in both prices and quantities. This will be formally represented by a non-cooperative game and the set of equilibria of this game will be derived. Before, however, we need to describe the market, the potential demand to both firms in this market and how sales are organized.

### 2.1 The market

Consider the Hotelling (1929) spatial duopoly where a continuum of consumers, each likely to buy one unit of a homogenous good, is uniformly distributed on the interval $[0, 1 + 2a]$. All consumers have the same valuation $v$ of the good, and bear a travel cost $t$ per unit of length. Firm 1 is located at point $a$ and firm 2, symmetrically, at point $1 + a$, so that they are separated by a distance normalized to 1.

Sales contracts are assumed to incorporate two frequently used clauses. The first is a "most-favored-customer" clause by which all customers of each firm should pay the same mill price. The second is a "best price guarantee" by which the mill price $P_i$ actually paid to firm $i$ cannot be higher than either firm $i$ listed price $p_i$ or firm $j$ delivered price $p_j + t$ at firm $i$ location:

$$P_i(p_i, p_j) = \min\{p_i, p_j + t\} \tag{1}$$

With this second clause, the market on which each firm competes can be divided into two segments, a *captive* segment $[0, a]$ for firm 1 (resp. $[1 + a, 1 + 2a]$ for firm 2) and a *contested* segment $[a, 1 + a]$ (see Figure 2). According to the most-

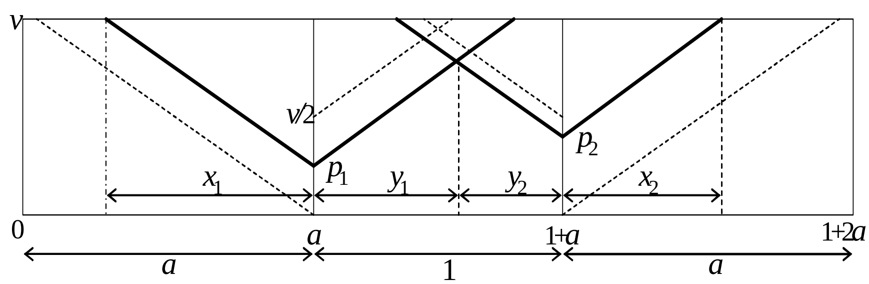



Figure 2: The market segments

favored-customer clause, the listed price $p_i$ concerns both the captive and the contested segments. As to the best price guarantee, it ensures that the captive segment of each firm remains so whatever the prices chosen by the competitors. Furthermore, each firm knows that its competitor will automatically adjust its price so as to defend its captive segment. In other words, undercutting does not pay.

Consider a pair of mill prices $(p_1, p_2)$ such that $|p_1 - p_2| \leq t$. Then the quantity demanded to firm $i$ on its captive segment is $x_i = (v - p_i)/t$ (see Figure 2). Indeed, a captive consumer located at a distance $x_i$ from firm $i$ must pay the delivered price $p_i + tx_i$ which should not exceed his reservation price $v$. On the contested segment the same applies, with the additional requirement that the delivered price $p_i + ty_i$ from firm $i$ should not exceed the delivered price $p_j + t(1 - y_i)$ from firm $j$. Thus the quantity demanded on this segment to firm $i$ is

$$y_i = \min\left\{\frac{v - p_i}{t}, \frac{t + p_j - p_i}{2t}\right\}. \tag{2}$$

When the prices $(p_1, p_2)$ violate the inequality $|p_1 - p_2| \leq t$, the firm setting the lower price takes the whole contested segment over, while its rival matches the delivered price according to the best price guarantee, managing to keep its captive segment.

To simplify the analysis, by avoiding an excessive number of cases, we impose the following condition on the parameters:

$$1 < \frac{v}{t} < a. \tag{3}$$

The inequality on the left implies that demand for firm $i$ in the contested segment is $y_i = (t + p_j - p_i)/2t < (v - p_i)/t$. Even when the two firms choose the monopoly price $v/2$, the contested segment is covered, so that the two firms actually compete for customers in this segment. As to the inequality on the right, it implies that the quantity that a firm can and will sell in its captive market is equal to demand $x_i = (v - p_i)/t$, for $p_i \leq v$. Even choosing a zero price, each firm faces a demand smaller than its captive segment, so that the aggregate demand $x_1 + x_2 + 1$ is always responsive to price changes.

By summing the demand on the captive and the contested segments, we obtain the potential demand to firm $i$:

$$x_i + y_i = \frac{v - p_i}{t} + \min\left\{\max\left\{\frac{t + p_j - p_i}{2t}, 0\right\}, 1\right\} \equiv D_i(p_i, p_j). \tag{4}$$

The potential aggregate demand is equal to

$$x_1 + x_2 + 1 = D_i(p_i, p_j) + D_j(p_j, p_i) = D(p_1, p_2) = \frac{2v - (p_1 + p_2)}{t} + 1. \tag{5}$$

## 2.2 The price-quantity game

In the *price-quantity game*, each firm $i$ announces a selling order $(p_i, q_i)$, expressing that it intends to sell the quantity $q_i$ at mill price $p_i$, with $0 \leq p_i \leq v$ and $0 \leq q_i \leq 1 + a$. Out of this quantity $q_i$, $x_i = (v - p_i)/t$ is for its captive market and $y_i = q_i - x_i$ is for the contested market. However, when fixing its selling order $(p_i, q_i)$, while anticipating a competitor's selling order $(p_j, q_j)$, each firm should perform a feasibility analysis. Two constraints have to be considered by firm $i$. The first one, related to the potential demand addressing to it in particular, $D_i(p_i, p_j)$, is a *competitiveness constraint* reflecting its comparative price advantage with respect to the competitor's price $(p_j - p_i)$, and with respect to the customers' reservation price $(v - p_i)$. The second constraint, related to the potential aggregate demand, $D(p_i, p_j)$, is a *market feasibility constraint*: the selling orders must be compatible with the market size.

Assuming for simplicity a unit production cost normalized to zero, the profit maximization program of firm $i$ can accordingly be defined as

$$\max_{(p_i,q_i)\in[0,v]\times[0,1+a]} p_i q_i \tag{6}$$
$$\text{s.t.} \begin{cases} q_i \leq D_i(p_i, p_j^*) \\ q_i \leq D(p_i, p_j^*) - q_j^* \end{cases}$$

where $(p_j^*, q_j^*)$ is the anticipated selling order of its competitor. We thus get a non-cooperative game, where the strategies of each firm are selling orders and the payoffs are given by (6). A pair of selling orders $((p_1^*, q_1^*), (p_2^*, q_2^*))$ solving

(6) for each firm simultaneously forms a Nash equilibrium of this game.

Clearly, for each firm $i$, one of the two constraints should bind at equilibrium. Also, the case $q_i^* < D_i(p_i^*, p_j^*)$ for some $i$ with $q_i^* = D(p_i^*, p_j^*) - q_j^*$, as well as the case $q_i^* = D_i(p_i^*, p_j^*)$ for $i = 1, 2$ with $q_i^* < D(p_i^*, p_j^*) - q_j^*$, are eliminated by definition of $D$. Hence, at a Nash equilibrium, both constraints should bind for both firms, so that the market clears: $q_1^* + q_2^* = D(p_1^*, p_2^*)$.[1] If the equilibrium is such that $|p_1^* - p_2^*| < t$, with the two firms sharing the contested segment, then each firm $i$ maximizes its revenue facing a kinked demand curve (with the kink in $(p_i^*, q_i^*)$) defined by the two constraints of (6).

## 2.3 The set of equilibria

First let us observe that the inequality $|p_1^* - p_2^*| < t$ is indeed always satisfied at equilibrium, both firms being active on the contested segment of the market. This can equivalently be expressed in the following lemma.

**Lemma 1** *At an equilibrium* $((p_1^*, q_1^*), (p_2^*, q_2^*))$, $D_i(p_i, p_j^*) = \dfrac{v - p_i}{t} + \dfrac{t + p_j^* - p_i}{2t}$, *for* $p_i$ *close to* $p_i^*$.

**Proof.** Suppose an equilibrium where $y_i^* = 0$ and $y_j^* = 1$, implying

$$P_i\left(p_i^*, p_j^*\right) = p_j^* + t \leq p_i^* = \arg\max_{p_i \in [0,v]} p_i \left(v - p_i\right)/t = v/2$$

(otherwise, firm $i$ would choose a price smaller than $p_j^* + t$). If $p_j^* < v/2 - t$, firm $j$ can choose a higher price and increase its profit. Indeed it would keep

[1] More generally, the market clearing condition may have to be imposed in addition to the Nash equilibrium conditions. See the definition of an "oligopolistic equilibrium" in d'Aspremont, Dos Santos Ferreira and Gérard-Varet (2007).

the whole contested segment and get closer to its monopoly price $v/2$ on its captive segment. Hence $p_j^* = v/2 - t$. The left-sided derivative of $p_i D_i(p_i, p_j^*)$ at $p_i = v/2$ is consequently $-v/4t < 0$, so that firm $i$ has an incentive to decrease its price and penetrate the contested segment. Thus, $y_i^* > 0$ for $i = 1, 2$ and the result follows from the definition of $D_i$. ■

Using this lemma, we can directly derive the first order conditions of the program (6) with the two constraints holding as equalities, and $\lambda_i, \mu_i \geq 0$ the Lagrange multipliers respectively associated with the competitiveness and the market feasibility constraints:

$$\begin{cases} p_i - \lambda_i - \mu_i = 0 \\ q_i + \lambda_i \frac{\partial D_i}{\partial p_i} + \mu_i \frac{\partial D}{\partial p_i} = 0 \end{cases}, \; i = 1, 2. \tag{7}$$

Let us define $\theta_i = \lambda_i / (\lambda_i + \mu_i) \in [0, 1]$, the relative weight of the competitiveness constraint, which can be interpreted[2] as the *competitive aggressiveness* of firm $i$. In such terms, and using $D \equiv D_i + D_j$, conditions (7) lead to:

$$D_i + p_i \frac{\partial D_i}{\partial p_i} + (1 - \theta_i) \, p_i \frac{\partial D_j}{\partial p_i} = 0, \; i, j = 1, 2, \; i \neq j. \tag{8}$$

We thus obtain a system of two equations with the two prices $(p_1, p_2)$ as unknowns and two parameters $(\theta_1, \theta_2)$. A straightforward computation leads to the solution:

$$p_i^* (\theta_i, \theta_j) = \frac{(6 + \theta_j)(2v + t)}{(5 + \theta_i)(5 + \theta_j) - 1}, \; i, j = 1, 2, \; i \neq j. \tag{9}$$

The set of equilibria of the price-quantity game may accordingly be parameterized by the competitive aggressiveness $(\theta_1, \theta_2)$ of the two firms. For each

[2] See d'Aspremont, Dos Santos Ferreira and Gérard-Varet (2007).

value of $\theta$, we shall call $\theta$-equilibrium the corresponding Nash equilibrium of the price-quantity game. Of course, the equations (9) do not ensure that the two firms are both active and together serve the whole contested segment for any pair $(\theta_1, \theta_2)$ in $[0,1]^2$. In order to simplify the analysis for not having to restrict the set of admissible pairs $(\theta_1, \theta_2)$, we rather introduce a further restriction on the parameters in the following proposition.

**Proposition 2** *Assume $3/2 < v/t < 14$. Then, we can associate with any $\theta \in [0,1]^2$ an equilibrium $((p_1^*(\theta), D_1(p^*(\theta))), (p_2^*(\theta), D_2(p^*(\theta))))$, with $p_i^*(\theta)$ given by (9) and $D_i(p)$ as indicated in Lemma 1. Conversely, any equilibrium must satisfy equations (9).*

**Proof.** Equations (9), together with the equalities $q_i = D_i(p)$, $i = 1, 2$, express the profit-maximizing first order conditions. These conditions are sufficient for a global maximum, since the profit to be maximized by each firm $i$ is a quasi-concave function of $(p_i, q_i)$, and the two constraints in (6) define a convex set. Also, as $p_i^*(\theta)$ is decreasing in both arguments, $p_i^*(\theta) \leq p_i^*(0,0) = (2v+t)/4$. For the contested market to be covered when the prices are both equal to this upper bound, we must have $p_i^*(0,0) + t/2 < v$, which is equivalent to $3/2 < v/t$. This condition excludes equilibria where firms are local monopolies in the contested segment. Finally, it is easy to check that the difference $p_i^*(\theta) - p_j^*(\theta)$ is maximized at $\theta_i = 0$ and $\theta_j = 1$, and that $p_i^*(0,1) - p_j^*(1,0) = (2v+t)/29 < t$, provided $v/t < 14$. This condition ensures that both firms are active in the contested segment. Under the assumed parameter restriction, any equilibrium must have both firms active in the contested segment and together serving it completely, so that the converse statement is also proved. ■

In the following, we shall have to refer to the the profit of each firm $i$, $\Pi_i(\theta_i, \theta_j) = p_i^*(\theta_i, \theta_j) D_i\left(p_i^*(\theta_i, \theta_j), p_j^*(\theta_j, \theta_i)\right)$ as a function of $\theta$:

$$\Pi_i(\theta_i, \theta_j) = \frac{(2v+t)^2}{2t} \frac{(2+\theta_i)(6+\theta_j)^2}{((5+\theta_i)(5+\theta_j)-1)^2}. \tag{10}$$

It is easy to check that $\Pi_i$ is decreasing in $\theta_j$, and unimodal with respect to $\theta_i$, with

$$\arg\max_{\theta_i} \Pi_i(\theta_i, \theta_j) = \frac{4+\theta_j}{5+\theta_j} \in \left[\frac{4}{5}, \frac{5}{6}\right]. \tag{11}$$

An increase in the competitive aggressiveness of firm $i$ is associated with a decrease in both prices, but more significant for price $p_i$, hence with an increase in the firm $i$ share of the contested market. Consequently, the profit of firm $j$ can only decrease, whereas there are two opposite effects on the profit of firm $i$. As its competitive aggressiveness increases, the increase in its market share eventually ceases to compensate for its price decrease.

### 2.4 Standard competition regimes as particular cases of equilibrium

The set of equilibria of the price-quantity game contains the outcomes of all standard regimes of spatially differentiated duopolistic competition. Each outcome can thus be associated with a specific pair of degrees of competitive aggressiveness.

### 2.4.1 The polar cases: tacit collusion and price competition

The two polar cases are characterized by the minimum and maximum values of the parameter $\theta_i$ for $i = 1, 2$.

- If $\theta_1 = \theta_2 = 0$ (the competitiveness constraint is ineffective), both firms charge the same price $p^m = (2v + t)/4$, which is the *collusive price* of the duopoly, the one that maximizes the sum of the two profits: $p_1 D_1 + p_2 D_2$ under the market feasibility constraint.
- If $\theta_1 = \theta_2 = 1$ (only the competitiveness constraint binds), both firms charge the same price $p^H = (2v + t)/5$, which corresponds to the *price equilibrium* in the Hotelling pure price competition game.

### 2.4.2 The Cournot solution

The Cournotian firm $i$ chooses the quantity $q_i$ in order to maximize its profit given the anticipated quantity $q_j$ of firm $j$. Using the price formulation, this amounts to solve

$$\max_{(p_i, p_j)} p_i D_i(p_i, p_j) \qquad (12)$$

$$\text{s.t. } D_j(p_i, p_j) = q_j.$$

The Cournot equilibrium prices $(p_1^C, p_2^C)$ are accordingly defined by the first-order conditions

$$D_i + p_i \frac{\partial D_i}{\partial p_i} + \frac{\partial D_i / \partial p_j}{-\partial D_j / \partial p_j} p_i \frac{\partial D_j}{\partial p_i} = 0,\ i, j = 1, 2,\ i \neq j, \qquad (13)$$

and $D_j(p_1^C, p_2^C) = q_j^C$. Comparing with equations (8), we see that equations (13) define the equilibrium of the price-quantity game for

$$\theta_i^C = 1 + \frac{\partial D_i/\partial p_j}{\partial D_j/\partial p_j} = 1 + \frac{1/2t}{-3/2t} = 2/3. \tag{14}$$

### 2.4.3 The Stackelberg equilibria

Take firm 1 as the leader and firm 2 as the follower. Suppose that the firms compete in quantities, and consider the corresponding Stackelberg equilibrium. In this case, the follower behaves as a Cournotian firm solving an optimization program in $q_2$ (given $q_1$), the solution of which is characterized, *independently* of $q_1$, by $\theta_2 = 2/3$ (see equation (14)).

Denote by $\left(\left(p_1^S, q_1^S\right), \left(p_2^S, q_2^S\right)\right)$ a Stackelberg equilibrium outcome. Clearly, it should satisfy, for firm 2, the Cournotian first order condition (8) with $\theta_2 = 2/3$. It should also solve, for firm 1, the problem (6) with $(p_2^*, q_2^*) = \left(p_2^S, q_2^S\right)$. Hence it should satisfy (8) for some $\theta_1$, and so the corresponding profit should be in the set $\{\Pi_1(\theta_1, 2/3) \mid \theta_1 \in [0,1]\}$. Since firm 1 is the leader, the profit should be the highest one, namely (by (11)) $\Pi_1(14/17, 2/3)$. Thus, the Stackelberg quantity equilibrium outcome is seen to coincide with an equilibrium outcome of the price-quantity game, for $\theta^{Sq} = (14/17, 2/3)$.

Now suppose that the firms compete in prices. In this case, the follower faces the sole competitiveness constraint, so that we may characterize the solution to its optimization problem by $\theta_2 = 1$. By a similar argument as above, the Stackelberg price equilibrium outcome coincides with an equilibrium outcome of the price-quantity game, for $\theta^{Sp} = (5/6, 1)$.

We observe that the leader is now in the worst possible position, since the competitive toughness of the follower is at its maximum, whereas the more moderate competitive toughness of the leader benefits more to the follower than to himself. The profit of the follower thus ends up larger than the profit of the leader (as well known in the context of strategic complementarity: see Gal-Or, 1985). This is in contrast with quantity competition, where the leader benefits from the first mover advantage (since $\theta_1^{Sq} > \theta_2^{Sq}$). Moreover, both profits are higher in quantity competition than in price competition (since $\theta^{Sq} < \theta^{Sp}$).

Finally, the Stackelberg equilibrium concept can also be applied to price-quantity strategies. In this case, the leading firm has complete control of the follower's environment, so that it can choose a price-quantity pair entailing the lowest possible competitive aggressiveness of its rival, namely $\theta_2 = 0$. Using the same argument and referring to equation (11), we obtain that the Stackelberg price-quantity equilibrium outcome coincides with an equilibrium outcome of the simultaneous price-quantity game, for $\theta^{Spq} = (4/5, 0)$.

## 3 Strategic choice of managerial aggressiveness

The lesson to be derived from the analysis we have just made of the Stackelberg concept is that the leading firm behavior can be interpreted as the choice of the optimal competitive aggressiveness, given the follower's. In a context of separation between ownership and management, the selection of the manager on the basis of his personality traits, experience or accepted policy orientation is a way for the owners of setting the degree of competitiveness of their firm. Hence, a natural further step in our analysis is to treat the $\theta$ parameters as exogenous in the price-quantity game, and to introduce a preliminary stage where these parameters are chosen strategically.

### 3.1 A reformulation of the price-quantity game

Let us consider the competitive aggressiveness parameters $\theta \in [0,1]^2$ as exogenously given. The modified game, which we shall call the *$\theta$-game*, has the same price-quantity strategies as before and payoffs determined, for each firm $i$, by the program:

$$\max_{(p_i,q_i)} \theta_i p_i q_i + (1-\theta_i)\, p_i\, (D(p_i,p_j) - q_j) \tag{15}$$
$$\text{s.t. } q_i \le D_i(p_i,p_j).$$

In such a game, the higher $\theta_i$ the less firm $i$ cares about the residual demand left by its rival, and the more it concentrates on pure price competition in order to conquer a large market share. Hence, the parameter $\theta_i$ can indeed be seen as the *aggressiveness* factor of firm $i$, actually as an attitude of the manager with respect to his competitor. The following proposition shows that the equilibrium of this game coincides with the equilibrium of the previous game characterized by the same value of $\theta$.

**Proposition 3** *For $\theta = (\theta_1,\theta_2) \in [0,1]^2$, the $\theta$-equilibrium of the price-quantity game coincides with the equilibrium of the $\theta$-game.*

**Proof.** Relations (8), associated with some value of $\theta$, are exactly the first order conditions of the program (15) of the corresponding $\theta$-game. By the concavity of the objective function and the linearity of the constraint, these first order conditions are sufficient for a global maximum. ■

## 3.2 The delegation game

Adopting a delegation point of view, we may consider each $\theta$-game as a subgame in a two-stage game requiring, in a first stage, that the owners of each firm $i$ hire a manager with aggressiveness $\theta_i$.[3]

The first stage game has the owner of each firm $i$ choosing a strategy $\theta_i \in [0,1]$, and leads to the payoffs $\Pi_i(\theta_i, \theta_j)$, $i = 1, 2$, as defined in (10). Computing the Nash equilibrium at this stage, characterized by $\frac{\partial \Pi_1}{\partial \theta_1} = \frac{\partial \Pi_2}{\partial \theta_2} = 0$, gives $\hat{\theta}_1 = \hat{\theta}_2 = 2\left(\sqrt{2} - 1\right) \simeq 0.828$. Thus, when competing in aggressiveness, firms are led to a (subgame perfect) equilibrium outcome between Cournot and Hotelling, since $\theta_i^C < \hat{\theta}_i < 1$, with a profit $\Pi_i\left(\hat{\theta}\right)$ lower than the Cournot (quantity competition) profit but higher than the Hotelling (price competition) profit.

[3] The structure of our formulation is closely related to the Industrial Organization literature on managerial incentives, under separation of ownership and control. This literature resorts however to single strategic variables (either quantities or prices), and introduces other payoff functions to be maximized by managers. These functions are convex combinations of either the firm profit and revenue (Fershtman and Judd, 1987, and Sklivas, 1987) or of both firms profits (Miller and Pazgal, 2001).

### 3.3 The impact of environmental hostility

We have heretofore assumed uniformity of travel costs per unit of length in the captive and contested market segments. Domestic and foreign travel conditions can however differ, sometimes quite sharply. More generally, if we take an abstract view of the characteristics space, beyond its strict geographical interpretation, a decrease, say, in the travel cost $t \in (0, v)$ in the sole contested market appears as a convenient way to make the two products more substitutable, and hence to increase the intensity of competition, independently of any autonomous change in competitive aggressiveness. Also, we may decrease the size of the captive market segments relative to the contested segment, and hence increase the degree of firms exposure to competition, by simply increasing the travel cost $t' \in (v/a, \infty)$ in the former (for simplicity, we will continue to refer to a symmetric game). In both cases, by changing $t$ or $t'$ we are simply modifying the environment of both firms, making it more or less hostile according to the variation of the ratio $t/t'$ we are considering, whether a decrease or an increase, respectively.

A simple inspection of equation (4) suggests that the modified potential demand to firm $i$ is

$$D_i(p_i, p_j) = \frac{v - p_i}{t'} + \min\left\{\max\left\{\frac{t + p_j - p_i}{2t}, 0\right\}, 1\right\}. \tag{16}$$

It is easy to check that Lemma 1 still applies, and that we may continue to use first order conditions (8), leading to

$$p_i^*\left(\theta_i, \theta_j\right) = \frac{\left(2 + 4t/t' + \theta_j\right)\left(1 + 2v/t'\right)}{\left(1 + 4t/t' + \theta_i\right)\left(1 + 4t/t' + \theta_j\right) - 1} t,\ i, j = 1, 2,\ i \neq j. \tag{17}$$

As before, the prices are decreasing with the aggressivenesses of both competitors. They are also decreasing with the environmental hostility, assessed here in terms of the (exogenous) intensity of competition, as measured by the inverse of the ratio $t/t'$. The argument in the proof of Proposition 1 can again be used to establish the same result, if we now assume, more generally, that

$$1+\frac{1}{2\,(t/t')}<\frac{v}{t}<6+8\,(t/t')\,. \tag{18}$$

Finally, from profit $\Pi_i$ to be maximized in $\theta_i$,

$$\Pi_i\left(\theta_i,\theta_j\right)=\left(\frac{\left(2+4t/t'+\theta_j\right)\left(1+2v/t'\right)}{\left(1+4t/t'+\theta_i\right)\left(1+4t/t'+\theta_j\right)-1}\right)^2\frac{2t/t'+\theta_i}{2}t,\; i=1,2,\; i\neq j, \tag{19}$$

and by computing the corresponding first order condition, we derive the reaction function of firm $i$ in the delegation game:

$$\theta_i=\frac{4t/t'+\theta_j}{1+4t/t'+\theta_j},\; i=1,2,\; i\neq j. \tag{20}$$

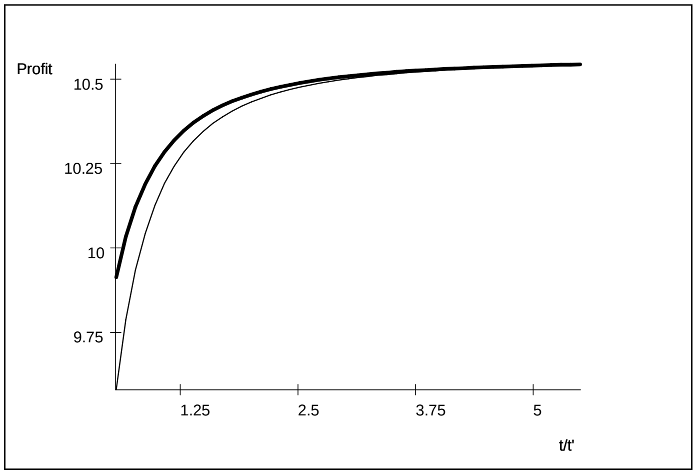
We observe that the degrees of competitive aggressiveness are strategic complements in the delegation game. Besides, the aggressiveness of any firm decreases with the environmental hostility, for a given level of the rival's aggressiveness. Because of strategic complementarity, this effect is of course reinforced at the equilibrium values:

$$\widehat{\theta}_i=2\sqrt{t/t'}\left(\sqrt{1+t/t'}-\sqrt{t/t'}\right),\; i=1,2. \tag{21}$$

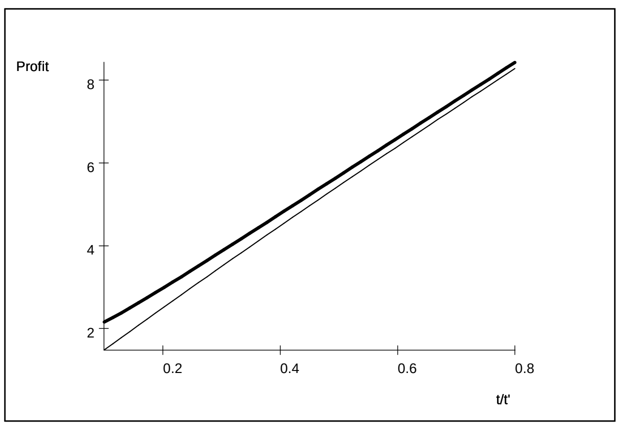
The equilibrium value $\widehat{\theta}_i$ of the aggressiveness factor is an increasing function of the ratio $t/t'$ of the travel costs in the two market segments. As this ratio decreases, the environment of both firms becomes more hostile, triggering the compensating effect of a decrease in competitive aggressiveness.

The way the decrease in the ratio $t/t'$ comes about (through a fall in $t$ or through a rise in $t'$) is indifferent as concerns the equilibrium value of the aggressiveness factor, although not as concerns equilibrium prices and profits, since changes in $t$ and in $t'$ do not work exclusively through the ratio $t/t'$ in this case. From the point of view of our discussion in this paper the significant point is however that in both cases the adjustment of the degree of competitive aggressiveness to a more hostile environment moderates the profit decline generated by the fall in the ratio $t/t'$. We illustrate this effect in the two following figures, where thick curves represent, for different values of the ratio $t/t'$, the equilibrium profits of the delegation game, whereas thin curves represent the equilibrium profits of the pure price competition game (the one associated with $\theta = (1, 1)$).[4]

[4]We use the parameter values $v = 6$ and, either $t' = 1$ and variable $t$ (in Figure 2), or $t = 1$ and variable $t'$ (in Figure 3). According to (**??**), we must assume $0.57 < t < 5.5$ in the former case, and $t' < 10$ in the latter.




Changes in product differentiation




Changes in the captive market size

The moderating effect of the aggressiveness factor adjustment slows down the profit decline as the two products become more and more substitutable in the contested market (Figure 3), or as captive markets shrink (Figure 4).

Thus, this effect countervails the immediate influence of a more hostile environment on the competition prevailing at the second stage of the delegation game: an increase in environment hostility (as product differentiation diminishes or as the captive market segments shrink) may induce a cut-throat competition with a profit squeeze for both firms, principally if the degree of competitive aggressiveness is at its maximum (that is, if competition is exclusively in prices). Anticipating such a detrimental price war leads the firms to adjust their degrees of aggressiveness to a lower level, in contradiction to the conventional wisdom claiming that tough guys should be drafted when the battlefield is under fire.

From an empirical point of view, the influence of environmental hostility on the relationship between firm performance and competitive aggressiveness has been extensively considered in the literature with differing results (Covin and Covin, 1990, Miles, Arnold and Thompson, 1993, Slater and Narver, 1994, McGee and Rubach, 1996/97, Lumpkin and Dess, 2001, Papadakis & Barwise, 2002, among others). In these studies, though, the hostility of a firm environment includes the agressiveness of its competitors. Therefore, a positive correlation between environmental hostility and competitive aggressiveness of a firm might be largely due to its strategic complementarity with its rivals. One of the messages of our approach is that competitive aggressiveness is a feature of each firm conduct, and should be separated from structural characteristics of the industry such as the hostility of the environment (limited in our model to the degree of product substitutability and the degree of exposure to competition). An interesting relationship to investigate empirically would be that of equilibrium competitive aggressiveness with environmental hostility as a structural feature.

## 4 Concluding remarks

In this paper competitive aggressiveness has been analyzed in a simple oligopolistic model *à la* Hotelling, where each one of two firms supplies two connected market segments, a captive segment and a contested segment. It is argued that the entrepreneurial orientation of each firm can be rationalized in terms of a profit maximizing objective. Two explanations are proposed. The first simply assumes that firms maximize profit subject to a preliminary feasibility analysis addressing both the customer side and the competitor side. The competitive aggressiveness of each firm is then endogenous and may be taken as a parameter to characterize the set of equilibria. The second explanation treats competitive aggressiveness as an exogenous variable under the control of each firm through its manager hiring decision. Thus, in a preliminary stage, firms choose their managerial aggressiveness, which is finally determined in the subgame perfect equilibrium of the game. When competition is exogenously intensified through higher product substitutability or through increased weight of the contested market segment, firms compensate at equilibrium for the weaker profitability induced by the more competitive environment by hiring less aggressive managers. Rather hire a dove than a hawk when the wind is rising.

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