Chapter 5: Production and Cost Analysis in the Short Run
Defining the Production Function

The formula can be read as “quantity of output is a function of the inputs listed inside the parentheses”

\[ Q = f (L, K, M...) \]

where

\( Q \) = quantity of output
\( L \) = quantity of labor input
\( K \) = quantity of capital input
\( M \) = quantity of materials input
Fixed Inputs Versus Variable Inputs

- **Fixed input**: quantity a manager cannot change during a given time
- **Variable input**: quantity a manager can change during a given time
- Amount of output would vary as managers made decisions regarding amounts of input
Short-run Versus Long-run Production

- Not expressed in terms of calendar time, but in terms of fixed and variable inputs

- Short-run production function: involves at least one fixed input

- Long-run production function: production process in which all inputs are variable
Managerial Rule of Thumb: Short-run Production and Long-run Planning

- Managers operate in the short run, but must have long-run vision.
- They need to be aware that the current amount of fixed inputs may not be appropriate as market conditions change.
- Managers make more long run economic decisions.
Model of the Short-run Production Function

**Total product**: total quantity of output produced with a given quantity of fixed and variable inputs

\[ \text{TP or } Q = f \left( L, K \right) \]

**where**

- **TP or** \( Q \) = total product or quantity of output
- **L** = quantity of labor input
- **K** = quantity of capital input
Average Product

*Average product*: amount of output per unit of variable input

\[
AP = \frac{TP}{L} \text{ or } \frac{Q}{L}
\]

where

\[
AP = \text{The average product of labor}
\]
Marginal Product

*Marginal product*: the additional output produced with an additional unit of variable input

\[
MP = \frac{\Delta TP}{\Delta L} = \frac{\Delta Q}{\Delta L}
\]

*where*

\[
MP = \text{The marginal product of labor}
\]
Total Product: Short-run Production Function

Law of diminishing returns where marginal product eventually decreases

Figure 5.1a
TP: Short-run Production Function

- TP increases rapidly up to level of labor input $L_1$ then increases at a slower rate as labor input increases.
- TP curve becomes flatter and flatter until it reaches maximum output level at $L_3$.
- Curve implies that marginal product of labor first increases rapidly then decreases, eventually becoming zero or less.
AP and MP: Short-run Production Function

Figure 5.1b
AP and MP: Short-run Production Function

- Between zero and $L_2$, MP curve lies above AP curve, causing AP curve to increase
- Below $L_2$, MP curve is below AP curve, causing AP curve to decrease
- Therefore, MP curve must intersect AP curve at maximum point of AP curve
Economic Explanation

- **Increasing marginal returns**: region where MP curve is positive and increasing
- **Law of diminishing returns**: region where marginal product curve is positive but decreasing
- **Negative marginal returns**: region where product curve is negative so that TP is decreasing
Law of Diminishing Returns

- Additional output generated by additional units of variable input (MP) is decreasing
- Occurs because capital input and technologies are held constant
Productivity Changes Across Industries

\[ Q = f(K, L, E, M, t) \]

where

- \( Q \) = industry output
- \( K \) = capital services
- \( L \) = labor services
- \( E \) = energy use
- \( M \) = materials use
- \( t \) = level of technology
Model of Short-run Costs Functions

- **Cost function**: shows relationship between cost of production and level of output

- **Opportunity cost**: reflects use of resources in one activity while foregoing another
 Explicit cost: payment to an individual that is recorded in an accounting system

 Implicit costs: value of using a resource that is not explicitly paid out, is often difficult to measure, and not recorded in an accounting system
Measuring Opportunity Cost

- Prices that a firm pays for input reflects opportunity cost.
- If managers do not recognize opportunity costs, they may have too much invested in buildings or other assets.
- **Historic cost**: amount of money a firm paid for an input when it was purchased.
Accounting Profit and Economic Profit

- **Profit**: difference between total revenue and total cost of production

- **Accounting profit**: difference between total revenue and total explicit cost

- **Economic profit**: difference between total revenue and total costs, both implicit and explicit

© 2005 Prentice Hall, Inc.
Managerial Rule of Thumb: Importance of Opportunity Costs

- Measuring opportunity costs can be difficult because accountants are trained to examine explicit costs.
- Managers need to take into account both types of costs (explicit and opportunity costs).
Short-run Cost Functions

- **Short-run cost function**: shows relationship between output and costs based on underlying short-run production function.
- It is a cost function for short-run production process in which there is at least one fixed unit of production.
Costs

- **Total fixed cost**: cost of using fixed input
- **Total variable cost**: price per unit of labor times quantity of labor input
- **Total cost**: sum of total fixed cost plus total variable costs
Costs

- **Average fixed cost**: total fixed cost per unit of output
- **Average variable cost**: total variable cost per unit of output
- **Average total cost**: total cost per unit of output plus average variable cost
- **Marginal cost**: additional cost of producing additional units of output
Total, Average, and Marginal Cost

- AFC decreases continuously as more output is produced
- Since TFC is constant, AFC must decline as output increases
- AVC and ATC first decrease then increase
- ATC always equals AFC plus AVC
Figure 5.2a

TC, TCV, TFC Functions
MC, ATC, AVC, and AFC Functions

Figure 5.2b
Short-run Production and Cost
Managerial Rule of Thumb: Understanding Your Costs

Managers need to understand

- Technology and prices paid for inputs of production
- Difference between variable and fixed costs
- Difference between average costs (costs per unit of output) and marginal costs (additional costs of producing additional units of output)
Econometric Estimation of Cost Functions

- Dean’s studies of a furniture factory, a leather belt shop, 1976
- Johnston’s study of British electric generating plants, road passenger transport, and food processing firm, 1960
- Hall, 1986
- Blinder, et al, 1990s
Summary of Key Terms

- Accounting profit
- Average fixed cost
- Average product
- Average total cost
- Average variable cost
- Cost function
- Economic profit
- Explicit cost
- Fixed input
- Historic cost
- Implicit cost
- Marginal returns
- Diminishing returns
- Long-run production functions
Summary of Key Terms

- Marginal cost
- Marginal product
- Negative marginal returns
- Production function
- Short-run production function
- Short-run cost function
- Total cost
- Total fixed cost
- Total product
- Opportunity cost
- Total variable cost
- Variable input