

EXHIBIT 7

principles of
microeconomics

THIRD EDITION

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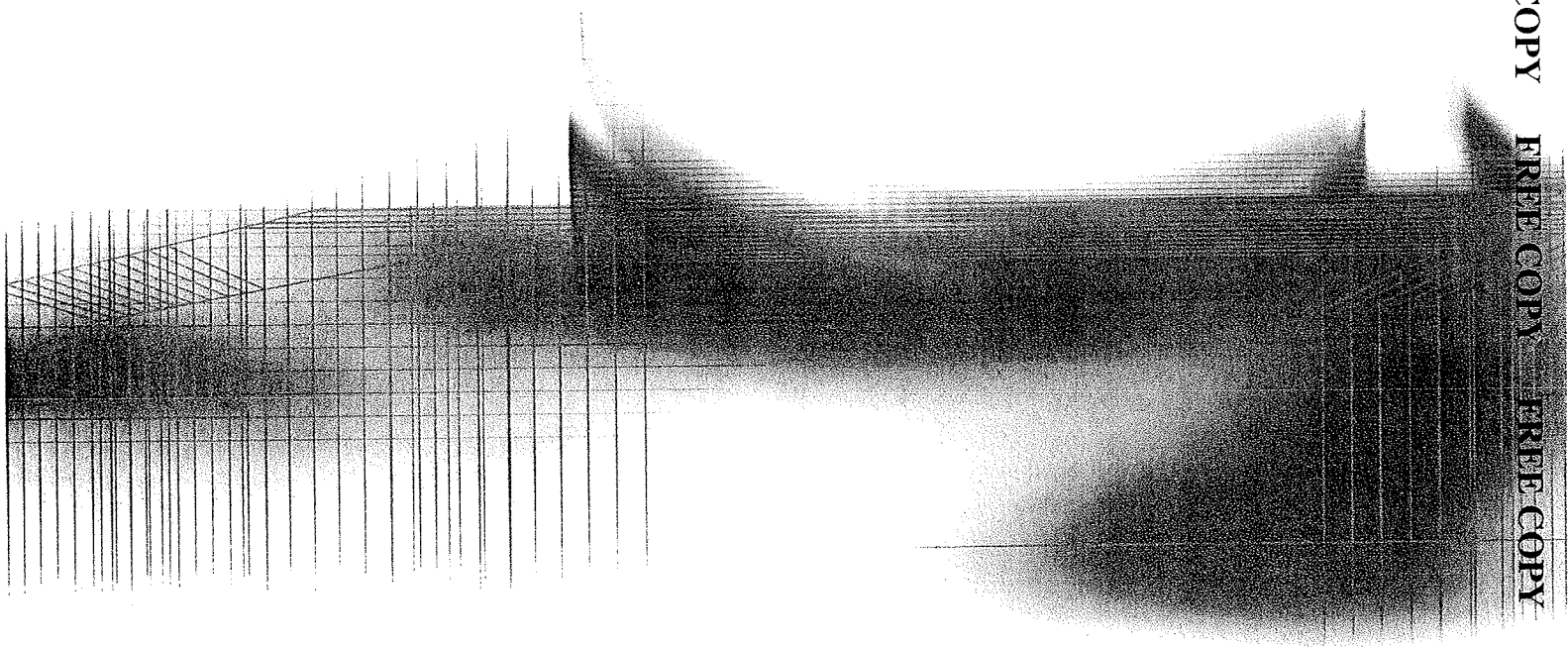
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Joseph E. Stiglitz

Carl E. Walsh



Imagine a business that picks up garbage. If this business counts only one out of every five houses as customers, it will have a certain cost of production. But if the company can expand to picking up the garbage from two out of every five houses, while it will need more workers, the workers will be able to drive a shorter distance and pick up more garbage faster. Thus, a doubling of output can result from a less than doubling of labor. Many examples of increasing returns, like garbage collection, involve providing service to more people in a given area. Telephone companies and electric utilities are two other familiar instances.

Constant Returns In between the cases of diminishing and increasing returns lies the case of *constant returns*, shown in Figure 7.3. Each additional unit of input increases output by the same amount, and the relationship between input and output is a straight line.

Types of Costs and Cost Curves

The production function is important to the firm because the inputs determine the cost of production. These costs are key determinants of the firm's profits and its decisions about how much to produce.

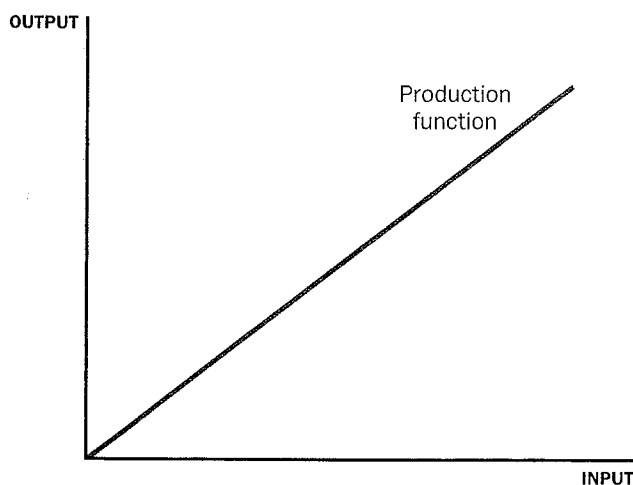


FIGURE 7.3 *Production Function with Constant Returns to an Input*

The marginal product of labor is constant, neither increasing nor diminishing as the firm expands production. On the graph, this means that the slope does not change.

Fixed and Variable Costs Some costs associated with inputs do not vary as the firm changes the level of production. For instance, the firm may need to hire someone to run the personnel office and someone to supervise the workers, and the cost of these inputs do not change as production varies, within limits. These costs are called **fixed costs**. Whether the firm produces nothing or produces at maximum capacity, it antes up the same fixed costs. Figure 7.4 shows how costs depend on output. Panel A depicts fixed costs as a horizontal line—by definition, they do not depend on the level of output. As an example, consider a would-be farmer who has the opportunity to buy a farm and its equipment for \$25,000. His fixed costs are \$25,000.

Variable costs correspond to inputs that vary with the level of production. Any cost that the firm can change during the time period under study is a variable cost. To the extent that the costs of such items as labor and materials can go up or down as output does, these are variable costs. If our farmer has only one input to vary, labor, then his variable cost would be, say, \$15 per hour for each worker. The variable costs corresponding to levels of output listed in Table 7.1 are shown in Table 7.2 and plotted in Figure 7.4B. As output increases, so do variable costs, so the curve slopes upward.

Total Costs Table 7.2 also includes a column labeled “Total cost.” **Total costs** are defined as the sum of fixed and variable costs, so this column is obtained by adding the farmer's fixed costs of \$25,000 to the variable costs. Thus,

$$\text{total costs} = \text{total variable costs} + \text{fixed costs.}$$

The total cost curve, summarizing these points, is shown in Figure 7.4C.

Marginal Cost and the Marginal Cost Curve

Throughout this book we have emphasized that rational decision making depends on evaluating trade-offs in terms of marginal costs and benefits. Should Ann spend another hour at the party? To make the decision, she weighs the marginal cost—the other things she could do with an hour of her time—against the marginal benefit—the enjoyment she will experience from remaining at the party another hour. Firms apply this same logic in their

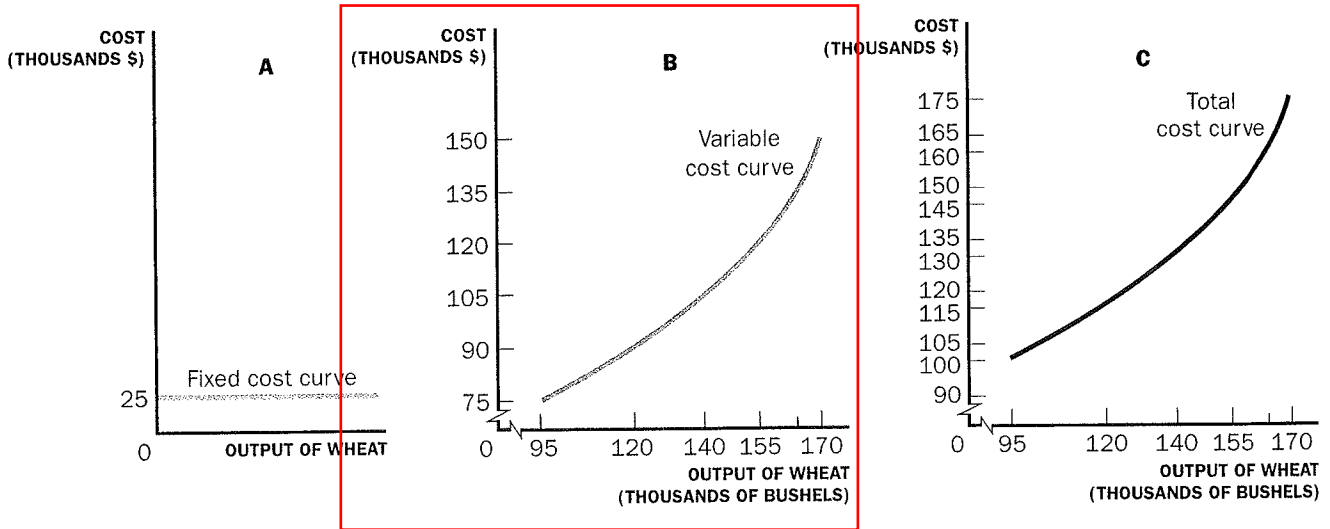


FIGURE 7.4 *Fixed, Variable, and Total Cost Curves*

Panel A shows a firm's fixed cost; by definition, fixed costs do not depend on the level of output. Panel B shows a firm's variable costs, which rise with the level of production. The increasing slope of the curve indicates that it costs more and more to produce at the margin, which is a sign of diminishing returns. Panel C shows a total cost curve. It has the same slope as the variable cost curve but is higher by the amount of the fixed costs.

decision making: They focus on marginal costs and benefits. Thus, one of the most important cost concepts is **marginal cost**, which we define here as the extra cost corresponding to each additional unit of production.

In the case of the wheat farmer's costs (see Table 7.2), as he increases labor input from 7,000 hours to 8,000

hours, output increases from 140,000 bushels to 155,000 bushels. Thus, the *marginal product* of the extra 1,000 hours of labor is 15,000 bushels. If the wage is \$15 per hour, the cost of increasing output by 15,000 bushels is \$15,000 ($\$15 \times 1,000$ extra hours). The marginal cost of the extra 15,000 bushels is \$15,000. To determine the

TABLE 7.2

<i>Cost of Producing Wheat</i>						
Output (bushels)	Labor required (hours)	Total variable cost (at a wage of \$15 per hour)	Total cost (\$)	Marginal cost (\$ per bushel)	Average cost (\$ per bushel)	Average variable cost (\$ per bushel)
95,000	5,000	75,000	100,000	—	1.05	.79
120,000	6,000	90,000	115,000	.60	.96	.75
140,000	7,000	105,000	130,000	.75	.93	.75
155,000	8,000	120,000	145,000	1.00	.94	.77
165,000	9,000	135,000	160,000	1.50	.97	.82
170,000	10,000	150,000	175,000	3.00	1.03	.88