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VERTICAL INTEGRATION AS A SUPERGAME

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1. INTRODUCTION

One of the conundrums posed by the theory of vertical integration is how to explain the phenomenon in situations when unilateral optimisation by both parties would decree otherwise. The problem is compounded by the fact that complete contracts between them are too costly or impossible. The uncertainty implied here is structural, that is, the absence of any objective basis to form calculable probabilities. One informal response in the industrial organisation literature has been to argue that the problem of trading here is essentially of an intertemporal character in which successive adaptations to this uncertainty are called for. The reaction of agents is that of bounded rationality. Actual contracts, in other words, turn out to be relational [Paul Milgrom & John Roberts (1992)]. They serve to structure the repeated relationship and set common expectations. Since the agenda of the theory of supergames is precisely to explain cooperation by means of repeated interaction, that model is particularly conducive to formalising this insight.

The problem is, of course, that for many repeated games the set of perfect equilibria may be large. Two broad research solutions are indicated in the literature. One is entry into the refinements of Nash equilibrium industry. The returns to this line of enquiry is best estimated in the colourful words of Kenneth Binmore (1992, p. 13). "...the literature on "refinements of Nash equilibrium" belongs on the same shelf with the works of the medieval scholastics". His "gesture to the future" is the second line of attack which is to show how equilibrium is achieved when the players are less than fully rational. This direction in its turn subdivides into two paths. One is recourse to finite automata theory, the other is to consider the adoption of epsilon-optimal strategies.

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The common core of both approaches is to treat the structural uncertainty facing both the players explicitly. The expectation here is that agents muddle their way to optimal solutions by the adoption of rules of thumb if the situation is encountered sufficiently frequently. They adjust their behaviour over time until there is no further room for improvement. The outcome is an equilibrium but not a fully rational one.

Many theorists working within the game theory cum industrial organisation tradition have endorsed just such a research programme. For instance, Adam Brandenburger (1993) argues that fully rational equilibrium theory may be an adequate description of the long-run behaviour of interacting agents. It is much less convincing as a description of players who have an ongoing relationship among themselves. The crossfertilisation of both disciplines has resulted in some useful concepts like the importance of 'commitment' in industrial organisation. Commitment has been defined as "the tendency of strategies to persist over time" [Pankaj Ghemawat (1991)]. One factor making for commitment is "lock-in", which is the result of investments in durable, specialised and untradeable assets. Investments of this kind involve sunk costs that inhibit exit from a strategy because the assets have value only if the strategy persists.

Some of the arguments made above are familiar in the literature of transactions costs and that is surprising considering the fact that the two orientations are regarded as having no common ground. Transaction Cost economics was founded on the twin premisses that the pure uncertainty that is the characteristic of the environment of agents along with their cognitive constraints leads to prospective market failure. An aspect of the former is that complete insurance markets do not exist, and consequently, complex claims contracts covering every possible contingency will be prohibitively costly to write, execute and enforce. Bounded rationality gives rise to the problem of opportunism and small numbers bargaining. The modern multi-divisional firm addresses both the issues by hierarchical modes of organisation. What is not sufficiently appreciated in the familiar interpretations of transaction cost theory is that the two factors interact in complex ways [O. E. Williamson (1993)]. Structural uncertainty leads to boundedly rational behaviour. Even if agents can perform computations of arbitrary complexity, the indeterminancy of situations with multiple equilibria poses a problem. The greater the uncertainty, the greater the gain from foreclosing options at their disposal.

2. THE MODEL

The canonical problem with which Transaction Cost economics deals is that of vertical integration. The following account of the familiar double marginalisation problem is from Jean Tirole (1988). A monopolist produces an intermediate good at a constant unit cost c. She sells it to a single retailer. The latter has a monopoly on a technology that transforms one unit of the intermediate good into one unit of the final good. P_w denotes the wholesale price and P is the consumer price. q denotes the quantity bought by the retailer. The consumer's downward-sloping demand function is denoted by $q=D(p)$.

The "upstream firm" who uses linear pricing charges $P_w>c$. The "downstream firm" then faces a marginal cost for her input equal to P_w and they make their pricing decision on this basis. However, any decision made by the retailer that increases her demand for the intermediate good by one unit generates an incremental profit of P_w-c for the manufacturer. The retailer who maximises her own profit does not, however, take the incremental profit of the manufacturer into account. She would therefore tend to take decisions that lead to too low a consumption of the intermediate good. The vertical externality is that the retailers cost for the good differs from that of the vertical structure. Total profit is lower than the vertically integrated one.

Suppose that the relationship between the two is modelled as a repeated game. The strategies are respectively the price of the intermediate good and the retail price. Then the payoff level associated with cooperation for the manufacturer (earned by setting the wholesale price equal to her unit cost) would be equal to zero and thus lower than her noncooperative equilibrium payoff.

Suppose however for a price sufficiently close to (higher than) the cooperative wholesale price, a payoff arbitrarily close to (higher than) her noncooperative payoff can be found. Then the present discounted value of the retailer's profits from sustaining cooperation would exceed the short-run gain from deviating (at a positive discount rate) as her per-period profit from cooperating would be higher than that from noncooperating. A folk theorem would apply. Total profits would be higher than those of the nonintegrated industry but would fall within a margin epsilon of integrated industry profits.

The relative superiority of the use of such a strategy is indicated in the following result. The familiar minimal (the assumption of continuity of the payoff functions is dropped) set of assumptions are as follows:

The "upstream firm" and the "downstream firm" are indexed by the numbers 1 and 2 respectively.

P_i is the strategy space of player i and is a subset of the Euclidean space R^m. $P=P_1\times P_2$ is the strategy space of the game.

$p_i\in P_i$ denotes a strategy of player i, and is therefore an element of P_i.

$p=(p_1, p_2)\in P$ is called a strategy combination and consists of two strategies, one for each firm.

π_i is the payoff function of player i and is scalar valued.

DEFINITION. *An ε-EQUILIBRIUM POINT is a combination $p^*\in P$ that satisfies*

$\pi_i(P^*)\geq\pi_i(P^*\backslash P_i)-\varepsilon$ for all $p_i\in P_i$ and for $i=1, 2$.

The assumptions are as follows:

ASSUMPTION 1. *$P_i\in R^m$ is compact and convex for $i=1, 2$.*

ASSUMPTION 2. *$\pi_i(P) \in R$ is defined, upper semicontinuous, and bounded for all $p \in P$ and $i = 1, 2$.*

$\pi_i(P \backslash S_i)$ is quasiconcave with respect to s_i.

Then,

PROPOSITION. *Epsilon-equilibrium points are locally unique.*

Proof. Suppose that $(p_1^*, p_2^*) \in P$ is an ε-equilibrium point. $\{p_1^*\} \times P_2$ is compact. It can be covered by a finite number of neighbourhoods of the form

$$\bigcup_{(p_2^1)} (p_1^*) \times V(p_2^1), \quad \bigcup_{(p_2^2)} (p_1^*) \times V(p_2^2) \cdots, \quad \bigcup_{(p_2^n)} (p_1^*) \times V(p_2^n)$$

Suppose that $p_2 \in P_2$. Then there correspond neighbourhoods

$$\bigcup_{p_2^i} (p_1^*) \times V(p_2^i)$$

such that

$$(p_1, p_2) \in \bigcup_{p_2^i} (p_1^*) \times V(p_2^i) \Rightarrow \pi_1(p_1, p_2) \le \pi_1(p_1^*, p_2) + \varepsilon$$

Putting

$$u_\varepsilon(p_1^*) = \bigcap_{i=1}^{n} \bigcup_{p_2^i} (p_1^*) \quad \text{and} \quad V(P_2) = \bigcup_{i=1}^{n} V(p_2^i),$$

we have

$$p_1 \in u_\varepsilon(p_1^*), \quad p_2 \in V(P_2) \Rightarrow \pi_1(p_1, p_2) \le \pi(p_1^*, p_2^*) + \varepsilon \qquad \text{Q.E.D.}$$

3. CONCLUSION

The study vindicates the intuition of Neil Kay (1989), Roy Radner (1980) and others that strict optimisation of each firm's response to the other firm's strategies would lead to the breakdown of hierarchy. Vertical integration is the result of bounded rationality on the part of decision makers.

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