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Abstract. In this paper we study the role of market competitiveness in a strategic delegation game in which owners delegate output decisions to managers interested in the firm's relative performance. In particular we study how the optimal delegation scheme - i.e. the distortion from pure profit maximization - is affected by market concentration and the elasticity of market demand. We show that these two indexes of market competitiveness do not alter managerial incentives in the same way: while the optimal degree of delegation decreases as the market becomes less concentrated, it increases as demand becomes more elastic.

Keywords: Strategic delegation, relative performance, oligopoly, isoelastic demand.

JEL Classification: D43, L13, L21.

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1. Introduction

Models of strategic delegation deal with the design of optimal delegation contracts offered by owners on a take-it-or-leave-it basis to managers, in order to motivate them to pursue a strategic advantage on the market. Indeed, the key feature of this approach has to be found in the strategic use of these contracts, which allows owners to benefit from committing - through delegation - to a non profit maximizing behaviour. The literature in the field builds on the ideas put forth by Vickers (1985), Fershtman and Judd (1987) and Sklivas (1987). In their theoretical framework market decisions are taken by managers according to the received delegation that defines the structure of their objective function, while owners optimally choose this structure by taking into account the strategic interactions at the market stage. Managers are implicitly assumed to be compensated according to their assigned objective function, so that the choice of the latter can be interpreted as a choice of an incentive compatible managers' compensation scheme. In the presence of such an incentive structure, the agency problem generated by the separation of ownership and management, is assumed to be overcome.

By recognizing the strategic nature of interactions between owners and managers, rivalry among firms is described both with respect to product market competition and to competition in the managerial delegation schemes. In the standard two-stage delegation game, each firm's owner delegates the product market decisions taken in the second stage to a manager, whose objective function is a linear combination of profits and another variable of interest for the manager (revenues, output, market share, relative performance, etc.). The weight to be given to this additional variable is strategically decided by profit-maximizing owners in the first stage. An interesting property of this game is that at equilibrium owners decide to allow the managers to deviate from pure profit maximization by giving a non-zero weight to the additional variable in their objective function. The rationale behind this result can be traced back to the incentives perceived by the owners at the market stage. Though at the standard Nash equilibrium each firm maximizes its profits given the choice of the rivals, at that equilibrium each firm would benefit from appropriately altering the rivals' decisions. Firms may pursue this aim through a commitment to distort their own decision, and may implement this strategy by optimally defining the extent of deviation from profit maximization allowed to their manager.

In this paper, strategic delegation is addressed in a framework in which the manager's variable of interest, entering the objective function and the compensations scheme in combination with own profits, is the relative performance of the firm with respect to its rivals. Both the economic and management literature have deeply analyzed the heterogeneity of motives which characterize managerial behaviour and basically entail the achievement of objectives other than pure profit-maximization. Within this large body of literature, managers objectives are more commonly formulated in terms of sales or output maximization;[1] recently, however, managerial attitudes towards relative performance have received increasing attention.[2]

Relative profits maximization has been argued to be plausible under several hypotheses. In an evolutionary perspective it has been considered as a more likely behaviour compared to profit maximization, since it generates market outcomes which are stable in an evolutionary sense.[3] Paradigms of managerial economics suggest that the preference for differential profits may be the rational choice of managers whose remuneration and prestige depend on the relative performance of their firm. The idea that the managers' objective function can be a combination of own and rivals' profits characterizes the papers by Lundgren (1996) – in which the weight given to relative profits affects the incentives to collusion – and by Palomino (2005) – where this weight affects the riskiness of managers' investment strategy in the financial market. In the literature on strategic delegation, where the distortion from profit maximization and its size are endogeneized, relative profits first appear in the work by Salas-Fumas (1992), who explicitly frames the strategic delegation decisions within a typical principal-agent problem. Miller and Pazgal (2001) demonstrate that when the optimal delegation contract embodies a relative performance variable, price and quantity competition turn out to be equivalent. The same authors (Miller and Pazgal, 2002) consider the strategic value of the owners' delegation choice in several competitive environments; they assume managers characterized by predetermined attitudes towards relative performance and interpret the strategic delegation choice as the choice to hire a manager with a certain attitude.

[1] Delegation contracts rewarding managers on the base of a linear combination of profits and revenues are considered in Fershtman and Judd (1987) and Sklivas (1987), while a combination of profits and output is found in Vickers (1985). Jansen et al. (2007) propose a delegation model based on profits and market shares.

[2] The structure of different compensation contracts, namely the schemes based on sales, market shares or relative profits, are analyzed in Manakis et al. (2007) who endogenize the choice of the type of contract, thus identifying the most profitable scheme.

[3] According to this approach, validated both in a static framework (Shaffer, 1989) and in a dynamic one (Vega-Redondo, 1997), a market selection process leads firms with the highest profit to survive in the market.

Some empirical (Aggarwal and Samwick, 1999) and experimental (Georgantzìs et al, 2008) evidence on the role of relative performance in firms' choice has also been provided.

Within the above framework of strategic delegation with relative performance, this paper investigates an issue mostly neglected in the literature, namely the determinants of the size of the distortion from the profit maximization procedure chosen by owners. In particular, we concentrate on market fundamentals and aim at studying how market competitiveness affects the optimal degree of strategic delegation, i.e. the weight of the relative performance variable. We develop our analysis in an oligopolistic quantity competition framework, and explore how the optimal delegation schemes are influenced by some of the key factors underlying market competitiveness – namely market concentration and the elasticity of market demand. Our main result is that there is no univocal relationship between the degree of market competitiveness and the size of the delegation parameter: while an increase in the number of firms is associated to a lower weight placed on rivals' performance, an increase in demand elasticity generates an increase in the strategic delegation parameter.

The paper is organized as follows. In the next section, by assuming a constant elasticity demand function, we obtain an explicit solution of the two-stage delegation game as a function of the number of firms and the elasticity of market demand. In the third section we analyze the properties of this Sub-game Perfect Nash Equilibrium, and discuss the role of market concentration and demand elasticity in defining the optimal structure of managerial incentives. A final section concludes.

2. The two-stage delegation game

We consider a market where n identical firms produce a homogenous product and compete over quantities. We discuss a two-stage strategic delegation game characterized as follows. At the second stage, the quantity decisions are taken by the managers of the firms, whose objective function includes both the firm's own profits and those of the rivals. At the first stage, each owner strategically sets the weight of rivals' profits in the objective function of her manager.

Therefore, at the second stage of the game, for each firm *i* the manager maximizes the following objective function:[4]

$$M_i = \pi_i - a_i \sum_{k \neq i} \pi_k$$

where π_i denotes the firm's own profits, and $\sum_{k \neq i} \pi_k$ denotes the sum of the rivals' profits. The weights a_i are chosen by the owners at the first stage.

We assume that the market demand faced by managers at the market stage is isoelastic so that

$$P(Q) = Q^{-1/\eta} \qquad \eta > 1$$

where $Q = \sum_{i=1}^{n} q_i$ and the restriction on η guarantees that the reaction functions are well-defined for all conceivable values of the parameters and the rivals' choices. All firms share the same linear cost function, with constant average and marginal cost *c*. The game is solved by backward induction.

At the market stage, the reaction function of the generic firm *i* can be written as:

$$(Q_{-i} + q_i)^{-\frac{1+\eta}{\eta}} q_i - (Q_{-i} + q_i)^{-\frac{1+\eta}{\eta}} a_i Q_{-i} - (Q_{-i} + q_i)^{-\frac{1}{\eta}} \eta + c\eta = 0 \qquad (1)$$

where $Q_{-i} = \sum_{j \neq i} q_i$.[5]

Substituting $Q_{-i} = Q - q_i$ in (1) and multiplying by $Q^{\frac{1+\eta}{\eta}}$, we can rewrite the reaction function in terms of the firm's market share:

$$s_i = \frac{1}{1 + a_i}\left(a_i + \left(1 - cQ^{1/\eta}\right)\eta\right) \qquad i = 1,\ldots,n$$

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[4] It can be shown that this objective function is equivalent to $M_i = (1 - a_i)\pi_i + a_i\left(\pi_i - \sum_{k \neq i} \pi_k\right)$, i.e. to a linear combination of the firm's profits and the difference between own the firm's profits and the profits of the rivals.

[5] The Second Order Conditions are verified for all values of a_i.

where $s_i = q_i/Q$. Since $\sum_{i=1}^{n} s_i = 1$, we get:

$$\sum_{i=1}^{n} \frac{a_i}{1+a_i} + \eta \sum_{i=1}^{n} \frac{1}{1+a_i} - c\eta Q^{\frac{1}{\eta}} \sum_{i=1}^{n} \frac{1}{1+a_i} = 1$$

which we can solve for Q, obtaining the full solution of the market stage:

$$Q^* = \left(\frac{\sum_{i=1}^{n} \frac{a_i}{1+a_i} + \eta \sum_{i=1}^{n} \frac{1}{1+a_i} - 1}{c\eta \sum_{i=1}^{n} \frac{1}{1+a_i}} \right)^{\eta} \tag{2}$$

$$P^* = \left(\frac{c\eta \sum_{i=1}^{n} \frac{1}{1+a_i}}{\sum_{i=1}^{n} \frac{a_i}{1+a_i} + \eta \sum_{i=1}^{n} \frac{1}{1+a_i} - 1} \right) \tag{3}$$

$$q_i^* = \left(\frac{\eta + a_i}{1+a_i} - \frac{c\eta}{1+a_i} \left(\frac{\sum_{i=1}^{n} \frac{a_i}{1+a_i} + \eta \sum_{i=1}^{n} \frac{1}{1+a_i} - 1}{c\eta \sum_{i=1}^{n} \frac{1}{1+a_i}} \right) \right) Q^* \tag{4}$$

It is straightforward to verify that when for all i the weight a_i is equal to zero, this solution coincides with the traditional Cournot solution under constant elasticity of demand.

In the sequel it is useful to rewrite the solution (2), (3) and (4) as follows:

$$Q^* = \frac{\left(\Psi + \Psi a_i + \eta + \eta\Omega_i + \eta\Omega_i a_i - 1\right)^{\eta}}{\left(1 + \Omega_i + \Omega_i a_i\right)^{\eta} \eta^{\eta} c^{\eta}} \tag{5}$$

$$P^* = \frac{\left(1 + \Omega_i + \Omega_i a_i\right)\eta c}{\Psi_i + \Psi_i a_i + \eta + \eta\Omega_i + \eta\Omega_i a_i - 1} \tag{6}$$

$$q_i^* = \left(\frac{1 - \Psi_i + \Omega_i a_i}{1 + \Omega_i + \Omega_i a_i} \right) Q^* \tag{7}$$

where $\Omega_i = \sum_{j \neq i} \frac{1}{1+a_j}$ and $\Psi_i = \sum_{j \neq i} \frac{a_j}{1+a_j}$. By defining the profit functions of the owners on the basis of (5), (6) and (7), we can now turn to the solution of the first stage of the game, in which the owners, through their choice of the a_i's, determine the optimal structure of the managers' objective function (compensation scheme). At this delegation stage, the reaction function of firm *i* (in implicit form) is:

$$\eta(1+\Omega_i a_i - \Psi_i)\left[(\Psi_i + \Omega_i)(1+a_i)\right] + \Omega_i\left[\Psi_i(1+a_i) - 1\right]\left[(\eta\Omega_i + \Psi_i)(1+a_i) + \eta - 1\right] = 0$$

Under symmetry, for all i, $a_i = a$, $\Omega_i = \Omega = (n-1)/(1+a)$ and $\Psi_i = \Psi = a(n-1)/(1+a)$. Solving the above reaction function under these restrictions, we obtain the symmetric Nash Equilibrium at the delegation stage:[6]

$$a^*(\eta, n) = \frac{(n-1)(2-\eta n) - 2\eta + \sqrt{\eta n^2(\eta n(n-2) - 4 + 5\eta)}}{2(n(n-2) + \eta + 1)} \tag{8}$$

The specification of the market demand and cost functions are such that the optimal delegation parameter, i.e. the sensitivity of the compensation scheme to the rivals' performance, can be expressed as a function of the elasticity of market demand and the number of firms, while the parameter of the cost function is irrelevant. Moreover, it can be checked that $0 < a^* \leq 1$: consistently with the strategic substitutability which characterizes the quantity stage at equilibrium, the owners induce their managers to behave more aggressively than they would under profit maximization.

3. Market competitiveness and the optimal structure of managerial incentives

In the above model with homogeneous products, market competitiveness is univocally defined by market concentration – i.e., the number of firms – and the elasticity of market demand. Therefore, the analysis of the properties of the function $a^*(\eta, n)$ gives an exhaustive

[6] It can be checked that the SOCs are satisfied at (8). Following Miller e Pazgal (2002, p.55) we rule out an additional solution, which implies that the weight given to the rivals' profits is higher than that of the firm's own profits.

picture of the way in which the degree of market competition affects the structure of incentives that owners find optimal to provide to their managers.

Consider first the role of market concentration. In this context, the case of duopoly deserves particular attention. Indeed, if only two identical firms are active in the market, their reaction functions at the delegation stage coincide perfectly, so that the symmetric solution (8) is just one of a continuum of equilibria.[7] The equilibrium pairs $(a_1*(\eta,2),0)$ and $(0,a_2*(\eta,2))$ at the extremes of the reaction function entail an output choice which coincides with the outcome of a Stackelberg model in which each firm alternatively takes the role of leader or follower. These findings extend to the constant elasticity case the indeterminacy result obtained by Miller and Pazgal (2002) with a linear demand function – indeed, this indeterminacy stems from the adoption of the relative performance approach in a homogeneous product framework.[8]

As the number of firms increases, however, this indeterminacy disappears, and (8) emerges as the unique solution of the delegation stage. Figure 1 describes the pattern of a^* as a function of n for different values of the elasticity of demand, starting from the symmetric equilibrium in the duopoly case.

---------- Insert Figure 1 about here ----------

It is worth noting that, for any given value of η, the pattern of the delegation parameter is not monotone: indeed, a^* increases when moving from a duopoly to a triopoly and then monotonically decreases for $n \geq 3$.

This non-monotonic behaviour suggests that a tougher competition induced by a lower market concentration reduces the optimal deviation from the pure profit maximization procedure, provided that the degree of competition in the market is sufficiently high.[9]

[7] Notice however that for all possible solutions of the delegation stage a unique solution exists for the market stage. Total profits and production in the industry are constant for all combinations of the delegation parameters along the overlapping reaction curves which are distinguished only by a different distribution of quantities and profits between the two firms.

[8] In Miller and Pazgal (2002) the optimal value of the delegation parameter chosen by the firm when the rival maximizes profits is equal to one - implying the maximization of profit differential. In our case the optimal value turns to be significantly lower than one (e.g., for η = 1.3 the delegation parameter a^*=0.193) with a lower weight attached to rival profits in managers' evaluation.

[9] A similar non-monotonic behaviour of the delegation parameter with respect to market concentration is obtained in Chirco et al. (2008) in a sales-based model of strategic delegation.

However, since a unique equilibrium exists only when at least three firms operate in the market, it is natural to focus on the negative relationship between a^* and n arising from this point onwards. In the limit, as the number of firms n tends to infinity, the weight attached to the rivals' profits tends to zero, i.e. each owner optimally chooses a delegation and compensation scheme exclusively based on own profits.

Let us now consider the pattern of the optimal delegation parameter as a function of the elasticity of demand. This is shown in Figure 2, where it is depicted for different values of n.

---------- Insert Figure 2 about here ----------

It can be noticed that when market demand becomes more elastic, the incentive given to managers to act on a relative performance basis is stronger: a^* is monotonically increasing in η for all n. When market elasticity approaches infinity, the delegation parameter tends to a positive value. Indeed, in the limit, owners decide to give a non-zero weight to the additional variable in the managers' objective function. This implies that as η tends to infinity the sub-game perfect equilibrium quantities do not converge to the Cournot profit-maximizing equilibrium quantities.[10] This behaviour of a^* is in line with the result obtained by Aggarwal and Samwick (1999) in the framework of a duopoly model with product differentiation. By using a relative performance approach to the delegation game, they prove that a positive relation exists between the delegation parameter and the index of product substitutability.

Therefore, the solution of the model shows that market competitiveness does not influence in the same direction the design of the incentive schemes offered to managers. When the environment faced by the firms becomes more competitive because a larger number of firms face the same market demand, owners strategically choose to put a lower weight on the rivals' profits. Conversely, when competitiveness in the market increases because market demand becomes more elastic, firms tend to motivate more strongly their managers towards the relative performance. The 'demand' component and the 'market concentration' component of the Lerner index of monopoly power do not have the same qualitative impact on firms' delegation decisions.

[10] For example, when $n = 3$ for $\eta \to \infty$ the limit quantity produced by each firm under profit maximization is $(1/3)e^{(-1/3)} = 0.23884$; the quantity produced under the optimal strategic delegation is $(1/3)e^{-2\sqrt{2}+3} = 0.39572$.

The intuition behind this counter-intuitive result can be sketched as follows. At the standard Nash equilibrium the owners of the firms perceive an incentive to change their own decision rules, in order to manipulate the rivals' choices. In our Cournot-type model the incentive is to adopt a more aggressive decision rule, in order to induce the rivals to produce less. Owners respond to this incentive by assigning their managers an objective function which embodies both profits and an additional variable – here the rivals' profits – the latter with an appropriate weight. Clearly, both the strength of the initial incentive to change the decision rule, and the value of the additional variable through which this change is realized, are shaped by market fundamentals – the weight given to this additional variable being a sort of 'balancing instrument' between the two. As market becomes more competitive, the incentive to strategically manipulate the rivals' decisions decreases; at the limit, both with $n \to \infty$ and with $\eta \to \infty$, this incentive vanishes. However the choice of the delegation parameter is tied to the behaviour of the incentive *vis à vis* that of the additional variable included in the managers' objective function. If the latter decreases more slowly than the incentive to delegate, the convergence to pure profit maximization is realized through a progressive reduction of the delegation parameter; on the contrary, when the additional variable decreases at a faster rate than the incentive, then the delegation parameter must progressively increase to ensure that the incentive is appropriately matched. According to this intuition, n and η have a different effect on the delegation parameter because they change the incentive to delegate and the rivals' profits at a different *relative* rate.

4. Conclusions

In this paper we study the market determinants of the optimal structure of managerial incentives in a strategic delegation framework. In particular, we investigate how market competitiveness, as measured by market demand elasticity and by the number of firms, shapes the incentives given by owners to managers interested in relative performance. We show that market concentration and demand elasticity do not alter managerial incentives in the same way: on the one hand, an increase in market competitiveness determined by a higher elasticity of market demand is associated with a higher weight attached to the rivals' profits; on the other hand, when lower market concentration makes markets more competitive, the value of the weight put on the rivals' profits tends to decrease.

This result seems at odds with the idea that as the market becomes more competitive, one should always observe a sort of convergence to pure profit maximization. Our analysis clarifies that this is actually the case only if 'convergence to profit maximization' means convergence to the same level of profits obtained under pure profit maximization; but this is not necessarily the case if it means convergence to a pure profit maximization procedure. As η increases, the level of profits earned by firms at the optimal strategic delegation equilibrium actually converges to the standard Cournot level; but this is not the outcome of a convergence in the decision rules and in the quantity choices. Rather, as η increases the degree of delegation turns out to be higher, and so does the related distortion in the quantity decisions. Even in the limit, when $\eta \to \infty$, a positive gap persists between the quantity chosen by the managers and that associated to pure profit maximization. In this sense, the observed convergence in the level of profits is not due to a reshaping of managerial incentives towards profit maximization; it occurs even in the presence of a high degree of strategic delegation, as the obvious consequence of price tending to marginal cost in both cases. The analysis is much simpler when stronger market competitiveness derives from a decrease in market concentration. In this case we observe a full convergence to a profit maximization decision rule.

As a final remark we notice that throughout this paper we have defined market competitiveness in terms of exogenous parameters. An extension to be included in the research agenda may regard the analysis of the delegation choices when firms' entry is endogenous. In a strategic framework, this line of research could also shed light on the relationship between delegation and market structure when the latter is not defined by a given number of firms, but rather determined by the firms' conduct.

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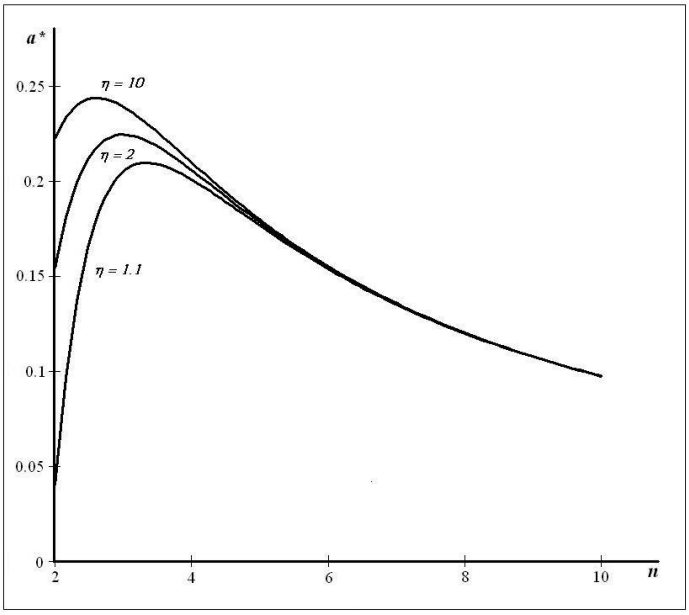

Figure 1. The pattern of a^* and the number of firms

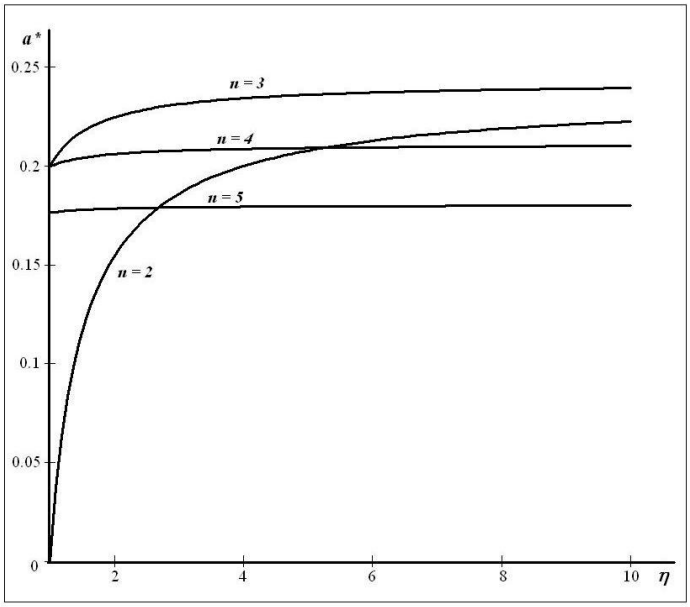

Figure 2. The pattern of a^* and the elasticity of market demand