Firms in Competitive Markets

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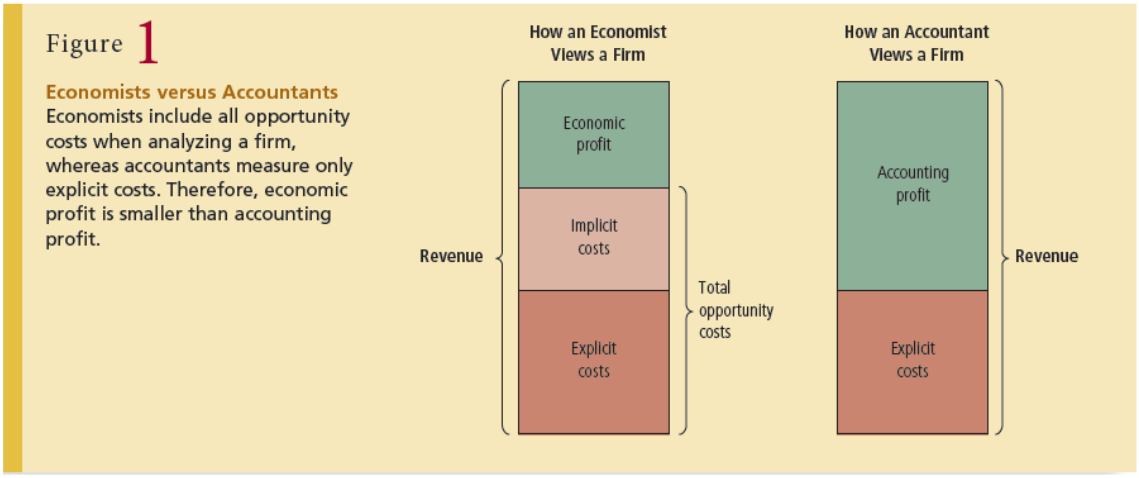
Abstract

Study notes based on (Mankiw, 1998, pp. 263-302).

The Costs of Production

The amount that the firm receives for the sale of its output is called its **total revenue**. The amount that the firm pays to buy inputs is called its **total cost**. We define **profit** as a firm's total revenue minus its total cost:

- Accounting profit = total revenue – total accounting (explicit) costs
- Economic profit = accounting profit – implicit opportunity cost = total revenue – total accounting cost – implicit opportunity cost = total revenue - total economic costs



The relationship between the quantity of inputs and quantity of output is called the **production function**. The **marginal product** of any input into production is the increase in the quantity of output obtained from an additional unit of that input. **Diminishing marginal product** is the property that the marginal product of an input declines as the quantity of the input increases.

Fixed costs are the costs that do not vary with the quantity of output produced. **Variable costs** are the costs that do vary with the quantity of output produced. **Average total cost** is total cost divided by the quantity of output

$$ATC = Total\ cost/Quantity = TC/Q.$$

Average fixed cost is fixed cost divided by the quantity of output

$$AFC = Fixed\ cost/Quantity = FC/Q.$$

Average variable cost is variable costs divided by the quantity of output

$$AVC = Variable\ costs/Quantity = VC/Q.$$

Marginal cost is the increase in total cost that arises from an extra unit of production

$$MC = Change\ in\ total\ cost/Change\ in\ quantity = \Delta TC/\Delta Q.$$

The following figure of cost curves show three features that are considered common: (1) Marginal cost rises with the quantity of output. (2) The average-total-cost curve is U-shaped. (3) The marginal-cost curve crosses the average-total-cost curve at the minimum of average total cost.

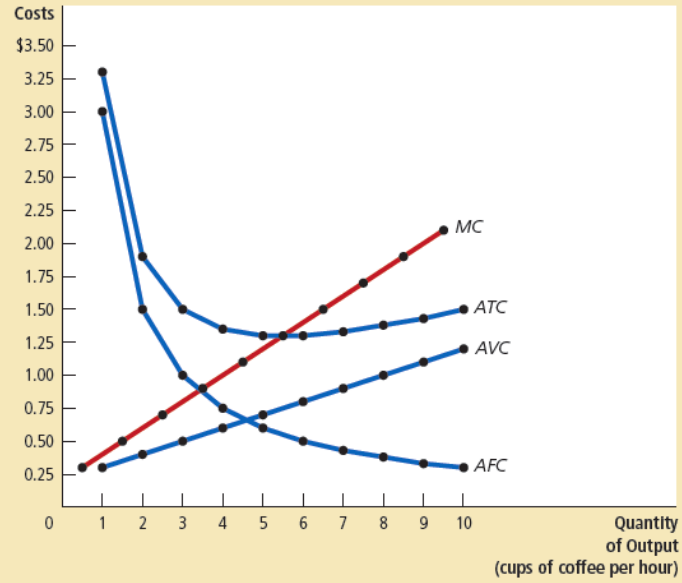


Figure 4

Conrad's Average-Cost and Marginal-Cost Curves

This figure shows the average total cost (*ATC*), average fixed cost (*AFC*), average variable cost (*AVC*), and marginal cost (*MC*) for Conrad's Coffee Shop. All of these curves are obtained by graphing the data in Table 2. These cost curves show three features that are typical of many firms: (1) Marginal cost rises with the quantity of output. (2) The average-total-cost curve is U-shaped. (3) The marginal-cost curve crosses the average-total-cost curve at the minimum of average total cost.

The first feature, that marginal cost rises with the quantity of output, is a consequence of the property of *diminishing marginal product*, since

$$marginal\ product = \Delta Q/\Delta TC = 1/MC$$

The third feature, that the marginal-cost curve crosses the average-total-cost curve at the minimum of average total cost, is a consequence of the following observation

$$\frac{d(ATC)}{dQ} = \frac{d}{dQ}\left(\frac{TC}{Q}\right) = \frac{Q \cdot d(TC) - TC \cdot dQ}{Q^2} = \frac{dQ}{Q}(MC - ATC).$$

Assuming $MC < ATC$ in the beginning and MC eventually becomes monotone increasing, we can conclude the average-total-cost curve reaches minimum at the output quantity where $MC = ATC$ – the intuition is clear: marginal cost rises with the quantity of output and when $MC < ATC$, the new contribution of unit cost is not enough to "compensate" the decline in average-total-cost.

The above formula also proves the second feature, that the average-total-cost curve is U-shaped, as far as MC curve crosses ATC curve from below. The bottom of the U-shape occurs at the quantity that minimizes average total cost and the corresponding quantity is called the **efficient sale** of the firm – *efficient* because the average cost is minimal and unit profit (unit price – average cost) is maximal. Using this new terminology, we say *the marginal-cost curve crosses the average-total-cost curve at the efficient scale*.

One caution though: diminishing marginal product does not start to occur immediately after the first worker is hired. Firms will first experience increasing marginal product for a while before diminishing marginal product sets in. So the shapes of cost curves should look like the following figure

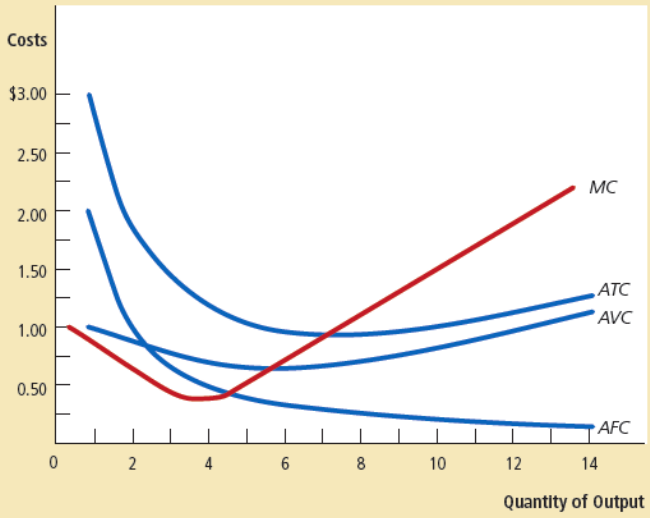


Figure 5

Cost Curves for a Typical Firm

Many firms experience increasing marginal product before diminishing marginal product. As a result, they have cost curves shaped like those in this figure. Notice that marginal cost and average variable cost fall for a while before starting to rise.

We comment that MC crosses AVC curve at its bottom too, as the same argument applies:

$$\frac{d(AVC)}{dQ} = \frac{d}{dQ}\left(\frac{VC}{Q}\right) = \frac{Q \cdot d(VC) - VC \cdot dQ}{Q^2} = \frac{dQ}{Q}(MC - AVC).$$

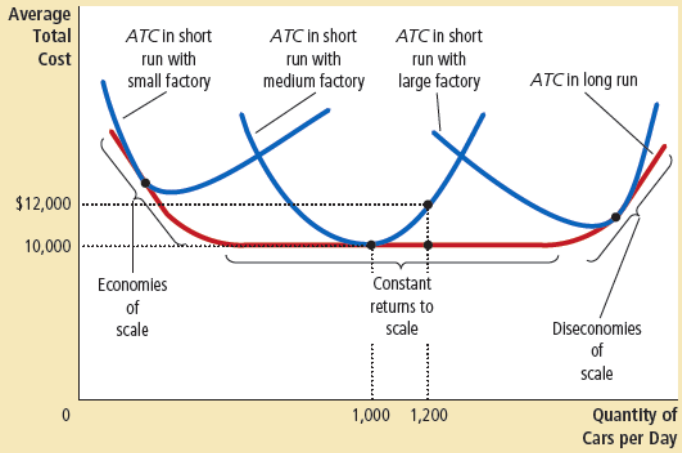
Lastly, we consider the average total cost in the short and long runs. **Economies of scale** is the property whereby long-run average total cost falls as the quantity of output increases, **diseconomies of scale** is the property whereby long-run average total cost rises as the quantity of output increases, and **constant returns to scale** is the property whereby long-run average total cost stays the same as the quantity of output changes.

Economies of scale might arise, for instance, because modern assembly-line production requires a large number of workers, each specializing in a particular task. Diseconomies of scale might arise, for instance, because it is difficult for firm managers to oversee a large organization.

Figure 6

Average Total Cost in the Short and Long Runs

Because fixed costs are variable in the long run, the average-total-cost curve in the short run differs from the average-total-cost curve in the long run.



Firms in Competitive Markets

A **competitive market**, sometimes called a **perfectly competitive market**, has two characteristics:

- There are many buyers and many sellers in the market (**Axiom 1**).
- The goods offered by the various sellers are largely the same (**Axiom 2**).

As a result of these conditions, the actions of any single buyer or seller in the market have a negligible impact on the market price. Each buyer and seller takes the market price as given, and they are said to be **price takers**.

There is a third condition sometimes thought to characterize perfectly competitive markets:

- Firms can freely enter or exit the market (**Axiom 3**).

Total revenue is defined as the total sales. **Average revenue** is total revenue divided by the quantity sold $AR = TR/Q$. **Marginal revenue** is the change in total revenue from an additional unit sold $MR = \Delta TR/\Delta Q$.

Marginal revenue and price-taking of a competitive firm

According to Axiom 1 and 2 of a competitive market, competitive firms are price takers so that the price of a good they produce is a constant independent of output quantity. Consequently, for a competitive firm, marginal revenue equals the price of the good and total revenue $TR = P \times Q$. In summary

$$competitive\ markets\ (Axiom\ 1\ \&\ 2)\ \Rightarrow MR = P$$

Profit maximization and supply curve of a competitive firm

Recall cost curves have three features: the marginal-cost curve (MC) is upward sloping, the average-total-cost curve (ATC) is U-shaped, and the marginal-cost curve crosses the average-total-cost curve at the minimum of average total cost.

Suppose marginal cost is smaller than marginal revenue in the beginning, but eventually surpasses the latter as quantity of output increases, then the profit is maximized at $MC = MR$. Beyond that point, new sales only incur loss. A mathematical proof goes as follows

$$\frac{\Delta\, profit}{\Delta Q} = \frac{\Delta(TR - TC)}{\Delta Q} = MR - MC$$

So profit reaches maximum at the quantity of output where $MR = MC$.

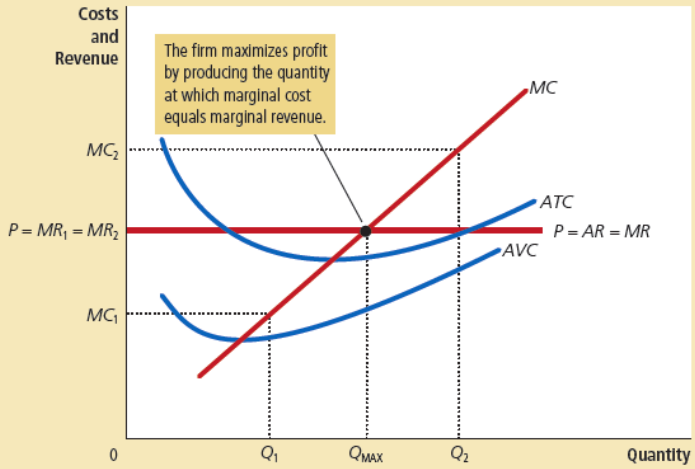
$$profit\ maximization\ \Rightarrow MR = MC.$$

Because a competitive firm is a price taker, its marginal revenue MR equals the market price P. For any given price, the competitive firm's profit-maximizing quantity of output is found by looking at the intersection of the price with the marginal-cost curve.

Figure 1

Profit Maximization for a Competitive Firm

This figure shows the marginal-cost curve (*MC*), the average-total-cost curve (*ATC*), and the average-variable-cost curve (*AVC*). It also shows the market price (*P*), which equals marginal revenue (*MR*) and average revenue (*AR*). At the quantity Q_1, marginal revenue MR_1 exceeds marginal cost MC_1, so raising production increases profit. At the quantity Q_2, marginal cost MC_2 is above marginal revenue MR_2, so reducing production increases profit. The profit-maximizing quantity Q_{MAX} is found where the horizontal price line intersects the marginal-cost curve.



We can now see how the competitive firm decides the quantity of its good to supply to the market. Because a competitive firm is a price taker, its marginal revenue equals the market price. For any given price, the competitive firm's profit-maximizing quantity of output is found by looking at the intersection of the price with the marginal-cost curve. In the above figure, that quantity of output is Q_{MAX}. *In essence, because the firm's marginal-cost curve determines how much the firm is willing to supply at any price, it is the competitive firm's supply curve.*

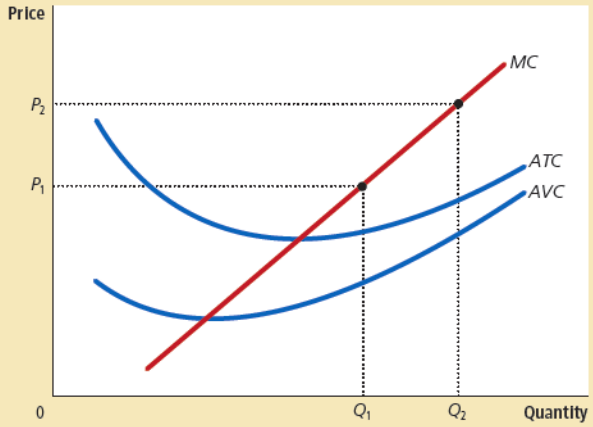


Figure 2

Marginal Cost as the Competitive Firm's Supply Curve
An increase in the price from P_1 to P_2 leads to an increase in the firm's profit-maximizing quantity from Q_1 to Q_2. Because the marginal-cost curve shows the quantity supplied by the firm at any given price, it is the firm's supply curve.

Shutdown and exit decisions of a competitive firm

A **shutdown** refers to a short-run decision not to produce anything during a specific period time because of current market conditions. **Exit** refers to a long-run decision to leave the market. A firm that shuts down temporarily still has to pay its fixed costs, whereas a firm that exits can save both its fixed and its variable costs.

A firm shuts down if the revenue that it would get from producing is less than the variable costs of production:

$shut\ down\ if\ TR < VC$, or equivalently for competitive market, $Shut\ down\ if\ P < AVC$.

We now have a full description of a competitive firm's profit-maximizing strategy. If the firm produces anything, it produces the quantity at which marginal cost equals the price of the good. Yet if the price is less than average variable cost at that quantity, the firm is better off shutting down and not producing anything.[1] *The competitive firm's short-run supply curve is the portion of its marginal-cost curve that lies above average variable cost.*

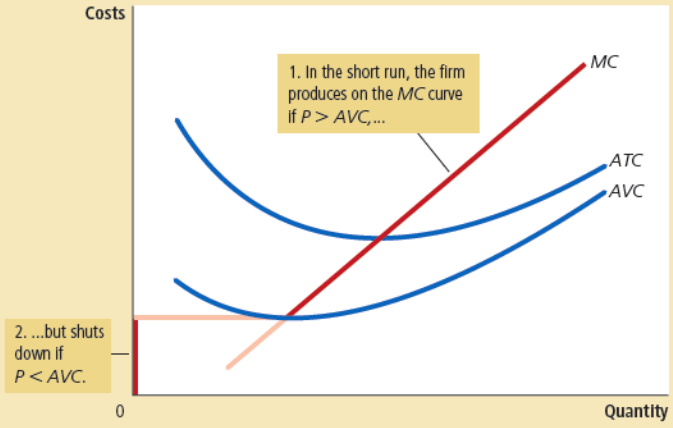


Figure 3

The Competitive Firm's Short-Run Supply Curve
In the short run, the competitive firm's supply curve is its marginal-cost curve (*MC*) above average variable cost (*AVC*). If the price falls below average variable cost, the firm is better off shutting down.

[1] Note *determining the optimal quantity to produce once in production* and *determining whether to produce* are two separate issues.

A firm exits if the revenue that it would get from producing is less than the total costs of production:

$$exit\ if\ TR < TC, \text{ or equivalently for competitive markets, } exit\ if\ P < ATC.$$

We can now describe a competitive firm's long-run profit-maximizing strategy. If the firm is in the market, it produces the quantity at which marginal cost equals the price of the good. Yet if the price is less than the average total cost at that quantity, the firm chooses to exit (or not enter) the market. *The competitive firm's long-run supply curve is the portion of its marginal-cost curve that lies above average total cost.*

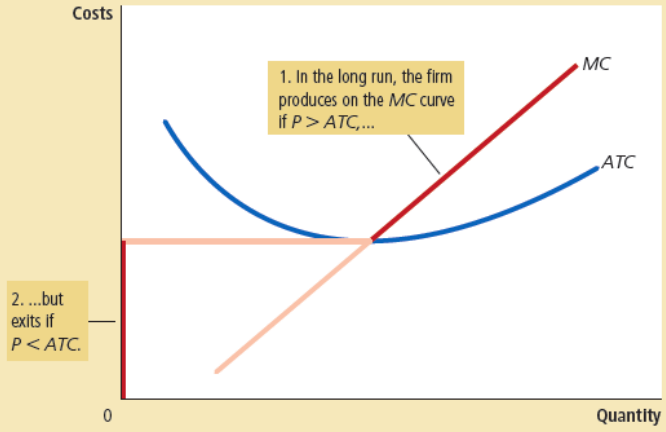


Figure 4

The Competitive Firm's Long-Run Supply Curve

In the long run, the competitive firm's supply curve is its marginal-cost curve (*MC*) above average total cost (*ATC*). If the price falls below average total cost, the firm is better off exiting the market.

The supply curve in a competitive market with free entry and exit

Firms will enter or exit the market until profit is driven to zero. Thus, the long-run equilibrium of a competitive market with free entry and exit must have firms operating at their efficient scale (i.e. $ATC = P = MR = MC$):

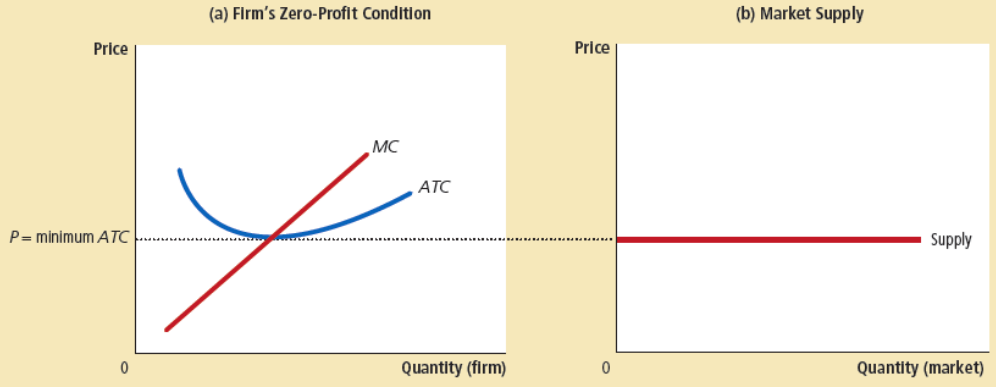
$$free\ entry\ and\ exit\ (Axiom\ 3) \Rightarrow P = ATC.$$

As a result, the long-run market supply curve must be horizontal at this price.

Figure 7

Long-Run Market Supply

In the long run, firms will enter or exit the market until profit is driven to zero. As a result, price equals the minimum of average total cost, as shown in panel (a). The number of firms adjusts to ensure that all demand is satisfied at this price. The long-run market supply curve is horizontal at this price, as shown in panel (b).



Why do competitive firms stay in business if they make zero profit? In the zero-profit equilibrium, economic profit is zero, but accounting profit is positive.

Bibliography

Mankiw, G., 1998. *Principles of Economics.* 北京: 机械工业出版社.