Microeconomics, Module 8, “Competitive Firm in the Long-Run”

Short vs Long-Run Equilibria

(The attached PDF file has better formatting.)

Competitive pricing and monopolistic pricing are the core topics in this course. None of the equations used in this course are complex, but it is not always clear which equations to use.

Question: Competitive pricing has many formulas; where do we start? Do we first solve for the short run equilibrium or for the long-run equilibrium? Do we solve for the market equilibrium or for the firm equilibrium?

Answer: In a steady-state, both the short run and the long-run equilibria hold. In this scenario, we solve first for the firm’s long-run equilibrium, and we derive the competitive *quantity* from the firm’s cost curves. The firm’s long-run competitive quantity depends only on its cost curves, not on the supply and demand curves.

Question: Does the market demand curve ever affect the long-run equilibrium?

Answer: We must check some constraints; for example, the firm’s competitive quantity must not be so high that the market price at that point is below the firm’s average cost. This constraint is the natural monopoly case, which we cover in the module on monopoly.

Steady states do not persist, for two reasons:

- The market demand curve changes, as firms invent new products. Traditional phones were connected to wires built into the home. Every year or two of the past decade, a new type of phone is introduced, and the demand for the previous types of phones falls. Demand for products falls as substitutes are invented. Pharmaceutical drugs are similar: demand for one drug dries up when a better substitute is brought to market, though the pharmaceutical drug is less competitive than the phone market.
- Costs change. The cost of producing laptop computers declines every year. Some suppliers add better features to keep the cost high; other suppliers sell inexpensive laptops. Every time the costs change, the competitive equilibrium changes.

Question: Are the effects of changing demand and changing costs that great?

Answer: The effects are so great that a market leader one year may be bankrupt a few years later. Costs may change by a factor of ten within a decade, and demand may disappear entirely within the same period. Word processors drove out typewriters, and minicomputers have driven out word processors. Cellular phone that cost 1,000 one year cost 200 a few years later. Insurance costs and demand are steady from year to year; consumer products may have highly variable costs and demand.

We return to the general procedure. In the steady state, we use the firm’s cost curves to derive its competitive quantity. We derive the firm’s production function from its costs, which tells us the quantity and price at the minimum average total costs.

Question: Doesn’t the optimal production function depend on the quantity? If the firm produces 10,000 units a month, the optimal size may be a large factory; if it produces 100 units a month, the optimal size may be a smaller factory.

Answer: The firm examines the size of the market to determine the optimal plant size. If market demand or costs change, the optimal plant size may change. One homework assignment in the corporate finance course examines this scenario.

The price is the marginal cost (which is the also the average total cost) at the firm's quantity. Given the price, the market demand curve tells us the total quantity demanded. This quantity divided by the firm's quantity is the number of firms in the industry.

We have derived the long-run equilibrium quantity and price. Since costs and demand are continually changing, these are not the short run equilibrium quantity and price. Rather, the firm's production function tells us its supply curve. The sum of the supply curves of all the firms in the industry is the industry supply curve. Landsburg mentions some modifications, such as the factor price effect, which are not material in most cases and which we ignore here.

The industry supply and demand curves tell us the short run price. These curves are adjusted for any changes in cost or demand since we derived the long-run equilibrium. In the short run, a competitive firm is a price-taker: given the market price, the firm produces the quantity where marginal cost equals the price.

The assumption of perfect competition allowed us to skip a step here. If the industry were not competitive, we use the demand curve to determine the marginal revenue, and we equate marginal cost to marginal revenue. For the competitive industry, the demand curve is flat, and the marginal revenue equals the price.

Question: In most industries, are costs increasing or decreasing over time? I presume that since inflation is positive, cost are increasing.

Answer: We use real costs, not dollar costs; monetary inflation has no effect on costs. For most consumer products, competition spurs innovation and increased efficiency, and costs decrease rapidly. For auto insurance, the ever increasing litigiousness of society raises real costs year after year.

Question: Does demand normally rise or fall over time? As consumers get wealthier, does demand rise?

Answer: Consumers are about 2% or 3% wealthier each year. But competition spurs innovation, and many consumer products now have lifetimes of only a dozen years before their demand evaporates. Demand starts small, rises rapidly for several years, and then starts declining.

The short run equilibrium depends on the industry supply and demand curves. If costs and demand had not changed, the firms would earn zero economic profits. Since the firm's costs and the market demand change since the long-run equilibrium was established, firms may earn economic profits or incur economic losses in the short run.

Question: Do these changes in costs and demand affect the long-run equilibrium?

Answer: The change in the firm's costs affects the long-run equilibrium, changing the equilibrium quantity for each firm and the equilibrium price (the point of minimum average costs). The change in market demand does not affect the firm's cost curves, but it does affect the number of firms in the industry.

- If the new optimal number of firms in the industry is greater than the existing number of firms, each firm produces above its optimal quantity during the period needed for new firms to enter, and each firm makes economic profits.
- If the new optimal number of firms in the industry is less than the existing number of firms, each firm produces below its optimal quantity during the period needed for firms to exit, and each firm incurs economic losses.

Question: Do entry and exit take long? To be licensed as an insurer takes a few months.

Answer: For many industries, entry may take five to ten years: building plants, doing research, and developing new products.

The final exam questions are modeled on the scenarios in Landsburg's text. We start with a perfectly competitive industry in which all firms are identical. We have fixed costs and a marginal cost curve for the firm. For simplicity, we use a constant cost industry.

Step 1: We start with the long-run equilibrium. We must derive the firm's minimum long-run average total cost. To find this cost, we need the average total cost curve, which we derive from the total cost curve.

- If we are given fixed and variable cost curves, we add them to get the total cost curve.
- If we are given fixed and average variable cost curves, we multiply average variable costs by quantity to get the variable cost curve.

In practice, we don't know the variable cost curve, but we know the marginal cost curve. The firm knows how much it costs to produce each additional unit, and it derives the other cost curves from this information. We integrate the marginal cost curve to derive the variable cost curve. We add the fixed costs, divide by the quantity, and set the partial derivative of this average cost with respect to quantity equal to zero. This gives the quantity at the most efficient production.

Illustration: Suppose fixed costs are $2,500, and marginal costs are 2q. This is the simplest scenario, since the final equation is easily solved. The variable costs for producing Q units is the integral of 2q from 0 to Q, which is Q^2.

- The total cost is $\$2,500 + Q^2$.
- The average cost is the total cost divided by Q = $2,500/Q + Q.
- The partial derivative with respect to Q is $-\$2,500/Q^2 + 1$. Setting this equal to zero gives Q = 50.

Question: Instead of using integrals, can we simply add up the marginal cost for each unit?

Answer: For N units, this sum is 2 + 4 + 6 + … + 2N = 2 × N × (N+1) / 2 = N(N+1). The integral gave us a total cost of N^2. The difference of $N(N+1) – N^2 = N$ stems from using continuous vs discrete function.

- *Discrete function:* the marginal cost for the Q^{th} unit is 2Q.
- *Continuous function:* the marginal cost for the Q^{th} unit is ½ × (2Q + 2(Q-1)) = 2Q – 1.

To go from discrete functions to continuous function (in this illustration) we subtract 1 from every unit produced, or a total of N for all N units produced.

Step 2: Since the firm earns zero economic profits, the average total cost at this quantity is the market price.

The casual reader of Landsburg's textbook, if asked what determines competitive price and quantity, might say: the supply and demand curves. The correct answer is

- For the *short run*, the competitive price and quantity are determined by the market supply and demand curves. These are *not* affected by the firm's fixed expenses. The market supply curve is the sum of the supply curves of the individual firms, adjusted for factor price effects and other minor items. If firms are identical, the market supply curve is the product of the firm's marginal cost curve and the number of firms.
- For the *long-run*, the competitive price and quantity are determined by the firm's fixed and marginal costs, not by the market supply and demand curves. The firm's choice of fixed vs variable costs depends on its expectations of the market demand, but this is not covered in the textbook.

We continue the numerical illustration. The average total cost at a quantity of 50 is $2,500/50 + 50 = $100. The marginal cost curve intersects the average total cost curve at its minimum, so we can also take the marginal cost at the equilibrium quantity: 2 × $50 = $100.

Question: For short run pricing (to determine the shut-down price), we say the marginal cost curve intersects the average *variable* cost curve at its minimum. For long-run pricing, we say the marginal cost curve intersects the average *total* cost curve at its minimum. Which one is correct?

Answer: They are both correct. These are different quantities and different prices.

Step 3: From the market demand curve, we determine the quantity demanded at the equilibrium price. If the firms are identical, the market quantity divided by the quantity supplied by each firm is the number of firms.

If the equilibrium long-run number of firms is not the same as the existing number of firms (and if it takes time for firms to enter and exit), firms earn short run economic profits or losses.

For the numerical illustration, suppose the market demand curve is Q = 20,000 – 100P. At P = 100, Q = 20,000 – 100 × 100 = 10,000. Each firm produces 50, so there are 200 firms in the industry. (To make this illustration reasonable, think of Q as daily production.)

The final exam focus on equilibrium prices and quantities, but many other items can be asked as well. For example, suppose a competing product is introduced, and market demand changes to Q = 18,000 – 100P. We derive the short run quantity and price for each firm.

The marginal cost curve for each firm is MC = 2q. Since price equals marginal cost, the supply curve for each firm is Q = ½ P. The supply curve for the industry is Q = 200 × ½ P = 100P. To find the equilibrium short run Q and P, we equal supply and demand:

$$100 P = 18{,}000 - 100P \Rightarrow 200P = 18{,}000 \Rightarrow P = 90 \text{ and } Q = 9{,}000.$$

Each firm produces 9,000 / 200 = 45.

We determine the short run profit or loss for each firm.

- The revenue is 45 × \$90 = \$4,050
- The fixed costs are \$2,500.
- The variable costs are 45^2 = \$2,025
- The profit is \$4,050 – \$2,500 – \$2,025 = –\$475

Question: What happens now, since all firms are losing money? Do they raise prices?

Answer: A firm that raises prices would lose its market share and suffer a net loss of \$2,500. If firms expect market demand to rise, they incur the loss and continue producing at this level. If they do not expect market demand to rise, some firms leave. Once twenty firms leave, the remaining firms earn zero economic profits.

Question: The firms are identical; which twenty firms leave?

Answer: Identical means the firm have similar production functions, not that they make identical decisions.

- Some firms may be optimistic and expect demand to rise; other firms may be pessimistic and expect demand to stay at the same level or to fall further.
- Some firms have other opportunities, and may decide to produce a different product.

If the firms are not perfectly identical, some firms are less efficient and more likely to exit.

Landsburg mentions two items that change the ideal scenario here.

(1) Few markets are perfectly competitive. In many instances, the imperfections do not distort the pricing. As long as entry and exit are easy and costless, the competitive equilibrium holds. But when firms have market power, the pricing procedure is different; we explain it in the modules on monopoly, market power, and price discrimination.

(2) In some markets, the average cost curve is downward sloping for the entire region relevant to pricing. This is true when marginal cost is constant and fixed costs are large. These industries are natural monopolies.

The traditional examples were municipal utilities, of which the best example was phone service. These industries have since become competitive because their cost structures have changed; fixed costs have been replaced by variable costs. Landsburg's examples now are computer software and other high-tech products. A similar example is pharmaceutical drugs, though this relies also on patent protection.

We use computer software to illustrate a natural monopoly. Suppose it costs $100 million for the research to produce a software application (fixed costs) and $10 to burn a diskette, package the software, copy the manual, transport the software to store shelves, and pay the distributor's costs. The marginal cost does not rise with increasing volume, since no factory is needed to produce more copies of the software. The total cost is $100 million + $10 × Q; the average cost is $100 million / Q + $10; and the partial derivative with respect to Q is –$100 million / Q^2. This equals zero at Q = infinity. But at Q = infinity, the market demand curve shows a price of P = 0. At a price of zero, the firm incurs losses of $100 million + $10 × Q. No firm wants to lose money. This pricing procedure does not work.