International Journal of Industrial Organization 3 (1985) 245–253. North-Holland

MANAGERIAL INCENTIVES AS A STRATEGIC VARIABLE IN DUOPOLISTIC ENVIRONMENT

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Final version received December 1984

The paper investigates two interrelated problems. The first is the output choice of a firm in which decisions are made cooperatively by managers who might have conflicting objectives. The second is the managerial incentives scheme as a strategic choice of owners who wish to maximize profits. Using an example in which a duopolistic market is studied, the paper shows that giving managers incentives that combine profit and sales maximization might be the dominant strategy for the owners.

1. Introduction

Traditional price theory rests on a highly simplified conception of the firm in which the single objective of the firm is profit maximization. Criticism of this hypothesis can be found throughout the economic literature [see, for example, Baumol (1958), Simon (1964), Williamson (1964) and Leibenstein (1979)]. But once we realize that decisions in firms are made by individuals who can have different motives and different objectives, we can argue [see Cyert and March (1963)] that decisions by firms look more like a compromise between conflicting parties than maximization of a single objective function. Explicitly or implicitly a process of bargaining occurs continuously, and the decision that is finally taken is the result of this bargaining process. Aoki (1980, 1982, 1983) described the modern corporation as a coalition of shareholders, employees and business partners. As Aoki pointed out, in order to analyze the behavior of such a corporation, a game theoretic approach should be used. Maximization of a single objective function cannot capture the interaction between all the economic agents who participate in the decision making process. Thus, the appropriate way to analyze the behavior of firms in which the output (or price) decision is done cooperatively by managers who have conflicting objectives, is by using a cooperative game framework.

*I wish to thank Eitan Muller, Gery Goldstein and three anonymous referees for their helpful comments.

To illustrate the point we develop in this paper an example in which decision making in a firm is described as a bargaining problem. In this example decisions are made cooperatively by two managers, one of whom wants to maximize sales, while the other wants to maximize profits. By adopting the Nash (1950) axiomatic approach we can find the compromise decision and the resulting output level.

The modern corporation is also characterized by a separation of ownership from management. This division between ownership and control becomes very important when managers pursue objectives other than profit maximizations. If managers depend primarily on profits for their compensation the separation of ownership and management becomes much less important. However, empirical work [see McGuire, Chiu and Elbing (1962)] indicates that management salaries are strongly correlated with sales, a result which supports Baumol's (1958) analysis of sales maximization. The empirical support of the contention that management has targets other than profit maximization points to a potential conflict between management and owners. It is this conflict which is another focus of this paper. Specifically, we investigate whether the existence of managerial objectives other than profit maximization necessarily contradicts the owners' ultimate goal of profit maximization. In the case of a monopolistic firm it is clear that such conflict exists. However, as we illuminate in this work, in a duopolistic environment it is not clear that a management that has other goals beside profit maximization does not indirectly serve the owners' objective of maximum profit.

If we accept the view that decisions are made in a firm as a result of a bargaining process and that under different managerial incentive schemes the firm will make different compromise decisions, we can consider the firm's managerial incentives scheme as part of the owner's strategy. By designing the managerial incentives system owners can determine the kind of decisions that the firm will make. Therefore even if we accept that owners wish to maximize profits it is not clear what is the managerial incentives scheme that best serves this purpose.

We illustrate this by discussing an example in which a duopolistic market is considered. We investigate the equilibrium in the market under two different sets of assumptions. First we consider the case in which the managements of both firms have incentives that combine sales and profit maximization. We then investigate the market equilibrium when only in one firm there are such incentives, while the managers of the second firm are profit maximizers. Assuming that owners can foresee the resulting equilibrium in the market, we show that giving managers incentives that combine profits and sales maximization may be the *dominant strategy* for the owners. Thus, even though owners wish to maximize profit, the equilibrium in the market is such that in both firms managerial incentives are combined from profits and sales maximization.

2. Conflict and compromise decisions in firms

Consider a firm in which decisions are made cooperatively by two managers who, due to different incentive schemes, have different objective functions. Manager one wants to maximize profit while manager two wants to maximize sales. The incentives schemes are assumed to be designed by the owner of the firm. In this section, however, we assume that incentives schemes are given and we analyze their impact on the firm's behavior. The next step will be to consider these incentives schemes as strategic variables and to investigate the market equilibrium.

Let π and s denote that profits and the sales of the firm, respectively. For simplicity assume that the managers' utility functions are linear such that $U^1(\pi)=a\pi$ is the utility function of the first manager and $U^2(s)=bs$ is the utility function of the second manager. Furthermore, in order to simplify the calculation assume that the demand function and the cost function are linear and given by $p=A-Bs$ and $C(s)=cs$, respectively.

Sales and price decisions, in this firm, are assumed to be made cooperatively by the two managers subject to the constraint that sales cannot exceed the demanded quantity i.e., $s\leqq(A-p)/B$ and the maximum sales level is $s_{max}=A/B$[1].

Following Nash (1950), a two player bargaining problem can be described using only two components (F,d) where d is a point in the plane which can be interpreted as the outcome when no agreement is reached and F is a subset of the plane which contains d and describes the set of all feasible utility payoffs that can be achieved by cooperation. Describing the decision process in the firm as a two manager bargaining problem, the set F of all feasible outcomes can be described as

$$F=\{(s,\pi)\in R^2 \mid s\in[0,s_{max}] \text{ and } \pi=(p-c)s \text{ such that } p\leqq A-Bs\}. \tag{1}$$

Now let us assume that if the two managers do not reach any agreement, sales and thus profits will be zero. Therefore the threat point can be defined as $d=(0,0)$. Different assumptions on the disagreement point will of course yield different solutions. Individual rationality implies that the two managers will never agree upon any price or output level that will yield negative profits. Let $\tilde{F}$ be a subset of F which describes all points in F which yield non-negative profit. From the definitions of the set F and $\tilde{F}$ we can conclude that $\tilde{F}$ is a compact set. From the concavity of the function $\pi(s)=s(A-Bs-c)$ which describes the frontier of the set $\tilde{F}$, we can conclude that the set $\tilde{F}$ is a convex set.

[1]As will be discussed below, from the requirement that the outcome of the bargaining problem is Pareto, price will be equal to $A-Bs$.

Adopting the axiomatic approach, a solution to a two player bargaining game is a function μ: $B \to R^2$ such that B denotes the class of all two player bargaining problems. [For a survey on the axiomatic approach, see Roth (1979)]. Different sets of axioms will yield of course different solution functions. Considering the Nash (1950) solution as the necessary outcome of the bargaining, the solution to the above bargaining game is a point (s^*, π^*) which lies on the frontier of $\bar{F}$ and maximizes $U_1(\pi)U_2(s)$, i.e., $s^* = \operatorname{Arg\,max} abs^2[A - Bs - c]$.

Simple calculations indicate that the Nash solution to this bargaining problem is

$$s^* = \frac{2(A-c)}{3B} \quad \text{and} \quad p^* = \tfrac{1}{3}(A+2c). \tag{2}$$

It is important to note that in this model the firm does not maximize any objective function. The solution is a compromise between two individuals who have different objective functions. From eq. (2) we learn that the output level will be above the monopolistic output level.

The above model solved the compromise decision for a firm in which specific managerial incentives were assumed. It is clear, however, that under a different incentives scheme, a different bargaining process will take place which will lead to a different compromise solution. The above compromise solution can be achieved also by a single decision maker who has a utility curve that tangent to the boundary of $\bar{F}$ in $\mu(\bar{F}, d)$. For example, if the compensation of a single manager is correlated with $\alpha\pi + \beta s$ where α and β are positive and $\beta/\alpha = \frac{1}{3}(A-c)$, then his price and sales decisions are identical to those suggested by (2). Thus, the compromise decision can be regarded either as a result of a bargaining game or as the behavior of a single decision maker who has the right incentives structure.

3. Equilibrium in a duopolistic market in which firms make compromise decisions

In a monopolistic market it is clear that incentives based on profit are optimal from the owners' point of view. Any compromise solution yields lower profits than the regular profit maximization monopolistic profit. However, this result cannot be automatically generalized to other market structures. In order to discuss the implication of a duopolistic environment on the optimal incentive scheme, we describe in this section two cases of duopolistic market. In section 3.1 we assume that both firms make compromise decisions, i.e., both managements have some precommitment to sales maximization. In section 3.2 we describe a duopolistic market in which one firm behaves according to the profit maximization hypothesis while the other makes compromise decisions.

3.1. Compromise–compromise equilibrium

Consider an industry consisting of two firms denoted by $i=1,2$. Assume that in both firms decisions are made cooperatively by two decision makers. As assumed in the previous section let $U_i^1(\pi_i)=a\pi_i$ be the utility function of the first decision maker in firm i and let $U_i^2(s_i)=bs_i$ be the utility function of the second decision maker in firm i.

In both firms decisions are made cooperatively accordings to the bargaining process described in the previous section. Under these assumptions the duopolostic competition can be described as follows: the output level of firm 2 affects the feasible set $\tilde{F}_1$ of the first firm and therefore affects the result of the bargaining problem. For a given output level of firm 2 the decision of firm 1 is $\mu_1(\tilde{F}(s_2), d)$. Thus, the ith firm's reaction function $s_i=\phi_i(s_j)$ can be described as follows:

$$s_i=\phi_i(s_j)=\mu_1(\tilde{F}_i(s_j), d_i), \qquad i \neq j, \tag{3}$$

and the competition can be investigated by a reaction function analysis.

Giving the Nash solution function, the reaction function of firm 1 will be the first order condition for maximizing the product of the utilities of the two managers,

$$s_1=\operatorname{Arg\,max} abs_1^2\,[A-B(s_1+s_2)-c].$$

The first order condition of this maximization is[2]

$$2As_1-3Bs_1^2-2Bs_1s_2-2cs_1=0, \tag{4}$$

and the reaction function of the first firm is given by

$$s_1=\phi_1(s_2)=\frac{2A-2Bs_2-2c}{3B}. \tag{5}$$

Similarly the reaction function of firm 2 is

$$s_2=\phi_2(s_1)=\frac{2A-2Bs_1-2c}{3B}. \tag{6}$$

Solving this system of two reaction functions yields a unique equilibrium

[2]The second order condition is easily followed using the fact that the solution to the bargaining problem is Pareto and therefore $s_1 > (A-Bs_2-c)/2B$.

point (s_1^*, s_2^*) such that

$$s_1^* = s_2^* = \frac{2(A-c)}{5B}. \tag{7}$$

Note that the point (s_1^*, s_2^*) can be regarded as a Nash equilibrium of the non-cooperative market game when the objective function of the two managements is to maximize $\alpha\pi + \beta s$ where $\beta/\alpha = (A-c)/3$. In order to prove that the industry will converge to this equilibrium point it remains to be shown that the system of reaction functions $\phi(s) = (\phi_1(s_2), \phi_2(s_1))$ is a contraction. For such differentiable functions to be a contraction it is necessary and sufficient that $|\phi_i^j(s_j)| < 1$ [see Friedman (1977, p. 74)]. Since eqs. (5) and (6) yield $|\phi_i^j(s_j)| = \frac{2}{3}$, $i = 1, 2$, $j \neq i$, we can conclude that the above equilibrium point is stable.

3.2. Compromise–profit maximization equilibrium

In a similar way we can investigate the asymmetric case in which decisions are made differently in the two firms. Consider, for example, a duopolistic market in which one firm is a profit maximizer while in the second firm output decisions are made according to the compromise decision rule.

This problem can be solved by a reaction function analysis. The reaction function of the profit maximizer (firm 1) is given by

$$s_1 = \phi_1(s_2) = \frac{A - Bs_2 - c}{2B}, \tag{8}$$

while the reaction function of firm two is given by eq. (6).

Solving this system of reaction functions yields an equilibrium point (s_1^*, s_2^*), such that

$$s_1^* = \frac{A-c}{4B}, \quad s_2^* = \frac{A-c}{2B}, \tag{9}$$

and the associated profits levels at the equilibrium point are

$$\pi_1^* = \frac{(A-c)^2}{16B}, \quad \pi_2^* = \frac{(A-c)^2}{8B}. \tag{10}$$

The implications of eqs. (9) and (10) are surprising. Even though both firms have the same cost function, the firm that emphasizes profits is achieving *lower* profits than the firm in which decisions are made according to the compromise decision rule and in which sales are not chosen to maximize profits. This result can be better understood by interpreting the compromise decision rule as a precommitment to output levels that are higher than those under the profit maximization rule. In a monopolistic environment it clearly reduces profit since it implies that the monopoly produces beyond the profit maximization output level. It is this precommitment to higher output levels which gives the advantage to the firm in a duopolistic market. The precommitment translates itself to a higher output rate and higher profit at the equilibrium point.

4. Incentives scheme and internal organization as strategic variables

Consider a duopolistic industry in which *owners* of the two firms strive to maximize profits. Since the modern firm is characterized by a separation of ownership and mangement, we assume that owners do not have control on the daily output decisions of firms. The problem facing these owners is to design a managerial incentive scheme and to organize their firms given that daily output decisions will be made by the managers of the firms. Further, we assume that owners foresee the quantity setting equilibrium which, as described in the previous section, depends on the objective functions of managers and on the way compromise decisions are made.

In order to simplify the discussion assume that owners have two options. The first one is to organize the firm such that decisions will be made by one manager who will strive to maximize profit (assuming that by an appropriate incentives scheme it is possible to motivate managers to adopt profit maximization as an objective function). The second option is to organize the firm so that decisions will be made cooperatively by two managers, one wishing to maximize profits, the other to maximize sales (or, alternatively, by one manager with an appropriate incentives scheme).

When the firm has a monopolistic position in the market the owners should adopt the first possibiliy, namely a management that will maximize profit. In the duopoly case, the options that the owners have and the associated payoffs at the equilibrium point are summarized by the matrix below:

	Owners of firm 2	
Owners of firm 1	Profit maximization	Compromise decisions
Profit maximization	$\frac{(A-c)^2}{9B}, \frac{(A-c)^2}{9B}$	$\frac{(A-c)^2}{16B}, \frac{(A-c)^2}{8B}$
Compromise decisions	$\frac{(A-c)^2}{8B}, \frac{(A-c)^2}{16B}$	$\frac{2(A-c)^2}{25B}, \frac{2(A-c)^2}{25B}$

When the owners of the two firms choose option one (profit maximization), the result is the regular Cournot quantity competition under the profit maximization hypothesis and the payoff of each firm is $(A-c)^2/9B$. When the two owners choose the second option (compromise decisions), the payoff at the equilibrium point can be calculated from eq. (7). When the owners of one firm choose the first option (profit maximization) while the owners of the other firm choose the second option (compromise decisions), the payoffs are given by eq. (10).

The matrix above represents a situation similar to the prisoners' dilemma. The *dominant strategy* of the owners is to organize the firm such that decisions will be made according to the compromise decision rule. Consequently, the equilibrium is such that both firms make compromise decisions and owners are worse off.

From the above solution we can conclude that although the sole objective of the owners is to maximize profit, they realize that in a duopolistic environment the incentives structure that will serve this purpose is *not* the one of profit maximization. Rather, a precommitment to output levels higher than those under the pure profit maximization is a dominant strategy from the viewpoint of the non-cooperative duopolistic individual owner. Thus, we can conclude that managerial compensation schemes that are not just tied to profits, do not necessarily contradict the owners' goal of profit maximization.

From the social welfare point of view, the compromise/compromise equilibrium is better than the Cournot equilibrium. In the new equilibrium the two firms expand their output. This movement down the demand function implies an increase in consumer surplus. Moreover, this increase in consumer surplus is big enough to offset the decrease in producers' profit.

5. Concluding comments

This paper has demonstrated that there is not necessarily a conflict between owners who want to maximize profits and managers who behave differently. Managers who strive to maximize different objective functions may, in so doing, serve the owners' ultimate purpose of profit maximization. Using an example in which managerial incentives were treated as a strategic variable, the paper showed that although owners wish to maximize profits, in a duopolistic market they may find it optimal to organize the firm such that decisions will be made according to some compromise between profits and sales maximization.

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