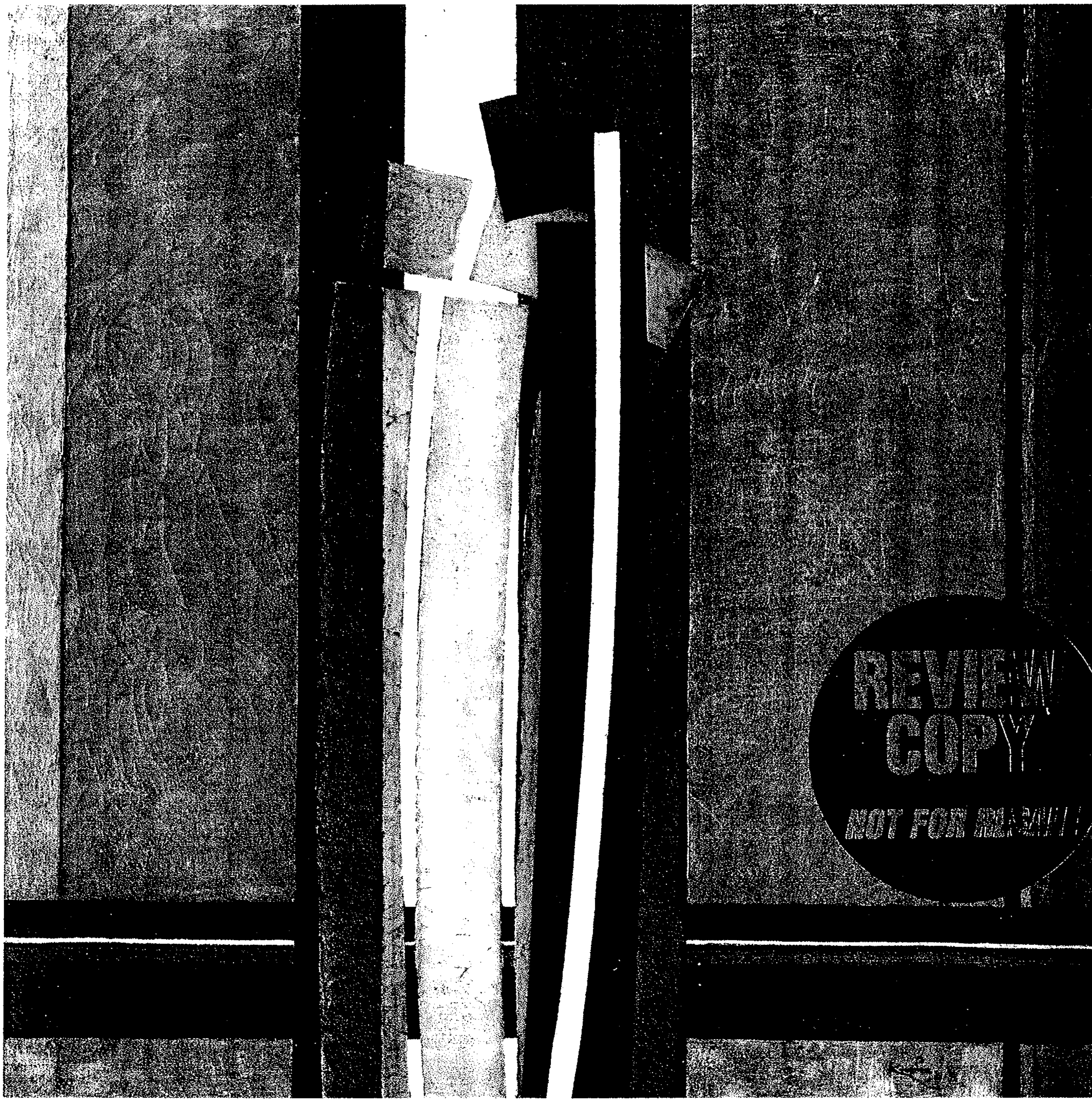
EXHIBIT 9

PRINCIPLES OF



MICROECONOMICS

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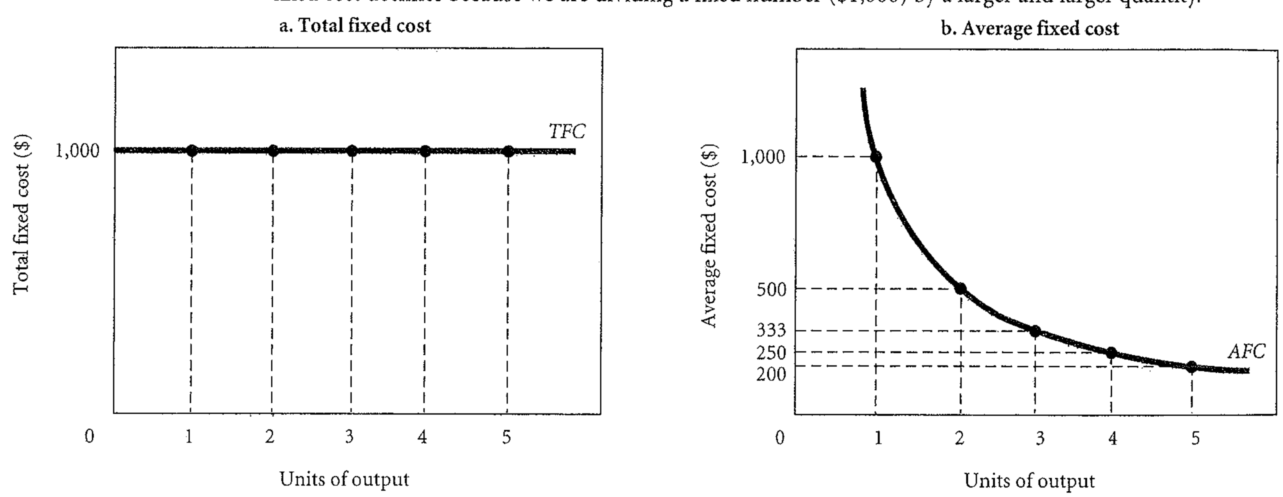
TABLE 7.1

Short-Run Fixed Cost (Total and Average) of a Hypothetical Firm

(1) q	(2) TFC	(3) AFC (TFC/q)
0	$1,000	$ —
1	1,000	1,000
2	1,000	500
3	1,000	333
4	1,000	250
5	1,000	200

FIGURE 7.2
Short-Run Fixed Cost (Total and Average) of a Hypothetical Firm

Average fixed cost is simply total fixed cost divided by the quantity of output. As output increases, average fixed cost declines because we are dividing a fixed number ($1,000) by a larger and larger quantity.



harvest your 120 acres. You might hire four farmhands and divide up the tasks, or you might buy several pieces of complex farm machinery (capital) and do the work single-handedly. Your final choice depends on a number of things. What machinery is available? What does it do? Will it work on small fields such as yours? How much will it cost to buy each piece of equipment? What wage will you have to pay farmhands? How many will you need to get the job done? If machinery is expensive and labor is cheap, you will probably choose the labor-intensive technology. If farm labor is expensive and the local farm equipment dealer is going out of business, you might get a good deal on some machinery and choose the capital-intensive method.

Having compared the costs of alternative production techniques, the firm may be influenced in its choice by the current scale of its operation. Remember, in the short run a firm is locked into a *fixed* scale of operations. A firm currently producing on a small scale may find that a labor-intensive technique is the least costly, whether or not labor is comparatively expensive. The same firm producing on a larger scale might find a capital-intensive technique less costly.

total variable cost curve
A graph that shows the relationship between total variable cost and the level of a firm's output.

The **total variable cost curve** is a graph that shows the relationship between total variable cost and the level of a firm's output (q). At any given level of output, total variable cost depends on (1) the techniques of production that are available and (2) the prices of the inputs required by each technology. To examine this relationship in more detail, let us look at some hypothetical production figures.

Table 7.2 presents an analysis that might lie behind three points on a typical firm's total variable cost curve. In this case, there are two production techniques available, *A* and *B*, one somewhat more capital intensive than the other. We will assume that the price of labor is $1

TABLE 7.2

Derivation of Total Variable Cost Schedule from Technology and Factor Prices

PRODUCE	USING TECHNIQUE	UNITS OF INPUT REQUIRED (PRODUCTION FUNCTION) K	L	TOTAL VARIABLE COST ASSUMING $P_K = \$2$, $P_L = \$1$ $TVC = (K \times P_K) + (L \times P_L)$
1 Unit of output	A	4	4	(4 × \$2) + (4 × \$1) = \$12
	B	2	6	(2 × \$2) + (6 × \$1) = **\$10**
2 Units of output	A	7	6	(7 × \$2) + (6 × \$1) = \$20
	B	4	10	(4 × \$2) + (10 × \$1) = **\$18**
3 Units of output	A	9	6	(9 × \$2) + (6 × \$1) = **\$24**
	B	6	14	(6 × \$2) + (14 × \$1) = \$26

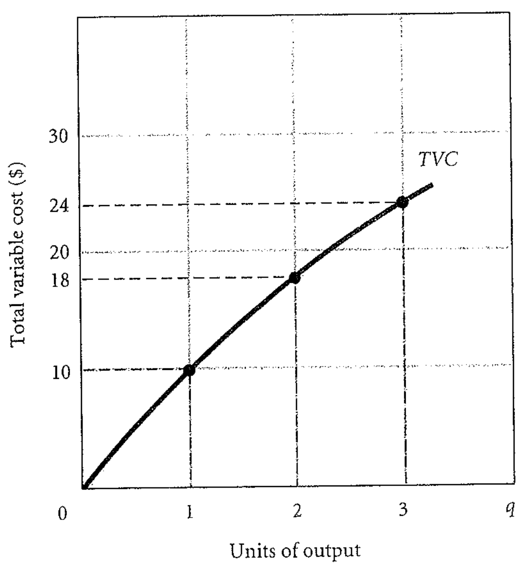


FIGURE 7.3
Total Variable Cost Curve

In Table 7.2, total variable cost is derived from production requirements and input prices. A total variable cost curve expresses the relationship between *TVC* and total output.

per unit and the price of capital is \$2 per unit. For the purposes of this example, we focus on *variable capital*—that is, on capital that can be changed in the short run. In practice, some capital (such as buildings and large, specialized machines) is fixed in the short run. In our example, we will use *K* to denote variable capital. Remember, however, that the firm has other capital, capital that is fixed in the short run.

Analysis reveals that to produce one unit of output, the labor-intensive technique is least costly. Technique *A* requires four units of both capital and labor, which would cost a total of \$12. Technique *B* requires six units of labor but only two units of capital for a total cost of only \$10. To maximize profits, the firm would use technique *B* to produce one unit. The total variable cost of producing one unit of output would thus be \$10.

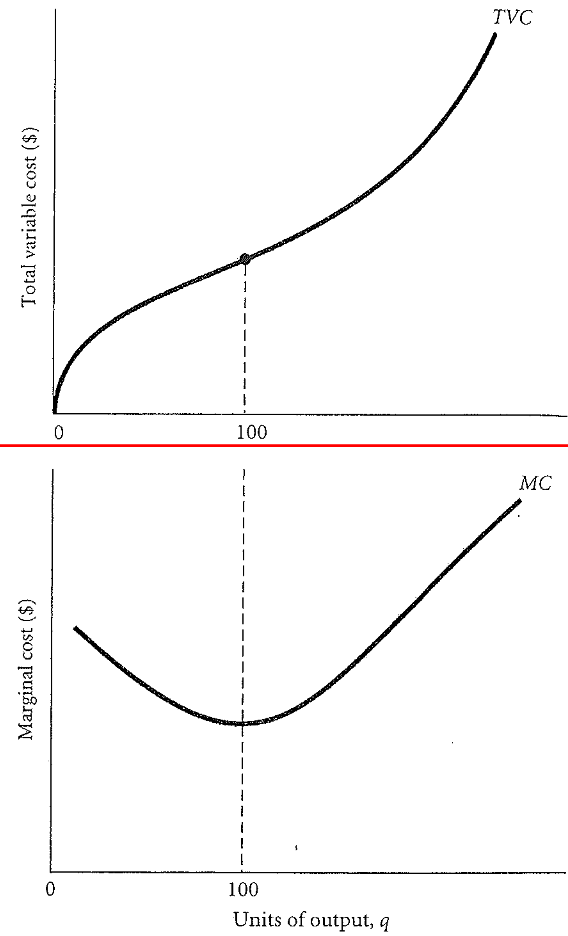
The relatively labor-intensive technique *B* is also the best method of production for two units of output. By using *B*, the firm can produce two units for \$18. If the firm decides to produce three units of output, however, technique *A* is the cheaper. By using the least-cost technology (*A*), the total variable cost of production is \$24. The firm will use nine units of capital at \$2 each and six units of labor at \$1 each.

Figure 7.3 graphs the relationship between variable costs and output based on the data in Table 7.2, assuming the firm chooses, for each output, the least-cost technology.

The total variable cost curve embodies information about both factor, or input, prices and technology. It shows the cost of production using the best available technique at each output level, given current factor prices.

FIGURE 7.5
Total Variable Cost and Marginal Cost for a Typical Firm

Total variable costs always increase with output. Marginal cost is the cost of producing each additional unit. Thus, the marginal cost curve shows how total variable cost changes with single unit increases in total output.



More output costs more than less output. Total variable costs (TVC), therefore, *always increase* when output increases. Even though the cost of each additional unit changes, *total* variable cost rises when output rises. Thus the *total* variable cost curve always has a positive slope.

You might think of the total variable cost curve as a staircase. Each step takes you out along the quantity axis by a single unit, and the height of each step is the increase in total variable cost. As you climb the stairs, you are always going up, but the steps have different heights. At first, the stairway is steep, but as you climb, the steps get smaller (marginal cost declines). The 100th stair is the smallest. As you continue to walk out beyond 100 units, the steps begin to get larger; the staircase gets steeper (marginal cost increases).

Remember that the slope of a line is equal to the change in the units measured on the Y-axis divided by the change in the units measured on the X-axis. The slope of a total variable cost curve is thus the change in total variable cost divided by the change in output ($\Delta TVC/\Delta q$). Because marginal cost is by definition the change in total variable cost resulting from an increase in output of one unit ($\Delta q = 1$), *marginal cost actually is the slope of the total variable cost curve:*

$$\text{slope of } TVC = \frac{\Delta TVC}{\Delta q} = \frac{\Delta TVC}{1} = \Delta TVC = MC$$

Notice that up to 100 units, marginal cost decreases and the variable cost curve becomes flatter. The slope of the total variable cost curve is declining—that is, total variable cost increases, but at a *decreasing rate.* Beyond 100 units of output, marginal cost increases and the total variable cost curve gets steeper—total variable costs continue to increase, but at an *increasing rate.*