CHAPTER CHECKLIST

1. Explain how economists measure a firm’s cost of production and profit.
2. Explain the relationship between a firm’s output and labor employed in the short run.
3. Explain the relationship between a firm’s output and costs in the short run.
4. Derive and explain a firm’s long-run average cost curve.

LECTURE TOPICS

■ Economic Cost and Profit
■ Short-run Production
■ Short-run Cost
■ Long-run Cost

11.1 ECONOMIC COST AND PROFIT

■ The Firm’s Goal
  To maximize profit

■ Accounting Cost and Profit
  An accountant measures cost and profit to ensure that the firm pays the correct amount of income tax and to show the bank.
  Economists predict the decisions that a firm makes to maximize its profit. These decisions respond to opportunity cost and economic profit.
Opportunity Cost
The highest-valued alternative forgone is the opportunity cost of a firm’s production.

Explicit Costs and Implicit Costs

Explicit cost
A cost paid in money.

Implicit cost
An opportunity cost incurred by a firm when it uses a factor of production for which it does not make a direct money payment.
The two main implicit costs are economic depreciation and the cost of the firm owner’s resources.

Economic depreciation
The opportunity cost of a firm using capital that it owns—measured as the change in the market value of capital over a given period.

Normal profit
The return to entrepreneurship. Normal profit is part of a firm’s opportunity cost because it is the cost of not running another firm.

Economic Profit
A firm’s economic profit equals total revenue minus total cost.
Total cost is the sum of the explicit costs and implicit costs and is the opportunity cost of production.
Because the firm’s opportunity cost of production includes normal profit, the return to the entrepreneur equals normal profit plus economic profit.
If a firm incurs an economic loss, the entrepreneur receives less than normal profit.
11.1 ECONOMIC COST AND PROFIT

Normal profit is an implicit cost. Accountants measure cost as explicit costs and accounting depreciation.

Economic profit equals total revenue minus opportunity cost. Accounting profit equals total revenue minus accounting cost.

Normal profit is an implicit cost. Accountants measure cost as explicit costs and accounting depreciation.

Economic profit equals total revenue minus opportunity cost. Accounting profit equals total revenue minus accounting cost.
The Short Run: Fixed Plant

The short run is a time frame in which the quantities of some resources are fixed.

In the short run, a firm can usually change the quantity of labor it uses but not the quantity of capital.

The Long Run: Variable Plant

The long run is a time frame in which the quantities of all resources can be changed.

A sunk cost is irrelevant to the firm’s decisions.

To increase output with a fixed plant, a firm must increase the quantity of labor it uses.

We describe the relationship between output and the quantity of labor by using three related concepts:

- Total product
- Marginal product
- Average product

Total Product

Total product (TP) is the total quantity of a good produced in a given period.

Total product is an output rate—the number of units produced per unit of time.

Total product increases as the quantity of labor employed increases.

Figure 11.2 shows the total product and the total product curve.

Points A through H on the curve correspond to the columns of the table.

The TP curve is like the PPF: It separates attainable points and unattainable points.
Marginal Product

Marginal product is the change in total product that results from a one-unit increase in the quantity of labor employed. It tells us the contribution to total product of adding one more worker. When the quantity of labor increases by more (or less) than one worker, calculate marginal product as:

\[
\text{Marginal product} = \frac{\text{Change in total product}}{\text{Change in quantity of labor}}
\]

Figure 11.3 shows total product and marginal product. We can illustrate marginal product as the orange bars that form steps along the total product curve. The height of each step represents marginal product.

The table calculates marginal product and the orange bars in part (b) illustrate it. Notice that the steeper the slope of the TP curve, the greater is marginal product.

The total product and marginal product curves in this figure incorporate a feature of all production processes:

- Increasing marginal returns initially
- Decreasing marginal returns eventually
- Negative marginal returns
11.2 SHORT-RUN PRODUCTION

Increasing Marginal Returns

Increasing marginal returns occur when the marginal product of an additional worker exceeds the marginal product of the previous worker.

Increasing marginal returns occur when a small number of workers are employed and arise from increased specialization and division of labor in the production process.

11.2 SHORT-RUN PRODUCTION

Decreasing Marginal Returns

Decreasing marginal returns occur when the marginal product of an additional worker is less than the marginal product of the previous worker.

Decreasing marginal returns arise from the fact that more and more workers use the same equipment and work space.

As more workers are employed, there is less and less that is productive for the additional worker to do.

11.2 SHORT-RUN PRODUCTION

Decreasing marginal returns are so pervasive that they qualify for the status of a law:

The law of decreasing returns states that:

As a firm uses more of a variable input, with a given quantity of fixed inputs, the marginal product of the variable input eventually decreases.

11.2 SHORT-RUN PRODUCTION

Average Product

Average product is the total product per worker employed.

It is calculated as:

Average product = Total product ÷ Quantity of labor

Another name for average product is productivity.
Figure 11.4 shows average product and its relationship to marginal product. The table calculates average product.

For example, when the quantity of labor is 3 workers, total product is 6 gallons per hour, so average product is $\frac{6}{3} = 2$ gallons per worker.

When marginal product exceeds average product, average product is increasing.

When marginal product equals average product, average product is at its maximum.

Marginal Grade and Grade Point Average

To understand the relationship between average product and marginal product, think about the relationship between a student's marginal grade and grade point average—average grade.
11.2 SHORT-RUN PRODUCTION

Figure 11.5 shows marginal grade and grade point average. Sam’s first course is French, for which she gets a C (2). Her marginal grade is 2, and her GPA is 2. She then gets a B (3) in calculus, which pulls her average up to 2.5.

Next, she gets an A (4) in economics, which pulls her GPA up to 3. In her next course, history, she gets a B (3), which maintains her GPA. In her final course, English, she gets a D (1), which pulls her average down.

11.3 SHORT-RUN COST

To produce more output in the short run, a firm employ more labor, which means it must increase its costs. We describe the relationship between output and cost using three cost concepts:

- Total cost
- Marginal cost
- Average cost

A firm’s total cost (TC) is the cost of all the factors of production the firm uses. Total cost divides into two parts:

- Total fixed cost (TFC) is the cost of a firm’s fixed factors of production used by a firm—the cost of land, capital, and entrepreneurship.
- Total fixed cost doesn’t change as output changes.
11.3 SHORT-RUN COST

**Total variable cost** (TVC) is the cost of the variable factor of production used by a firm—the cost of labor. To change its output in the short run, a firm must change the quantity of labor it employs, so total variable cost changes as output changes. Total cost is the sum of total fixed cost and total variable cost. That is,

\[ TC = TFC + TVC \]

Table 11.2 on the next slide shows Sam’s Smoothies’ costs.

---

**Table 11.2**

<table>
<thead>
<tr>
<th>Labor (workers per hour)</th>
<th>Output (gallons per hour)</th>
<th>Total fixed cost (dollars per hour)</th>
<th>Total variable cost (dollars per hour)</th>
<th>Total cost (dollars per hour)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>10</td>
<td>0.00</td>
<td>10.00</td>
</tr>
<tr>
<td>1.00</td>
<td>1</td>
<td>10</td>
<td>6.00</td>
<td>16.00</td>
</tr>
<tr>
<td>1.60</td>
<td>2</td>
<td>10</td>
<td>9.60</td>
<td>19.60</td>
</tr>
<tr>
<td>2.00</td>
<td>3</td>
<td>10</td>
<td>12.00</td>
<td>22.00</td>
</tr>
<tr>
<td>2.35</td>
<td>4</td>
<td>10</td>
<td>14.10</td>
<td>24.10</td>
</tr>
<tr>
<td>2.70</td>
<td>5</td>
<td>10</td>
<td>16.20</td>
<td>26.20</td>
</tr>
<tr>
<td>3.00</td>
<td>6</td>
<td>10</td>
<td>18.00</td>
<td>28.00</td>
</tr>
<tr>
<td>3.40</td>
<td>7</td>
<td>10</td>
<td>20.40</td>
<td>30.40</td>
</tr>
<tr>
<td>4.00</td>
<td>8</td>
<td>10</td>
<td>24.00</td>
<td>34.00</td>
</tr>
<tr>
<td>5.00</td>
<td>9</td>
<td>10</td>
<td>30.00</td>
<td>40.00</td>
</tr>
</tbody>
</table>

---

**Figure 11.6** shows Sam’s Smoothies’ total cost curves. Total fixed cost (TFC) is constant—it graphs as a horizontal line. Total variable cost (TVC) increases as output increases. Total cost (TC) also increases as output increases.

---

The vertical distance between the total cost curve and the total variable cost curve is total fixed cost, as illustrated by the two arrows.
11.3 SHORT-RUN COST

Marginal cost

A firm's marginal cost is the change in total cost that results from a one-unit increase in total product.

Marginal cost tells us how total cost changes as total product changes.

Table 11.3 on the next slide calculates marginal cost for Sam’s Smoothies.

---

**Average Cost**

There are three average cost concepts:

**Average fixed cost** (AFC) is total fixed cost per unit of output.

**Average variable cost** (AVC) is total variable cost per unit of output.

**Average total cost** (ATC) is total cost per unit of output.

---

The average cost concepts are calculated from the total cost concepts as follows:

\[ TC = TFC + TVC \]

Divide each total cost term by the quantity produced, \( Q \), to give

\[ \frac{TC}{Q} = \frac{TFC}{Q} + \frac{TVC}{Q} \]

or,

\[ ATC = AFC + AVC \]

---

**Table 11.3**

Sam’s Smoothies’ Marginal Cost:

<table>
<thead>
<tr>
<th>Output (Quarts per hour)</th>
<th>Total cost (dollars per hour)</th>
<th>Marginal cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>10.00</td>
<td>6.00</td>
</tr>
<tr>
<td>1</td>
<td>16.00</td>
<td>6.00</td>
</tr>
<tr>
<td>2</td>
<td>19.62</td>
<td>2.40</td>
</tr>
<tr>
<td>3</td>
<td>22.00</td>
<td>2.13</td>
</tr>
<tr>
<td>4</td>
<td>24.10</td>
<td>2.10</td>
</tr>
<tr>
<td>5</td>
<td>26.30</td>
<td>2.80</td>
</tr>
<tr>
<td>6</td>
<td>30.00</td>
<td>2.40</td>
</tr>
<tr>
<td>7</td>
<td>34.00</td>
<td>3.60</td>
</tr>
<tr>
<td>8</td>
<td>34.00</td>
<td>6.00</td>
</tr>
<tr>
<td>9</td>
<td>40.00</td>
<td></td>
</tr>
</tbody>
</table>
11.2 SHORT-RUN COST

The vertical distance between these two curves is equal to average fixed cost, as illustrated by the two arrows.

The marginal cost curve (MC) is U-shaped and intersects the average variable cost curve and the average total cost curve at their minimum points.

11.3 SHORT-RUN COST

Why the Average Total Cost Curve Is U-Shaped

Average total cost, ATC, is the sum of average fixed cost, AFC, and average variable cost, AVC.

The shape of the ATC curve combines the shapes of the AFC and AVC curves.

The U shape of the average total cost curve arises from the influence of two opposing forces:

- Spreading total fixed cost over a larger output
- Decreasing marginal returns
11.3 SHORT-RUN COST

Cost Curves and Product Curves

The technology that a firm uses determines its costs. At low levels of employment and output, as the firm hires more labor, marginal product and average product rise, and marginal cost and average variable cost fall. Then, at the point of maximum marginal product, marginal cost is a minimum. As the firm hires more labor, marginal product decreases and marginal cost increases.

But average product continues to rise, and average variable cost continues to fall. Then, at the point of maximum average product, average variable cost is a minimum. As the firm hires even more labor, average product decreases and average variable cost increases.

<table>
<thead>
<tr>
<th>Table 11.4 A Compact Glossary of Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Term</strong></td>
</tr>
<tr>
<td>Fixed cost</td>
</tr>
<tr>
<td>Variable cost</td>
</tr>
<tr>
<td>Total fixed cost</td>
</tr>
<tr>
<td>Total variable cost</td>
</tr>
<tr>
<td>Total cost</td>
</tr>
</tbody>
</table>

Figure 11.8 illustrates the relationship between the product curves and cost curves. A firm’s marginal cost curve is linked to its marginal product curve. If marginal product rises, marginal cost falls. If marginal product is a maximum, marginal cost is a minimum.
A firm’s average variable cost curve is linked to its average product curve.

If average product rises, average variable cost falls.

If average product is a maximum, average variable cost is a minimum.

At low outputs, \( MP \) and \( AP \) rise and \( MC \) and \( AVC \) fall.

At intermediate outputs, \( MP \) falls and \( MC \) rises; and \( AP \) rises and \( AVC \) falls.

At high outputs, \( MP \) and \( AP \) fall and \( MC \) and \( AVC \) rise.

**Shifts in Cost Curves**

**Technology**

A technological change that increases productivity shifts the total product curve upward. It also shifts the marginal product curve and the average product curve upward.

With a better technology, the same inputs can produce more output, so an advance in technology lowers the average and marginal costs and shifts the short-run cost curves downward.

**Prices of Factors of Production**

- An increase in the price of a factor of production increases costs and shifts the cost curves.
- But how the curves shift depends on which resource price changes.
- A change in rent or some other component of fixed cost shifts the fixed cost curves (TFC and AFC) upward and shifts the total cost curve (TC) upward but leaves the variable cost curves (AVC and TVC) and the marginal cost curve (MC) unchanged.
11.3 SHORT-RUN COST

- A change in wage rates or some other component of variable cost shifts the variable curves (TVC and AVC) and the marginal cost curve (MC) upward but leaves the fixed cost curves (AFC and TFC) unchanged.

11.4 LONG-RUN COST

- **Plant Size and Cost**
  
  When a firm changes its plant size, its cost of producing a given output changes.
  
  Will the average total cost of producing a gallon of smoothie fall, rise, or remain the same?
  
  Each of these three outcomes arise because when a firm changes the size of its plant, it might experience:
  
  - Economies of scale
  - Diseconomies of scale
  - Constant returns to scale

---

11.4 LONG-RUN COST

- **Economies of Scale**
  
  Economies of scale exist if when a firm increases its plant size and labor employed by the same percentage, its output increases by a larger percentage and average total cost decreases.
  
  The main source of economies of scale is greater specialization of both labor and capital.

11.4 LONG-RUN COST

- **Diseconomies of Scale**
  
  Diseconomies of scale exist if when a firm increases its plant size and labor employed by the same percentage, its output increases by a smaller percentage and average total cost increases.
  
  Diseconomies of scale arise from the difficulty of coordinating and controlling a large enterprise.
  
  Eventually, management complexity brings rising average total cost.
11.4 Long-Run Cost

Constant Returns to Scale

Constant returns to scale exist if when a firm increases its plant size and labor employed by the same percentage, its output increases by the same percentage and average total cost remains constant.

Constant returns to scale occur when a firm is able to replicate its existing production facility including its management system.

The Long-Run Average Cost Curve

The long-run average cost curve shows the lowest average cost at which it is possible to produce each output when the firm has had sufficient time to change both its plant size and labor employed.

Figure 11.9 shows a long-run average cost curve. In the long run, Samantha can vary both capital and labor inputs.

With its current plant, Sam’s ATC curve is ATC_1.

With successively larger plants, Sam’s ATC curves would be ATC_2, ATC_3, and ATC_4.

The long-run average cost curve, LRAC, traces the lowest attainable average total cost of producing each output.
11.4 LONG-RUN COST

Sam's experiences economies of scale as output increases to 9 gallons an hour, … constant returns to scale for outputs between 9 gallons and 12 gallons an hour, … and diseconomies of scale for outputs that exceed 12 gallons an hour.