Entry Deterrence and Strategic Delegation

Xavier Wauthy
Fonds National de la Recherche Scientifique
IRES, Université catholique de Louvain

November 1997

Abstract:
We consider a game in which firms' owners assign to their managers a delegation scheme weighting profits and market shares. Managers then compete in quantities. We show first that this delegation scheme typically leads to quantities being strategic substitutes or complements depending on firms relative size. Second we consider a game of entry and show that the incumbent may achieve entry deterrence using this delegation scheme. When entry is deterred, the incumbent acts as a pure monopolist. .

keywords: entry deterrence, market shares, strategic delegation
JEL Classification: L13, L22

1/ Introduction

Several recent papers (i.a. Fersthman and Judd (85), Sklivas (87), Basu (95)) put forward the idea that managerial delegation could be used as a strategic device in oligopoly competition. These papers assume that the objective function assigned to the manager combines profits and sales maximization and provide a rationale for such a delegation scheme: Owners find it profitable to assign to managers an objective which departs from standard profit maximization because this contract has a commitment value in the competition game to follow. For instance, Basu (95) shows that Stackelberg leadership can be made endogenous using this framework.

The present paper shares many of the ideas of these authors. Indeed, we also consider a delegation game in which firms' owners and managers may sign a contract in a first period, whose terms are common knowledge in a second period where market competition takes place. However, we consider the case where the contract involves a compensation scheme for the manager which places a positive weight on the level of the firm's market share, instead of sales.

Many theoretical models have been developed recently in order to explain why firms should care about market shares. More precisely, we would like to explain why firms seem to compete for market shares, beyond the level that could be explained by short run profit maximization. The switching cost literature (Klemperer (95)) or the literature on network externalities (Katz and Shapiro (85)) emphasizes the role of present market shares as a determinant of future profits. Caminal and Vives (96) shows that in a context of imperfect information about products' quality, a large market share can signal a high quality. In this case, "the interest of firms in market share then arises from the informational value attached to market shares by consumers."[1].More generally, it could be argued that market shares are a better indicator of managers' performance relative to competing firms. Indeed, absolute sales levels may decrease or increase simply because of demand fluctuations. In the present note market shares do not have any specific economic value, i.e. they do not influence the shape of industry demand. However, market shares matter because they have a strong commitment value when the firm delegates management.

Our main results are the following: First, under our delegation scheme, quantities are strategic complements (in the sense of Bulow, Geanakoplos and Klemperer (85)) when

[1]Caminal and Vives, p.222

the firm is largely dominant and strategic substitutes otherwise, even though quantities are strategic substitutes in the standard Cournot framework. In other words, our delegation scheme tends to yield non-monotonic best best replies in the quantity game. Second, this delegation scheme can be used by an incumbent firm as an entry deterrence mechanism. Moreover, when entry is deterred the monopoly outcome is preserved.

The note is organized as follows. In section 2 we consider the implications of our delegation scheme for the behaviour of the firm in a quantity game. Section 3 is devoted to the analysis of the entry deterrence game. Section 4 concludes.

2/ Market Share Incentives and Cournot Competition

Let us consider a symmetric Cournot game between n firms. For simplicity, we assume that marginal costs are constant and normalized to 0. Let $p(Q)$ denote the inverse demand for the homogeneous product, which is assumed to have all of the standard properties for quantities being strategic substitutes in the Cournot game, i.e. $p(Q)$ is decreasing and concave. Moreover, we assume that $p(0)$ is finite.

Delegation from the owner to the manager takes the form of a contract specifying the wage of the manager. We assume that the contract is designed so that the manager is led to maximize the following objective function: $O_i(q_i) = \pi_i(q_i, Q_{-i}) + \beta \mathrm{s}_\mathrm{i}$ where $\mathrm{s_i} = \frac{\mathrm{q_i}}{\Sigma_j q_j}$ and $\beta \geq 0$. Thus, the contract specifies a wage schedule which is linear in $O_i(q_i)$. We assume a competitive market for managers. Therefore, in equilibrium, the manager must recieve his reservation wage. There is no asymmetric information between the owner and the manager. Contracts are signed and become public knowledge before quantity competition takes place. These assumptions are restrictive but fairly standard in the literature on strategic delegation .[2]

Given the incentive scheme described above, the behaviour of firm i's manager in the Cournot game is captured by the first order condition on $O_i(q_i)$. Straightforward computations yield equation (1):

$$\frac{\partial O_i}{\partial q_i} = p(.) + q_i \frac{\partial p(.)}{\partial q_i} + \beta \frac{Q_{-i}}{(q_i + Q_{-i})^2} = 0 \qquad (1)$$

Note that the second order conditions are satisfied for any demand function satisfying them in a standard Cournot game. The following comments are in order. First, equation

[2]In particular , these assumptions are those made in Fersthman and Judd (87), and Basu (95). See Fershtman, Judd and Kalai (1991) on the importance of contracts' observability.

(1) implicitely defines the best reply of firm i against the quantity of the opponents Q_{-i}. Let us denote by $\phi_i(Q_{-i})$ the explicit solution of equation (1). Since the last term in the expression is positive, it is obvious that the best reply of firm i must involve a larger quantity under market share delegation than in the standard Cournot game. Second, note also that the best reply against $Q_{-i}=0$ is the monopoly output. *This is in sharp contrast with the approach of Fershtman and Judd (87) where strategic delegation implies larger output even in the monopoly case.* Finally, and more interestingly, it is easy to see that the sign of $\partial\phi_i(.)/\partial Q_{-i}$ is indeterminate. Using the implicit function theorem, it is straightforward to show that the best reply's slope is positive whenever equation (2) is satisfied.

$$\frac{\partial\phi_i}{\partial q_i}>0 \Leftrightarrow \left(\frac{\partial p(.)}{\partial Q_{-i}}+q_i\frac{\partial p(.)}{\partial q_i \partial Q_{-i}}\right)(q_i+Q_{-i})^2+\beta(q_i-Q_{-i})>0 \tag{2}$$

Thus, the assumptions made on the demand function in order to ensure that quantities are strategic substitutes in a standard Cournot game, i.e. the first term in inequality (2) is negative are not sufficient in the present setting. It is indeed obvious that if $q_i-Q_{-i}>0$, a sufficiently large β will result into a positive slope for firm i 's best reply. This result is summarized in the following proposition.

> **Proposition 1:** *In an industry where quantities are strategic substitutes under standard Cournot competition, the best reply of a delegating firm using $O_i(q_i)$ is not monotone: quantites are strategic complements when the firm is largely dominant and strategic substitutes otherwise.*

Thus, under the incentive scheme $O_i(q_i)$, the manager of a largely dominant firm is likely to adopt an agressive behaviour and thus likely to fight for market shares against small competitors. This result is quite intuitive. Moreover, it suggests that such a delegation scheme could be used by the owner of an incumbent firm as a strategic device to deter entry. Indeed, since the incumbent is by definition dominant before entry takes place, the manager is less likely to accomodate entry given $O_i(q_i)$. This issue is studied in the next section by mean of an example.

3/ The Entry Deterrence Game

In this section, we consider a variant of the standard Dixit (79) entry deterrence game. Our model follows closely the presentation by Tirole (88). In this latter model, a sequential game is considered. The incumbent firm has the possibility to precommit to a particular level of capacity k_1 in the first stage. Entry may take place in the second stage. The entrant has to install a capacity level k_2 and has to bear a sunk cost F only if

$k_2 > 0$, i.e. if he enters. Capacity precommitment in the first stage together with the sunk cost in the second stage makes it possible for the incumbent to deter entry while preserving some market power. Entry is deterred provided the incumbent installs a capacity which is large enough to induce negative profits for the entrant at her best reply in case of entry.

We consider a slightly modified version of this game. In the first stage, the incumbent has to possibility to hire a manager under the contract specified in the preceeding section. Thus, there is delegation if $\beta > 0$. We assume that this contract cannot be renegotiated in second period. In the second stage of the game, the contract is public knowledge and the entrant decides whether to enter, bearing the sunk cost F and possibly hiring a manager under contract $O_E(q_E)$, or to stay out of the market. In case of entry, a simultaneous Cournot game takes place between the two firms. We assume that it is not possible to precommit in quantities in the first stage. We consider the case of a linear inverse demand function. It is then easy to see that our delegation scheme makes it possible to deter entry. The argument is easily captured by referring to figure 1.

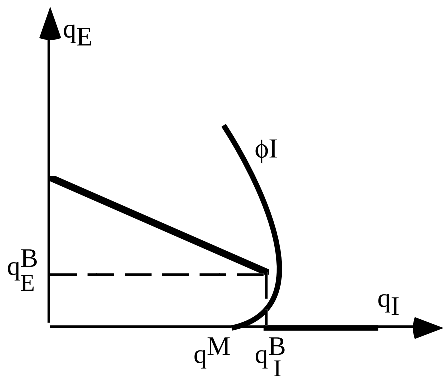

Figure 1: Entry deterrence through delegation

Firm E is the entrant. Her best reply in a standard Cournot game is discontinuous. Indeed, below some quantity level, q_E^B, profits become negative in case of entry, because of the sunk cost. In this last case, no entry is the best strategy since it secures zero profits. In order to deter entry, the owner must choose a value for β such that the incumbent's best reply is to the right of the discontinuity point. This is sufficient if we do not allow the entrant to use our delegation scheme. If we allow him to delegate under $O_E(q_E)$ then the necessary condition is that the incumbent's best reply must lie strictlyto the right of the isoprofit curve of the entrant at point (q_I^B, q_E^B) for $q_E > q_E^B$. In this case indeed, the entrant cannot gain by hiring a manager. Necessary and sufficient conditions for entry deterrence are given in Proposition 2.

Proposition 2: *Assume that* $p = 1 - Q$ *and entry involves a sunk cost* F*, then there exists an optimal* β^* *such that the incumbent deters entry with the delegation scheme* $O_i(q_i)$*.The owner of the incumbent firm obtains in this case the monopoly profits less the reservation wage of the manager.*

Proof: The game is solved as follows. Under the assumption that demand is given by $p = 1 - Q$, the best reply of the entrant, if he does not delegate, is given by $q_E = (1 - q_I)/2$. Recall that from equation (1), our delegation scheme involves larger quantities then under standard Cournot competition. We then identify the critical level of q_I to which the best reply in case of entry yields zero profits. This level , denoted by q_I^B , is the solution of the following equation:

$$\left(1 - q_I^B - \frac{1 - q_I^B}{2}\right)\left(\frac{1 - q_I^B}{2}\right) - F = 0 \tag{3}$$

We obtain $q_I^B = 1 - 2\sqrt{F}$. The best reply in case of entry is $q_E^B = \sqrt{F}$. It then remains to choose a value for β such that the best reply of the incumbent against $q_E^B = \sqrt{F}$ is precisely $q_I^B = 1 - 2\sqrt{F}$.

In the present case, the best reply of a firm under delegation scheme $O_i(q_i)$ is implicitely defined by equation (4).

$$(q_1 + q_2)^2 (1 - 2q_1 - q_2) + bq_2 = 0 \tag{4}$$

Solving this equation in β for $\left(q_I^B, q_E^B\right)$, we obtain the *entry deterrent level* for β :

$$\beta^* = \frac{\left(1 - \sqrt{F}\right)^2 \left(1 - 3\sqrt{F}\right)}{\sqrt{F}} \tag{5}$$

Tedious computations show that for relatively large values of F the corresponding incumbent's best reply lies everywhere above the isoprofit curve $\pi_2\left(q_I^B, q_E^B\right) - F$, therefore entry is deterred for all possible delegation scheme that the entrant could use. When this condition holds, entry is deterred under any possible delegation scheme. Indeed, there exist no possibility for the entrant to acheive larger profits along the incumbent's best reply, i.e. in any possible equilibrium of the quantity game. For smaller values of the sunk cost, it remains true that the incumbent's best reply lies strictly above the isoprofit curve of the entrant passing at point (q_I^B, q_E^B) for $q_E > q_E^B$. Therefore, the entrant cannot profitably enter by using contract $O_i(q_i)$. Recall indeed that the incentive scheme $O_i(q_i)$ generates best reply functions involving larger quantities than in the standard Cournot game.

Finally, it is clear from equation (1), the manager chooses the monopoly output when entry is deterred. QED

In our setting, the profitability of entry deterrence depends only on the level of the wage required for the manager's participation. Thus, as in Dixit's model entry deterrence is not necessarily profitable. However it seems reasonable to argue that the cost of entry deterrence in the present model, which is in fact the reservation wage level of the manager is smaller than the cost of extra-capacities involved in Dixit's one. Moreover, when entry is deterred, the incumbent implements the monopoly solution, so that gross profits are the monopoly ones.

4/ Final Remarks

In this note, we have assumed that the owners of firms could assign to their managers an objective which puts a positive weight on market shares, even though market shares as such have no economic value. The main feature of such a delegation scheme is that quantities are viewed as strategic substitutes for the manager of a dominant firm whereas they are complements for a small firm. This result has been derived under very general conditions on demand functions. We have then shown by mean of an example that such a delegation scheme could be perfectly rational for a profit maximizing incumbent. This is so because, once publicly known, this contract has a strong commitment value.

Note that our model differs from the received literature on strategic delegation which tends to assume a delegation scheme based on sales incentives. However, the idea that delegation has a strategic value is common to both approaches. In a two-stage duopoly game where owners choose first an optimal contract based on sales incentives, and managers compete in the second stage, it has been shown that both owners are likely to delegate in a Subgame Perfect Equilibrium, even though this results into lower profits ex-post. Clearly, this result would also obtain in our setting. However, our approach exhibits an important qualitative difference: sales incentives lead to a more agressive behaviour in the quantity game, as compared to the standard Cournot competition, however, a firm is always "accomodating", since quantities are strategic substitutes. In our setting, the willingness to accomodate depends on the firm's size relative to the industry. Typically, a dominant firm will not accomodate.

In our example an incumbent can acheive entry deterrence with a delegation scheme based on market shares. A similar result would be harder to obtain with a delegation scheme based on sales. It is indeed obvious that the non-monotone best replies are very helpful in order to deter entry when the entrant is also allowed to delegate. Moreover, monopoly profits would not be preserved in this last case and entry deterrence becomes more costly when the sunk cost becomes smaller.

References

Basu K. (1995), Stackelberg equilibrium in oligopoly: an explanation based on managerial incentives, Economic Letters, 49: 459-464.

Bulow J., J. Geanakoplos and P. Klemperer (1985), Multimarket oligopoly: Strategic substitutes and complements, Journal of Political Economy, 93:488-511.

Caminal R. and X. Vives (1996), Why market shares matter: an information-based theory, Rand Journal of Economics, 27:221-239.

Dixit A. (1979), A model of duopoly suggesting a theory of entry barriers, Bell Journal of Economics, 10:20-32

Fershtman C. and K.L. Judd (1987), Equilibrium incentives in oligopoly, American Economic Review, 77:927-940.

Fershtman C., K.L. Judd and E. Kalai (1991), Observable contracts: strategic delegation and cooperation, Internatioanl Economic Review, 32:551-559.

Katz M.L. and C. Shapiro (1986), Technology adoption in the presence of network externalities, Journal of Political Economy, 94:822-841.

Klemperer P. (1995), Competition when consumers have switching costs: An overview with applications to industrial organization, macroeconomics and international trade. Review of Economic Studies, 62:515-539.

Sklivas S. D. (1987), The strategic choice of management incentives, Rand Journal of Economics, 18:452-458.

Tirole J. (1988), The trheory of Industrial Organization, MIT Press, Cambridge Massachusetts.