MECS 570-1: Organizational Economics I

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Boundaries of the Firm, Part 5: Organizational IO

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The informal theory and the two formal theories we have examined so far have taken a partial-equlibrium approach and explored how environmental factors such as uncertainty, the degree of contractual incompleteness, and ex post lock-in shape the firm-boundary decision. In this note, we will look at a model in which firm boundary decisions are determined in industry-equilibrium, and we will derive some predictions about how firm-level organization decisions impact the competitive environment and vice versa.

Embedding a model of firm boundaries into an industry-equilibrium framework can be difficult, so we will need to put a lot of structure both on the particular model of firm boundaries we look at as well as on the sense in which firms compete in the market. Different papers in this literature (Grossman and Helpman, 2002; Avenel, 2008; Gibbons, Holden, and Powell, 2012; Legros and Newman, 2013) focus on different models featuring different determinants of firm boundaries. Grossman and Helpman (2002) derives a trade-off between the fundamentally Neoclassical consideration of diminishing returns to scale and the search costs associated with finding alternative trading partners.

Gibbons, Holden, and Powell (2012) consider a Grossman-Hart-Moore-style model in which firms can organize either in a way that motivates a party to acquire information about product demand or in a way that motivates a different party to reduce marginal production costs. The paper embeds this model of firm boundaries into a Grossman-Stiglitz-style rational expectations equilibrium and shows that, if some firms are organized to acquire information, their information will be partially contained in the prices of intermediate goods, which in turn reduces other firms' returns to organizing to acquire information. In equilibrium, differently organized firms will coexist.

This note will focus on Legros and Newman (2013), which embeds a particularly tractable form of the Hart and Holmstrom (2002/2010) model of firm boundaries into a price-theoretic framework. In the Hart and Holmstrom model, integration unifies contractible payoff rights and decision rights, thereby ensuring that decisions made largely with respect to their effects on contractible payoffs. Under integration, different managers make decisions, and these decisions are particularly sensitive to their effects on their noncontractible private benefits. The Legros and Newman (2013) insight is that when a production chain's output price is high, the contractible payoffs become relatively more important for the chain's total surplus, and therefore integration will become relatively more desirable.

Description There are two risk-neutral managers, L and R, who each manage a division, and a risk-neutral third-party HQ. Two decisions, $d_L, d_R \in [0,1]$ need to be made. These decisions determine the managers' noncontractible private benefits $b_L(d_L)$ and $b_R(d_R)$ as well as the probability distribution over output $y \in \{0, A\}$, where high output, A, is firm-specific and is distributed according to a continuous distribution with cdf $F(A)$ and support $[\underline{A}, \bar{A}]$. High output is more likely the more well-coordinated are the two decisions: $\Pr[y = A| d_L, d_R] = 1 - (d_L - d_R)^2$. Output is sold into the product market at price p. Demand for output is generated by an aggregate demand curve $D(p)$.

The revenue stream, $\pi = py$ is contractible and can be allocated to either manager, but each manager's private benefits are noncontractible and are given by

$$\begin{aligned} b_L(d_L) &= -d_L^2 \\ b_R(d_R) &= -(1-d_R)^2, \end{aligned}$$

so that manager L wants $d_L = 0$ and manager R wants $d_R = 1$. The decision rights for d_L and d_R are contractible. We will consider two governance structures $g \in \{I, NI\}$. Under $g = I$, a third party receives the revenue stream and both decision rights. Under $g = NI$, manager L receives the revenue stream and the decision right for d_L, and manager R receives the decision right for d_R.

At the firm-level, the timing of the game is as follows. First, HQ chooses a governance structure $g \in \{I, NI\}$ to maximize joint surplus. Next, the manager with control of d_ℓ chooses $d_\ell \in [0,1]$. Finally, revenues and private benefits are realized, and the revenues accrue to whomever is specified under g. Throughout, we will assume that if HQ is indifferent among decisions, it will make whatever decisions maximize the sum of the managers' private benefits. The solution concept is subgame-perfect equilibrium given an output price p. An industry equilibrium is a price level p^*, and a set of governance structures and decisions for each firm such that industry supply, $S(p)$, coincides with industry demand at price level p^*.

The Firm's Program For now, we will take the industry price level p as given. For comparison, we will first derive the first-best (joint surplus-maximizing) decisions, which solve

$$\max_{d_L, d_R} pA\left(1 - (d_L - d_R)^2\right) - d_L^2 - (1 - d_R)^2$$

or

$$d_L^{FB} = \frac{pA}{1 + 2pA}, d_R^{FB} = \frac{1 + pA}{1 + 2pA}.$$

The first-best decisions partially reflect the role that coordination plays in generating revenues as well as the role that decisions play in generating managers' private benefits. As such, decisions are not perfectly coordinated: denote the decision gap by $\Delta^{FB} = d_R^{FB} - d_L^{FB} = 1/(1 + 2pA)$.

Under non-integration, manager L receives the revenue stream, and managers L and R simultaneously choose d_L^{NI} and d_R^{NI} to solve

$$\max_{d_L} pA\left(1 - \left(d_L - d_R^{NI}\right)^2\right) - d_L^2$$

and

$$\max_{d_R} - (1 - d_R)^2 ,$$

respectively. Clearly, manager R will choose $d_R^{NI} = 1$, so manager L's problem is to

$$\max_{d_L} pA \left(1 - (d_L - 1)^2\right) - d_L^2,$$

and therefore she chooses $d_L^{NI} = pA/ (1 + pA)$. Since manager L cares both about her private benefits and about revenues, her decision will only be partially coordinated with manager R's decision: the decision gap under non-integration is $\Delta^{NI} = d_R^{NI} - d_L^{NI} = 1/ (1 + pA)$.

Under integration, since the headquarters does not care about managers' private benefits, it perfectly coordinates decisions and chooses $d_L^I = d_R^I$, and by assumption, it sets both equal to 1/2. The decision gap under non-integration is $\Delta^I = d_R^I - d_L^I = 0$.

Denote total private benefits under governance structure g by $PB^g \equiv b_L (d_L^g) + b_R (d_R^g)$, and denote expected revenues by $REV^g = E [\pi| d_g]$. Total welfare is therefore

$$W (g) = \left(PB^I + REV^I\right) 1_{g=I} + \left(PB^{NI} + REV^{NI}\right) 1_{g=NI}.$$

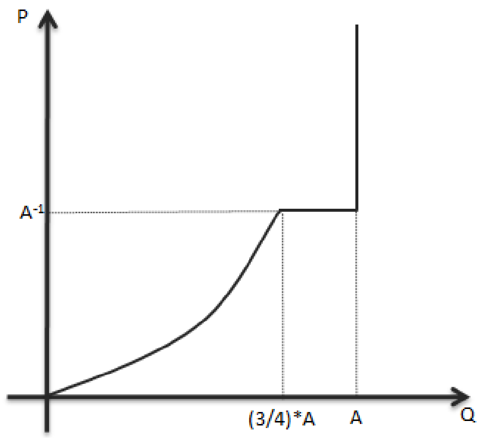
Since the coordination gap is smaller under integration than under non-integration, and expected revenues are higher under integration that under non-integration, there is a trade-off between greater coordination under integration and greater private benefits under non-integration.

Importantly the difference in expected revenues under the two governance structures, $REV^I - REV^{NI}$, is increasing in p and A, and it is increasing faster than is the difference in private benefits, $PB^{NI} - PB^I$. There will therefore be a cutoff value $p^* (A)$ such that if $p > p^* (A) = 1/A$, $g^* = I$, and if $p < p^* (A)$, $g^* = NI$. If $p = p^* (A)$, the firm is indifferent.

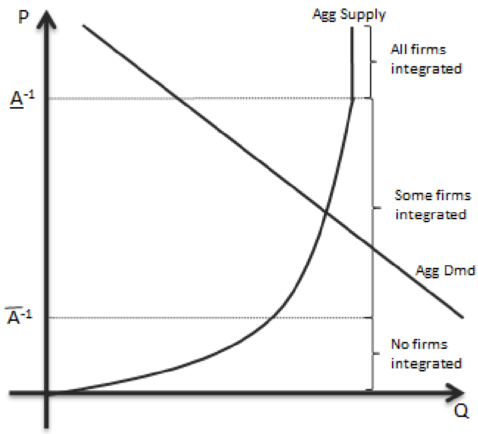
Industry Equilibrium Given a price level p, a firm of productivity A will produce expected output equal to

$$y(p;A) = \begin{cases} A\left(1-\left(\frac{1}{1+pA}\right)^2\right) & p < 1/A \\ A & p > 1/A. \end{cases}$$

The following figure depicts the inverse expected supply curve for a firm of productivity A. When $p = 1/A$, the firm is indifferent between producing expected output $3A/4$ and expected output A.



Industry supply in this economy is therefore $Y(p) = \int y(p;A)\,dF(A)$ and is upward-sloping. For $p > 1/\underline{A}$, the inverse supply curve is vertical. If $p < 1/\bar{A}$, all firms choose to be non-integrated, and if $p > 1/\underline{A}$, all firms choose to be integrated. For $p \in \left(1/\bar{A}, 1/\underline{A}\right)$, there will be some integrated firms and some non-integrated firms. If demand shifts outward, a (weakly) alrger fraction of firms will be integrated. The following figure illustrates industry supply and industry demand.

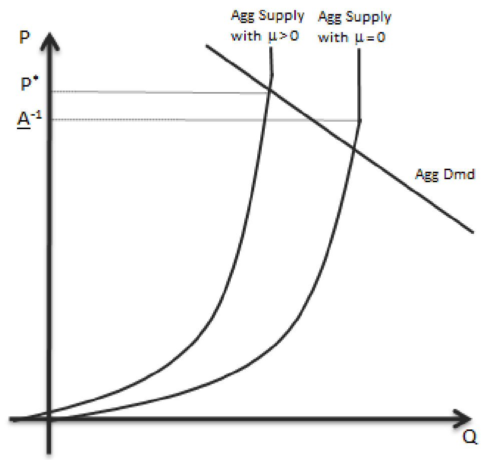


As drawn, the inverse demand curve intersects the inverse supply curve at a value of $p \in (1/\bar{A}, 1/\underline{A})$, so in equilibrium, there will be some firms that are integrated (high-productivity firms) and some that are non-integrated (low-productivity firms). If the inverse demand curve shifts to the right, the equilibrium price will increase, and more firms will be integrated.

Output prices are a key determinant of firms' integration decisions, and one of the model's key predictions is that industries with higher output prices (or, for a given industry, during times when output prices are higher), we should expect to see more integration. This prediction is consistent with findings in Alfaro, Conconi, Fadinger, and Newman (2016), which uses industry-level variation in tariffs to proxy for output prices, and McGowan (2016), which uses an increase in product-market competition in the U.S. coal mining industry as a negative shock to output prices.

Since output prices are determined at the market level, a firm's integration decision will necessarily impact other firms' integration decisions. As an illustration, suppose a fraction $\mu \in [0, 1]$ of firms in the industry are exogenously restricted to being non-integrated, and suppose that such firms are chosen randomly and independently from their productivity.

An increase in μ from 0 to $\mu' \in (0, 1)$ will lead to a reduction in industry supply and therefore to an increase in equilibrium price. This change can lead other firms in the industry that would have otherwise chosen to be non-integrated to instead opt for integration.



The above figure illustrates the inverse supply curve under $\mu = 0$ and under $\mu' > 0$. Under $\mu = 0$, in equilibrium, there will be some firms that choose to be non-integrated. As drawn, in the $\mu' > 0$ case, output prices will be $p^* > 1/\underline{A}$, so all the firms that are not exogenously restricted to be non-integrated will in fact choose to be integrated.