Economics of Industrial Organization

Lecture 2: Costs and Technology

비용과 산업의 구조

- Cost structures are a *key determinant of industry structure and pricing behavior.*
- Definition: A firm's "technology" is the production relationship it uses to turn input goods into outputs. A firm might be able to make 1 unit of output with (3,1,1) units of inputs (x,y,z), or it might be able to make 1 unit of output with (1,2,5) units of inputs (x,y,z).

The technology available to a firm, plus input costs, gives us a cost function.

- We represent a firm's technology with a production function:

$$q = f(x_1, x_2, x_3, \ldots x_k)$$

비용극소화 Cost Minimization

- A firm's cost minimization problem is *to find the cheapest way of producing some output level* $\bar{q}$ *given technology and input prices.*
- We represent this problem as:

$$Min_{x_i} \sum_{i=1}^{k} w_i x_i \quad s.t. f(x_1, x_2, \ldots, x_k) = \bar{q}$$

By solving this problem for different levels of $\bar{q}$ we obtain the minimum cost of each possible production level.

Example

- Suppose we have a firm with 2 inputs, x_1 and x_2.
  Suppose the firm has the production function
  $f(x_1,x_2) = x_1^{1/2}x_2^{1/2}$.
  Suppose that input costs w = (3, 2)
  What is the cheapest way to produce q = 4?
- Solve: $\text{Min}_x\ (3x_1 + 2x_2)$ s.t. $x_1^{1/2}x_2^{1/2} = 4$
  Solve by substitution.
  $x_1^{1/2}x_2^{1/2} = 4$
  $x_1^{1/2} = 4x_2^{-1/2}$
  $x_1 = 16x_2^{-1}$
  Min: $3[16x_2^{-1}] + 2x_2^2$
  Foc: $-48x_2^{-2} + 4x_2 = 0$
  $x_2 = 12^{1/3}$
  $x_1 = 16/(12^{1/3})$

비용함수 Cost Functions

- We typically represent the firm's cost function with the expression *C(q) + F.*
  This lets us find:
- Fixed costs, F.
- Average costs, *AC(q) = [C(q) + F]/q*
  We may separate this into average fixed costs F/q and average variable costs C(q)/q.
- Marginal cost: *MC(q) = dC(q)/dq.*
- Some fixed costs may be "*sunk costs*", which are fixed costs which cannot be recovered, even if a firm does not produce anything or exits the market. *Entry costs are often (partly) sunk.*

Costs and output decisions

- Recall that profit maximization implies that MR = MC. Thus, a firm will produce at the intersection of marginal cost and marginal revenue as long as it produces any output at all.
- A firm will produce positive output (in the short run) as long as the price exceeds AVC. A firm will shut down if the price falls below AVC.
- A firm will exit the industry in the long run if the price falls below its long run ATC.
- A firm will be willing to enter an industry only if the present value of entry exceeds the sunk entry costs.

최소효율규모
Minimum Efficient Scale

- Recall that when average costs are falling, we have economies of scale; when average costs are rising, we have diseconomies of scale.
- *Economies of scale can come from fixed costs, or from specialization or more efficient production techniques. Diseconomies of scale typically occur because of increasing costs of coordination and management at larger scale.*
- We can measure scale economies by the measure $S = AC(q)/MC(q)$. Recall that MC < AC means AC is falling, MC > AC means AC is rising. So S > 1 implies economies of scale and S < 1 implies diseconomies of scale.
- Definition: ***Minimum efficient scale*** *is the lowest level of output at which economies of scale are exhausted*; i.e. the lowest q* at which $S \leq 1$ for all $q > q^*$.

자연독점 Natural Monopoly

- Suppose that market demand is such that the maximum market demand is less than the MES. Then, economies of scale are global in such a scale, so we have a natural monopoly.
- Definition: An industry is a **natural monopoly** if the average cost of producing any quantity q* is less than the average cost of producing any q' < q*.
- Formally, we require this to be true for every q*, but typically we call industries natural monopolies as long as this holds true for the q* equal to observed demand, even if average costs would eventually rise at some point past this.
- *Natural monopolies are particularly common for utilities; these often have large fixed costs for building a network (eg electricity transmission, cable TV, landline phones), and so strongly decreasing average costs.*

Efficient number of firms

- The efficient number of firms in an industry for producing a particular output level is that which does so at minimum total cost. *If the minimum efficient scale is large, it would be inefficient to have too many firms serving the market.*
- *In general, the larger the economies of scale, the more concentrated we would expect to see the market.*
- There can be a tradeoff here; higher concentration reduces welfare by increasing market power, but with economies of scale higher concentration (i.e. fewer firms) can increase welfare.
- The best attainable solution might have firms exercising some market power and firms operating below minimum efficient scale.

Sunk costs and market structure

- Recall that firms will only enter an industry with sunk entry costs if they expect to break even. This means they must earn positive profits per period to offset the entry cost.
- Example: Suppose entry costs in an industry are $100 million. Suppose that a fair economic return on investment is 10%. Then, firms must expect to earn excess (economic) profits of $10million per year to be willing to enter this industry. If expected profits are above this, more firms will enter (reducing market power and driving down profits).
- *Thus, in an industry with large sunk entry costs, we should expect to observe a positive price markup (i.e. P > MC) through exercise of market power. We should expect to observe higher concentration in these industries.*

Sunk costs and excess entry

- We can sometimes observe an interesting asymmetry in industries with sunk entry costs.
- Suppose that firms initially enter to the point where the present value of industry profits equal industry costs; this is a long-run equilibrium.
- *Suppose that costs unexpectedly fall; now profits are higher than that needed to cover entry costs, so more firms enter the market, driving profits*
- *Suppose instead that costs unexpectedly rise, reducing profits (but leave them still non-negative). This will* ***not*** *lead to firms exiting: the entry costs are sunk, and cannot be recovered, so there is no marginal incentive to exit.*
- Does this describe the US airline industry?

범위의 경제 Economies of Scope

- We say that an industry has “economies of scope” when it is less costly to produce some set of outputs in one firm than it would be to produce the set in two or more firms.
- Example: Suppose the cost producing two goods q_1 and q_2 are $C(q_1, q_2)$. Scope economies exist if:
  $C(q_1, 0) + C(0, q_2) – C(q_1, q_2) > 0$
- Example: it may be cheaper to have a rail company that provides both passenger and freight services than it is to have two separate companies, one that provides each product.
- Economies of scope arise for two main reasons:
  a) *Outputs share common inputs.* (Ex: railways, cereal)
  b) *Cost complementarities.* (Ex: software design and consulting)