PRODUCTION COSTS

SHORT RUN VERSUS LONG RUN

A firm makes numerous decisions in its effort to maximize profits. It must choose a product to produce and sell. It must decide upon a particular production technology to use to produce the good or service. After the firm is in business, it must be ready to make decisions of all kinds in response to changes in the market. In all of these decisions, the firm has a range of alternatives to choose from. One of the most important determinants of the alternatives available to a firm in its decision making is the time dimension of the decision.

For convenience we will distinguish between the long run and the short run and will use this important distinction throughout the rest of the book. In the long run, a firm is free to vary all its inputs. Thus, a long-run decision for a firm is a planning decision. The decisions to enter a new business or build a new plant are long-run decisions. The choice of a least-cost combination of all inputs, or the technology that embodies this combination, is a long-run decision. Long-run decisions are based on expectations about future prices and costs. The decision maker is free to consider a wide range of alternatives and faces few constraints.

In the short run, at least one of the firm's input levels is fixed. For example, in the short run the firm's production technology and its stock of capital equipment are fixed. Thus, a short-run decision is a constrained decision. The firm's short-run profit-maximizing decision is to choose an output level (and levels of inputs that can be varied in the short run) that maximizes profit.

The short run is not a chronological period of time but rather is defined by the firm's production technology. For example, it may take an electrical utility five or more years to vary all of its inputs. It takes a long time to build a new power-generating plant. On the other hand, an entrepreneur in retail trade may be able to vary all of his inputs within a six-month period. A retail store can be built from scratch and stocked for business in a matter of months. This implies that the short run is approximately five years in the electrical utility industry but only six months in retail trade. The nature of the firm's business determines the length of the short run.

This distinction between short run and long run is a general one. It can be used to characterize all kinds of decisions, not just those made by firms. Before a semester begins, you decide whether to work or go to school or which courses to take. If you decide to go to school and enroll in five classes, you may consider dropping one of the courses during the semester. The decision to take five courses in this semester was a long-run decision; the decision to drop a course is a short-run decision that is influenced by the fact that you are enrolled in four other courses.

Sunk Costs. Decisions should be based on the full opportunity costs of different alternatives. Sometimes, however, it is difficult to distinguish between the full opportunity costs of an action and costs that have already been incurred–**sunk costs**. Historical costs are sunk costs because they have been paid in the past and a decision today will not alter them. Thus, sunk costs are irrelevant to today's decision making and should be ignored. When a firm is deciding whether to produce another unit of its output, it should consider only the extra costs of the unit such as those for materials and labor. The cost of an existing machine used to produce the unit should be ignored. The firm owns the machine, and its cost is not altered by producing one more unit (ignoring depreciation).

What about other decisions? Should the tuition cost of a course be considered when trying to decide whether you should drop the course? No, unless you will get a tuition refund. The tuition cost was incurred in the past when you made the long-run decision and, after any refund period has expired, dropping the course will not change that cost. What matters for this decision is the future costs incurred and benefits received by continuing in the course. Tuition has become a sunk cost. In the next section we see very explicitly how profit-maximizing firms ignore sunk costs in their short-run decisions. Remember that only the true costs of an action or decision should be included in the decision-making process. Sunk costs should be ignored. Good economic decision making is forward thinking.

THE SHORT-RUN PRODUCTION PROCESS

To be able to calculate the short-run costs of producing various levels of output a firm needs certain information. First, it needs to know the types and quantities of inputs it will use in the production process. In addition, it needs to know the per unit price of each input. Combining this information with any implicit costs yields the total cost of each level of output the firm produces. The prices of inputs purchased by the firm are determined in the market for each input. The quantity of each input required to produce a particular level of output is determined by the firm's production function.

THE FIRM'S SHORT-RUN PRODUCTION FUNCTION

To understand the short-run relationship between output and costs, we must first understand the physical process of production. The technical relationship between the quantity of inputs required to produce a good and the quantity of output produced is called a production function. The production function determines the maximum output that can be produced from a given quantity of inputs (including technology). Thus, the production function embodies productive efficiency–the process of getting the maximum output from a given quantity of inputs.

As an illustration, assume that a production process requires only capital (K) and labor (L) to produce output (Q). In the short run, the firm employs at least one input that is fixed in amount (usually capital); it cannot vary the quantity of this input. Thus, in the short run, the firm's level of output is determined by the quantity of labor employed with a fixed stock of capital equipment.

A simple example of a short-run production function for snow removal in a parking lot is given in Table 6.1. In this example, output is measured as cubic yards of snow removed per minute. The short-run production function is illustrated in the first two columns of the table. The first column shows the amount of labor employed. The second column shows how much output is produced for each amount of labor (assuming a fixed stock of capital, in this case, three snowplows). Notice the output pattern. As more and more labor is added to the production process, output increases, but ultimately it increases by smaller and smaller amounts.

The change in output associated with an additional unit of the variable input (labor in this example) is called its marginal physical product (MP), and can be written, in the case of labor (L), as:

$$\mathbf{MPL = \Delta Q / \Delta L}$$

The marginal product of the variable input is important in the firm's decision-making process. It tells the firm how much additional output will be produced by adding one more unit of the input to the production process. The third column of Table 6.1 shows the marginal product associated with each unit of labor. Note that the marginal product of labor rises from 20 units to 28 units as we employ the first 3 units of labor. However, beginning with the fourth unit of labor, marginal product begins to decline, falling to 5 units of output for the seventh unit of labor.

This pattern of diminishing marginal productivity for the variable input occurs in every short-run production function. It is the law of diminishing returns in production. Diminishing returns occur in the short run because more and more of one input is being added to a production process with at least one fixed input. The amount of additional output that can be produced in this case is physically limited by the amount of the fixed input. In Table 6.1, the law of diminishing marginal returns occurs between the third and fourth units of labor employed.

To better understand this concept, note that the firm in our example has three machines–snowplows–that produce the firm's output–snow removal. At least one worker must operate the plows. Additional workers will increase output. One or two additional workers can increase output significantly. Each worker is able to spend more time operating machines and less time running between them. As we add more than three workers, however, fewer ways exist for them to increase output. They can operate the plows while other workers rest or they can take care of all the other tasks while three workers only operate the plows. However, as more and more workers are added, less and less additional output is produced. At some point, an additional worker might actually reduce output by simply getting in the way and reducing the productivity of other workers.

Table 6.1: *Short-Run Production Function for Snow Removal*

	Measures of Daily Productivity	
Units of Labor Per Day	Total Output	Marginal Product
0	–	–
1	20	20
2	45	25
3	73	28
*4	99	26
5	121	22
6	136	15
7	141	5

Capital units = 3
* Diminishing marginal returns are incurred with the fourth unit of labor.

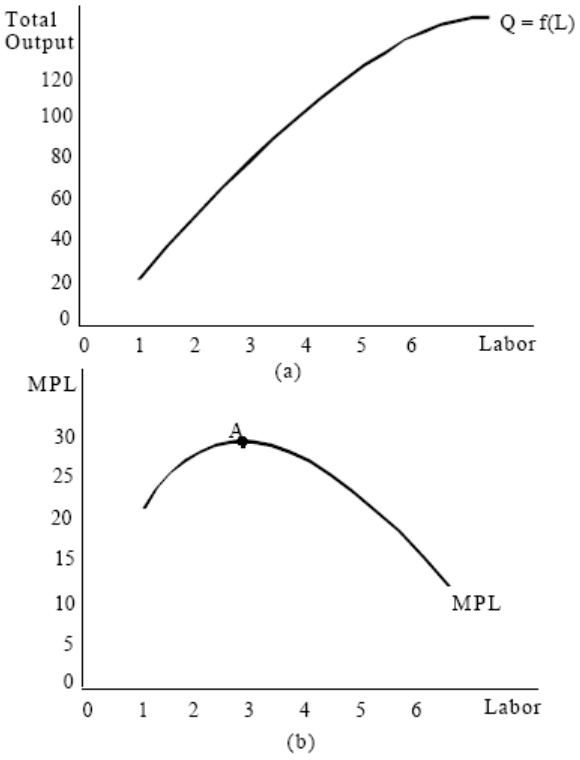

Figure 6.1: ***The Short-Run Production Function, Average Product, and Marginal Product***
The total and marginal output schedules in Table 6.1 are graphed as functions of the labor input in Figures 6.1 (a) and (b). In Figure 6.1 (a) we have graphed total output. Output increases as more units of labor are added, but the rate of increase in output decreases with additional units of labor. The marginal product of labor is illustrated in Figure 6.1 (b). Initially, marginal product increases as units of labor are increased. However, the marginal product of labor begins to decline when diminishing marginal productivity sets in. This occurs at point A in Figure 6.1 (b).

THE FIRM'S SHORT-RUN COST FUNCTIONS

The production function is one important determinant of production costs. It determines the kind and quantity of inputs required for a given level of output. The other determinant of costs is input prices. The firm pays the market price for each input that it purchases to use in production. Therefore, for any given level of output, the total cost of production (TC) is the sum of the costs (price times the quantity) of each input used in the production process (plus any implicit costs).

In the short run, at least one input is fixed and other inputs are variable. Fixed costs do not vary with output. Total fixed cost (TFC) is the sum of all costs that do not vary with output. In our example, the fixed cost is the cost of capital. Other examples of fixed costs include overhead expenses, the building in which the firm is located, and the entrepreneur's opportunity costs. In the short run, fixed costs are sunk costs. They are incurred regardless of the level of output. Thus, in making short-run output decisions, fixed costs are ignored.

Variable costs vary directly with the quantity of output produced. Total variable cost (TVC) is the sum of all costs that vary directly with the quantity of output produced. Examples of variable costs include some labor costs, the costs of raw materials, and the cost of energy used in the production process. Because all costs are either fixed or variable, it is the case that:

$$\mathbf{TC = TFC + TVC}$$

ACTIVITY

Using data in table 6.1 (total output) draw a new table and calculate TFC, TVC and TC. Assume that the price of a unit of labor is $30, the price of capital per unit per day is $25, and the amount of capital is fixed at 3 units (the snowplows). Then graph total costs (x) vs Q (y) and plot the figures you´ve calculated to form three curves (TC, TVC, and TFC). What do you conclude?