11 OUTPUT AND COSTS

Outline

I. Decision Time Frames

A. The firm has one objective: *profit maximization*. In order to attain maximum profits the firm must take a variety of decisions. One of these is the decision of how to produce a given quantity of output. This decision depends on the relationship between a firm's output and costs, which in turn depends on the time frame. There are two time frames:

1. the short run.
2. the long run.

B. The **short run** is a period of time during which the quantity of at least one input is fixed and the quantities of the other inputs can be varied.

1. *Variable inputs* are those for which it is possible to change the quantity used in the short run.
2. *Fixed inputs* are those whose amount cannot be changed in the short run.
3. No uniform amount of time divides the short run from the long run for all industries.
4. Short-run decisions are easily reversed.

C. The **long run** is the time frame in which the quantities of *all* resources can be varied.

1. Plant size, as well as labor and all other resources, are variable in the long run.
2. Long-run decisions are not easily reversed.
3. **Sunk costs** are irrelevant to a firm's decisions. They have already been incurred and cannot be changed. An example of a sunk cost is the past cost of buying a new plant.

II. Short-Run Technology Constraint

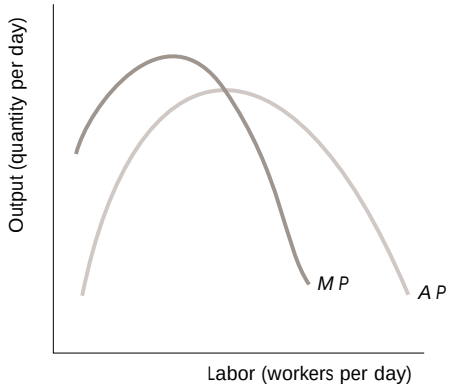
A. To boost output in the short run, a firm must increase the amount used of a variable input. Three relationships capture aspects of this technological constraint:

1. **Total product** is the total amount produced.

2. The **marginal product** of labor is the increase in output resulting from a one-unit increase in the amount of labor employed.
3. The **average product** of labor equals total output divided by the amount of labor employed.

B. Figure 11.1 shows how marginal and average products are related to the amount of labor used.

FIGURE **11.1**
The Marginal and Average Products



C. When the marginal product of labor curve rises, the firm experiences **increasing marginal returns;** that is, the marginal product of an additional worker exceeds the marginal product of the previous worker.

D. When the firm experiences **diminishing marginal returns**, the marginal product of labor curve falls; that is, the marginal product of an additional worker falls short of the marginal product of the previous worker. The **law of diminishing returns** states that, as a firm uses more of a variable input without changing the quantity of fixed inputs, the marginal product of the variable input eventually diminishes.

E. The marginal product and average product curves in Figure 11.1 have the usual relationship between average and marginal variables:
1. The average product increases when the marginal product exceeds the average product.
2. The average product falls when the marginal product is smaller than the average product.
3. The average product is at its maximum and does not change when the marginal product equals the average product.

III. Short-Run Cost

A. **Total cost,** *TC*, is the cost of *all* the productive resources used by the firm. It can be divided into two separate costs:
1. **Total fixed cost,** *TFC*, is the cost of the firm's fixed inputs; this cost is independent of the level of the firm's output.
2. **Total variable cost,** *TVC*, is the cost of the firm's variable inputs; this cost changes with the firm's level of output.
3. Total cost equals total fixed cost plus total variable cost, or $TC = TFC + TVC$.

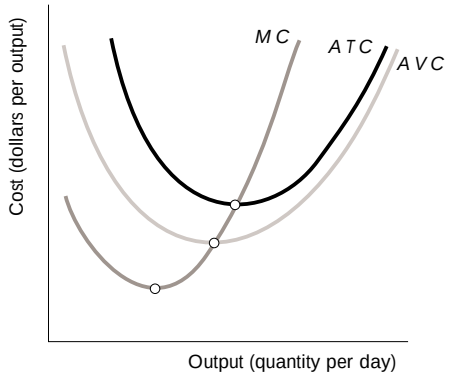
B. **Marginal cost,** *MC*, is the increase in total cost resulting from a one-unit increase in output.

C. **Average total cost,** *ATC*, is total cost per unit of output; **average fixed cost,** *AFC*, is fixed cost per unit of output; **average variable cost,** *AVC*, is variable cost per unit of output.
1. Average total cost equals average fixed cost plus average variable cost, or $ATC = AFC + AVC$.

D. Marginal cost, average total cost, and average variable cost curves are illustrated in Figure 11.2.

1. The marginal cost, average total cost, and average variable cost curves are U-shaped.
   a) Initially the average total cost curve slopes downward because the average fixed cost drops rapidly as fixed costs are spread over more output.
   b) Because of diminishing returns, the average variable cost curve eventually rises, and thus the average total cost curve also eventually rises.
2. The marginal cost curve cuts the average total cost and average variable cost curves at their minimum.

FIGURE **11.2**
Average and Marginal Cost Curves



E. The shapes of a firm's cost curves are determined by the technology it uses:

1. Marginal cost is at its minimum at the same output for which marginal product is at its maximum; the output range over which the marginal cost declines is the same range over which the marginal product increases; and the output range where marginal cost increases is the same range where marginal product declines.

F. A technological advance that increases productivity shifts the product curves upward and the cost curves downward. If a technological advance requires that more capital and less labor be used, at low levels of output the average total cost curve shifts upward and at higher levels of output the average total cost curve shifts downward.

G. Changes in the prices of resources shift the cost curves.

1. An increase in a *fixed* cost shifts the total cost (*TC*) and average total cost (*ATC*) curves upward but does not shift the marginal cost (*MC*) curve.
2. An increase in a *variable* cost shifts the total cost (*TC*), average total cost (*ATC*), and marginal cost (*MC*) curves upward.

IV. Long-Run Cost

A. **Long-run cost** is the cost of production when a firm uses the economically efficient quantities of capital and labor.

B. The **production function** shows the relationship between different amounts of capital and labor the firm can use and the maximum amount of output that can be produced. The firm's production function determines the behavior of long-run cost.

C. The marginal product of capital is the increase in output resulting from a one-unit increase in the amount of capital employed, holding constant the amount of labor employed.

1. Just as the law of diminishing returns indicates that the marginal product of labor (eventually) diminishes, so too does the marginal product of capital (eventually) diminish.

D. The **long-run average cost curve** (*LRAC*) shows the lowest average total cost for different levels of output when both capital and labor inputs are varied.

1. For any output, the *LRAC* curve is derived from the short-run average total cost curve that has the smallest average cost for that level of output.

E. When long-run average cost falls, there are *economies of scale*; when long-run average cost rises, there are *diseconomies of scale*; when the long-run average cost remains constant, there are *constant returns to scale*.

1. **Economies of scale** occur when "the percentage increase in output exceeds the percentage increase in (all) inputs." When there are increasing returns to scale, the long-run average cost falls.
2. **Diseconomies of scale** occur when "the percentage increase in output is less than the percentage increase in (all) inputs." If the firm experiences decreasing returns to scale, the long-run average cost rises.
3. **Constant returns to scale** occur when "the percentage increase in a firm's output is equal to the percentage increase in (all) its inputs." With constant returns to scale, the long-run average cost is constant.
4. **Minimum efficient scale** is the smallest quantity of output at which the long-run average cost reaches its lowest level. If the long-run average cost curve has the typical U shape, the minimum point identifies the minimum efficient scale output level.