

Lecture VIII: Grossman and Hart – Vertical and Lateral Integration [Part I]

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Introduction

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Article

- ▶ Grossman, S.J. and O.D. Hart. 1986. The Costs and Benefits of Ownership: A Theory of Vertical and Lateral Integration. *Journal of Political Economy* 94(4), 691-719.

General Setup

- ▶ "Such situations in turn are likely to arise when either the buyer or seller must make investments that have a smaller value in use outside their own relationship than within the relationship (i.e., there exist 'asset specificities')"
- ▶ "While these statements help us understand when the costs of contracting between separately owned firms may be high, they do not elucidate what the benefits are to 'organizing the transaction within the firm.'"

- ▶ "...if vertical integration always reduces transaction costs, any buyer A and seller B that have a contractual relationship should be able to make themselves better off as follows:
 - (i) A buys B and makes the previous owner of B the manager of the new subsidiary;
 - (ii) A sets a transfer price between the subsidiary and itself equal to the contract price that existed when the firms were separate enterprises; and
 - (iii) A gives the manager of B a compensation package equal to the profit of the subsidiary."

- ▶ "Given this, however, how can integration ever be strictly worse than nonintegration; that is, what limits the size of the firm?"
- ▶ "A second question raised by the transaction cost-based arguments concerns the definition of integration itself." Does it matter if a firm calls its hired personnel employees, independent contractors, or associates?
- ▶ "We define integration in terms of the ownership of assets and develop a model to explain when one firm will desire to acquire the assets of another firm."

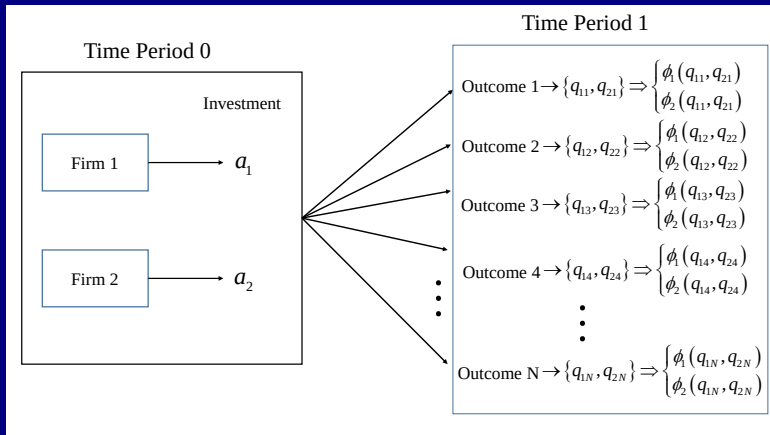
What is Integration?

- ▶ "We define a firm to consist of those assets that it owns or over which it has control; we do not distinguish between ownership and control and virtually define ownership as the power to exercise control."
- ▶ "In the eighteenth century much of the manufacturing of shoes switched from the 'putting out' system, in which the worker sewed the upper and lower halves of the shoe at home, to factory work, in which the factory owner's machines were used by the worker to put the shoes together."

Setup

- ▶ We start by assuming two firms - 1 and 2 who conduct business within a relationship (assume a vertical market channel).
- ▶ Each firm is owned by an individual who receives the residual return from the firm's activities.
- ▶ In this model we have two periods 0 and 1. In period 0 the firms make a relationship specific investment a_1 and a_2 .
- ▶ At date 1 the state of the world is revealed. At this date each firm makes additional actions q_1 and q_2 .
- ▶ A pictorial of the decision is presented in Figure 9

Overview of Decision Model



- The benefits to each owner can then be written as

$$B_i [a_i, \phi_i (q_1, q_2)] . \quad (1)$$

In this case the benefit to each owner is a function (ϕ_i) of control over each firm's assets (in this case q_1 and q_2 are defined as control over each firm's assets).

- ▶ For example, under one state of nature the downstream firm (assumed to be firm 2) may benefit from additional output from the upstream firm (firm 1).
- ▶ The ability to acquire additional product can be thought of as control of firm 1's assets.
- ▶ This additional control is acquired at the cost of a "side payment" to the original contract $\Rightarrow \phi_1(q_1, q_2) > 0$.

- ▶ This side-payment increases the benefit to owner 1
 $\Rightarrow \partial B_1 [a_1, \phi_1 (.)] / \partial \phi > 0$.
- ▶ Each firm's problem is the roughly represented in Figure 13.

Independent Firm's Problems

Time Period 1

$$\begin{aligned}
 \text{Outcome 1} &\rightarrow \{q_{11}, q_{21}\} \Rightarrow \begin{cases} \phi_1(q_{11}, q_{21}) \\ \phi_2(q_{11}, q_{21}) \end{cases} \Rightarrow \begin{cases} B_1[a_1, \phi_1(q_{11}, q_{21})] \\ B_2[a_2, \phi_2(q_{11}, q_{21})] \end{cases} \\
 \text{Outcome 2} &\rightarrow \{q_{12}, q_{22}\} \Rightarrow \begin{cases} \phi_1(q_{12}, q_{22}) \\ \phi_2(q_{12}, q_{22}) \end{cases} \Rightarrow \begin{cases} B_1[a_1, \phi_1(q_{12}, q_{22})] \\ B_2[a_2, \phi_2(q_{12}, q_{22})] \end{cases} \\
 \text{Outcome 3} &\rightarrow \{q_{13}, q_{23}\} \Rightarrow \begin{cases} \phi_1(q_{13}, q_{23}) \\ \phi_2(q_{13}, q_{23}) \end{cases} \Rightarrow \begin{cases} B_1[a_1, \phi_1(q_{13}, q_{23})] \\ B_2[a_2, \phi_2(q_{13}, q_{23})] \end{cases} \\
 \text{Outcome 4} &\rightarrow \{q_{14}, q_{24}\} \Rightarrow \begin{cases} \phi_1(q_{14}, q_{24}) \\ \phi_2(q_{14}, q_{24}) \end{cases} \Rightarrow \begin{cases} B_1[a_1, \phi_1(q_{14}, q_{24})] \\ B_2[a_2, \phi_2(q_{14}, q_{24})] \end{cases} \\
 &\vdots \\
 \text{Outcome N} &\rightarrow \{q_{1N}, q_{2N}\} \Rightarrow \begin{cases} \phi_1(q_{1N}, q_{2N}) \\ \phi_2(q_{1N}, q_{2N}) \end{cases} \Rightarrow \begin{cases} B_1[a_1, \phi_1(q_{1N}, q_{2N})] \\ B_2[a_2, \phi_2(q_{1N}, q_{2N})] \end{cases}
 \end{aligned}$$

$$\begin{aligned}
 \max_{a_1} \pi_1(a_2, \{q_{21}, \dots, q_{2N}\}) \\
 = \sum_{j=1}^N B_{1j} [a_1, \phi_1(q_{1j}, q_{2j})]
 \end{aligned}$$



$$\begin{aligned}
 \max_{a_2} \pi_2(a_1, \{q_{11}, \dots, q_{1N}\}) \\
 = \sum_{j=1}^N B_{2j} [a_2, \phi_2(q_{1j}, q_{2j})]
 \end{aligned}$$

- ▶ Again, the state-space is assumed to be too large to efficiently contract or the contracts are too expensive to enforce.
- ▶ The result is that the firms make *ex ante* investments and then once the states of the world are realized they adjust the levels of production *ex post* through choices of q_1 and q_2 .
- ▶ "This benefit is again supposed to be nonverifiable and hence noncontractable."
- ▶ "At date 1, the owner of firm i (i.e., the manager who has been given ownership rights in the date 0 contract) has the right and power to choose q_i ."

- ▶ "If there is no further negotiations, the choices of different owners are made simultaneously and noncooperatively."
- ▶ "Given that the q 's become contractable at date 1, however, the contract may be renegotiated (costlessly)."
- ▶ "Then B_1 and B_2 are realized."
- ▶ Taking Outcome 1 in Figure 13 - Suppose that Outcome 1 implies that neither firm want more or less output. q_1 and q_2 are then chosen to maximize the individual benefits under the terms of the initial investment.

- ▶ Alternatively, assume that under Outcome 2 in Figure 13 that the upstream firm (firm 2) requires more input – It was a good sales year and they need to increase output beyond the original terms of the contract.
 - ▶ In this case, firm 2 could make a side-payment for additional output (which will probably be provided at additional cost).
 - ▶ The point is the side payment - how much additional benefit can firm 1 extract from firm 2?
 - ▶ Suppose that the original contract was for \$10/widget and that it cost firm 1 to \$8/widget (so the original contracted profit is \$2/widget).
 - ▶ Assume that the widget is really worth \$15/widget to Firm 2. The incomplete contract could allow firm 1 to increase the price of the widget to \$12.50/widget – essentially taking half the normal profit.

- ▶ "...we assume that there is a competitive market in identical potential trading partners at date 0, which determines the *ex ante* division of the surplus between the two managers. Given this *ex ante* division, an optimal contract simply maximizes one manager's benefit subject to the other manager's receiving his reservation utility (note that there is no uncertainty)."

Analysis of the Optimal Contract, Including the Allocation of Ownership Rights

- The optimal contract must maximize the total *ex ante* net benefits of the two managers

$$B_1 [a_1, \phi_1 (q_1, q_2)] + B_2 [a_2, \phi_2 (q_1, q_2)] . \quad (2)$$

"It is useful to consider as a benchmark the first-best, where contrary to our assumptions above a_1 and a_2 are verifiable and q_1 and q_2 are *ex ante* contractable.

- ▶ **Definition.** Let a_1^* , a_2^* , q_1^* , and q_2^* be the (assumed unique) maximizers of $B_1 + B_2$, subject to $a_i \in A_i$, $q_i \in Q_i$, ($i = 1, 2$).
- ▶ Interesting cases:
 - ▶ Firms remain separate – nonintegrated. (Manager 1 owns and controls the assets of firm 1 while manager 2 owns and controls the assets of firm 2).
 - ▶ Firm 1 owns firm 2.
 - ▶ firm 2 owns firm 1.

Case I – Independent Firms

- ▶ Typical in these type of problems, the best way to solve it is recursively – what is the optimal action at time 1?
- ▶ At date 1 the choices of a_1 and a_2 have already been made and all we are concerned with is the choices of q_1 and q_2 .
- ▶ **Assumption 1.** There exists a unique pair $(\hat{q}_1, \hat{q}_2)$ satisfying $q_1 = \hat{q}_1$ maximizes $\phi_1(q_1, \hat{q}_2)$ subject to $q_1 \in Q_1$, and $q_2 = \hat{q}_2$ maximizes $\phi_2(\hat{q}_1, q_2)$ subject to $q_2 \in Q_2$.

- It is always somewhat bad to add notation in order to simplify the problem – but let's return to the implied in Figure 13. Specifically, q_1 and q_2 are vectors

$$q_1 = \begin{bmatrix} q_{11} \\ q_{12} \\ \vdots \\ q_{1N} \end{bmatrix} \quad q_2 = \begin{bmatrix} q_{21} \\ q_{22} \\ \vdots \\ q_{2N} \end{bmatrix}. \quad (3)$$

Each of these events are different contracting events after the state of the world has been revealed

$$\begin{aligned} q_{11} &\sim \left\{ \begin{array}{cccc} q_{11,1} & q_{11,2} & \cdots & q_{11,k_1} \end{array} \right\} \\ q_{21} &\sim \left\{ \begin{array}{cccc} q_{21,1} & q_{21,2} & \cdots & q_{21,k_2} \end{array} \right\}. \end{aligned} \quad (4)$$

- The result is a full matrix of strategy combinations

$$\{q_{11} \cdot q_{21}\} \sim \begin{pmatrix} \{q_{11,1}, q_{21,1}\} & \{q_{11,2}, q_{21,1}\} & \cdots & \{q_{11,k_1}, q_{21,1}\} \\ \{q_{11,1}, q_{21,2}\} & \{q_{11,2}, q_{21,2}\} & \cdots & \{q_{11,k_1}, q_{21,2}\} \\ \vdots & \vdots & \ddots & \vdots \\ \{q_{11,1}, q_{21,k_2}\} & \{q_{11,2}, q_{21,k_2}\} & \cdots & \{q_{11,k_1}, q_{21,k_2}\} \end{pmatrix} \quad (5)$$

- The benefit of these various strategies for each individual then becomes

$$\phi_1(\{q_{11} \cdot q_{21}\}) = \begin{pmatrix} \phi_1(q_{11,1}, q_{21,1}) & \phi_1(q_{11,2}, q_{21,1}) & \cdots & \phi_1(q_{11,k_1}, q_{21,1}) \\ \phi_1(q_{11,1}, q_{21,2}) & \phi_1(q_{11,2}, q_{21,2}) & \cdots & \phi_1(q_{11,k_1}, q_{21,2}) \\ \vdots & \vdots & \ddots & \vdots \\ \phi_1(q_{11,1}, q_{21,k_2}) & \phi_1(q_{11,2}, q_{21,k_2}) & \cdots & \phi_1(q_{11,k_1}, q_{21,k_2}) \end{pmatrix}$$

$$\phi_2(\{q_{11} \cdot q_{21}\}) = \begin{pmatrix} \phi_2(q_{11,1}, q_{21,1}) & \phi_2(q_{11,2}, q_{21,1}) & \cdots & \phi_2(q_{11,k_1}, q_{21,1}) \\ \phi_2(q_{11,1}, q_{21,2}) & \phi_2(q_{11,2}, q_{21,2}) & \cdots & \phi_2(q_{11,k_1}, q_{21,2}) \\ \vdots & \vdots & \ddots & \vdots \\ \phi_2(q_{11,1}, q_{21,k_2}) & \phi_2(q_{11,2}, q_{21,k_2}) & \cdots & \phi_2(q_{11,k_1}, q_{21,k_2}) \end{pmatrix}. \quad (6)$$

- ▶ The strategy for each individual s_i is defined as a vector of weights that sum to one

$$s_1 = \begin{pmatrix} s_{11} \\ s_{12} \\ \vdots \\ s_{1k_1} \end{pmatrix} \quad s_2 = \begin{pmatrix} s_{21} \\ s_{22} \\ \vdots \\ s_{2k_2} \end{pmatrix} \quad (7)$$

- ▶ Following the von Neumann-Morgenstern axioms - the expected value of each strategy can then be computed as a linear function of the individual choices. For example, the value of strategy 1 for individual 1 is then

$$u(s_{11}) = \sum_{j=1}^{k_2} s_{2j} \phi_1(q_{11,1}, q_{21,j}) \quad (8)$$

- ▶ Thus, the optimal strategy for individual 1 given a strategy vector for individual 2 can be computed as

$$u(s_1^*) = \max_{s_{1i}} \sum_{i=1}^{k_1} s_{1i} \sum_{j=1}^{k_2} \phi_1(q_{11,1}, q_{21,j}) \quad (9)$$

s.t. $\sum_{i=1}^{k_1} s_{1i} = 1$

- ▶ Following my discussion from Lecture 33 of my Computational Economics course – $\Delta_i = \left\{ s_i \in S_i : \sum_j s_{ij} = 1, s_i \geq 0 \right\}$ defines the set of possible strategies for individual i . The set of all possible strategies can be written as

$$\Delta = \prod_{i \in N} \Delta_i \subseteq R_M \quad (10)$$

- **Definition:** We say that $s^* \in S$ is a *Nash Equilibrium* if $s^* \in \Delta$ and for all $i \in N$ and all $s_i \in \Delta_i$, $u_i(s_i, s_{-i}^*) \leq u_i(s^*)$.