

How to Study for Chapter 15 Costs of Production in the Long Run

Chapter 15 continues the principles concerning costs of production by bringing in the long-run.

1. Begin by looking over the Objectives listed below. This will tell you the main points you should be looking for as you read the chapter.
2. New words or definitions and certain key points are highlighted in italics and in red color. Other key points are highlighted in bold type and in blue color.
3. You will be given an In Class Assignment and a Homework assignment to illustrate the main concepts of this chapter.
4. There are several new words in this chapter. Be sure to spend time on the various definitions. There are also new calculations. Go over each carefully. Be sure you understand how each number was derived (do the calculations for yourself). Then, plot the calculations on graph paper to see how the graph is derived. Check your graphs against the one in the text.
5. Go over the graph very carefully. Be sure you can explain in your own words why each graph has the shape it has.
6. When you have finished the text, the Test Your Understanding questions, and the assignments, go back to the Objectives. See if you can answer the questions without looking back at the text. If not, go back and re-read that part of the text. When you are ready, take the Practice Quiz for Chapter 15.

Objectives for Chapter 15 Costs of Production in the Long Run

At the end of Chapter 15, you will be able to answer the following:

1. Define what is meant by the "**long-run**".
2. Explain what is the **long-run average total cost** and how it is derived.
3. Explain what is meant by "**economies of scale**" and why they exist?
4. Explain what is meant by "**learning by doing**" or the "**learning curve**" and what is meant by "**dynamic increasing returns to scale**".
5. Explain what is meant by "**diseconomies of scale**" and why they exist.
6. Explain what is meant by "**constant returns to scale**".
7. What does the long-run average total cost actually look like for most products?
8. Explain what is meant by "**minimum efficient scale**" and what has been happening to it over time? Why has this been happening?
9. Explain what is meant by "**economies of scope**" and why they exist. Why are economies of scope important in knowledge-based companies?
10. What is a "**first mover advantage**"?

Chapter 15 Costs of Production in the Long Run (latest revision June 2004)

In the last chapter, the **long-run** was defined as the time period in which **all factors of production are variable**. We can now vary the amount of capital. We can expand or contract the size of the business. Or perhaps a new business can enter the industry or an existing business can go out of business permanently.

Let us consider two choices in the amount of capital. One is the choice we already used in Chapter 14. The other is a larger company with more capital. Because there is more capital, **the total costs of the capital and the implicit cost are now \$210,000, instead of \$180,000.** The larger amount of capital means that we do not need as many workers. The new machinery can do some of the work that people were previously doing. And the additional machinery makes the remaining workers more productive. To simplify, let us **assume that the reduced need for workers lowers the average variable cost (the variable cost per home) by \$5,000 for each home produced because it lowers the cost of the workers.** (Remember that the average variable cost is the cost of the labor and the cost of the natural resources to build each house.)

<u>Quantity</u>	<u>Average Fixed Cost</u>	<u>Average Variable Cost</u>	<u>Average Total Cost₂</u>
1	\$210,000	\$155,000	\$365,000
2	105,000	145,000	250,000
3	70,000	135,000	205,000
4	52,500	135,000	187,500
5	42,000	139,000	181,000
6	35,000	145,000	180,000
7	30,000	152,143	182,143
8	26,250	160,000	186,250
9	23,333	168,333	191,666
10	21,000	177,000	198,000
11	19,091	185,909	205,000
12	17,500	195,000	212,500
13	16,154	204,231	220,385

<u>Quantity</u>	<u>Average Total Cost₂</u>	<u>Original Average Total Cost₁</u>
1	\$365,000	\$340,000
2	250,000	240,000
3	205,000	200,000
4	187,500	185,000
5	181,000	180,000
6	180,000	180,000
7	182,143	182,857
8	186,250	187,500
9	191,666	193,333
10	198,000	200,000
11	205,000	207,273
12	212,500	215,000
13	220,385	223,077

In the first table, **the average fixed cost was calculated by dividing \$210,000 by the quantity of homes. The average variable cost was assumed to be \$5,000 below the numbers in Chapter 14.** The second table repeats the average total cost calculations and compares them with the calculations of Average Total Cost of Chapter 14. (In Chapter 14 calculations, the amount of capital was lower but the cost of labor was greater.)

Which size of company do you choose --- the first (from Chapter 14) one with less capital or the second one (from Page 2 above) with more capital? The answer depends on the number of houses you expect to produce and sell in a year. Notice in the lower table on Page 2 that **up to 6 houses, it is cheaper to produce with the smaller company** (that is, with the smaller amount of capital). The larger company would not have enough sales; with its large amount of capital, much of the capital would be underutilized, raising the cost per house. **Above 6 houses, the larger company can produce each house at a lower cost.** The large quantity sold means that the capital will be more fully utilized. *If the company expects to produce 6 houses or fewer, it is best to have the smaller sized company; if it expects to produce more than this, it is best to have the larger sized one.*

Of course, there are many possible sizes (that is, amounts of capital). The graph on the following page below traces out the average total cost curves for several sizes. **ATC₁ represents the average total cost curve for the smallest one (least amount of land and capital). The increasing numbers represent the average total cost for larger and larger sizes (that is, larger amounts of capital).** ATC₁ in blue represents the graph of the Average Total Cost calculation you made in Chapter 14. Up to 6 houses, the company can produce each house at the lowest cost if it uses this amount of capital (remember that the total fixed cost was \$180,000). But beyond 6 houses, it is cheaper to produce if the company uses the larger amount of capital (the second choice from Page 2 above-- with the total fixed cost being \$210,000). ATC₂ in purple represents the graph of the Average Total Cost for the larger amount of capital from Page 2. Beyond six houses, the company will use this amount of capital. Therefore, the Average Total Cost in purple becomes relevant after 6 houses. But it is only relevant up to 15 houses. After 15 houses, it is cheaper for the company to produce with an even larger amount of capital. ATC₃ in green graphs the Average Total Cost for this even larger amount of capital. It becomes relevant after 15 houses but only up to 23 houses. After 23 houses, an even larger amount of capital would allow the company to produce cheaper. The Average Total Cost for this even larger amount of capital, ATC₄, is graphed in orange. And so on. *The relevant part of each Average Total Cost curve is the part where it is below all of the other Average Total Cost curves.* As we consider more and more possible sizes, that part becomes smoother and traces out a U shape. This is shown by the black dotted line. We call this line *the long-run total average cost. It shows the cost per house of producing every possible quantity of houses, allowing the company to produce with the amount of land and capital that can produce that given quantity as cheaply as possible.*

Test Your Understanding

Go back the calculations of Average Variable Cost, Average Fixed Cost, and Average Total Cost you made for the orange grove in Chapter 14. Now, consider two choices in the amount of capital. One is the choice used in Chapter 14. The other is a larger grove with more machinery; **the total amount of land, capital, and implicit cost is now \$54,000, instead of \$36,000.** The larger amount of capital means that we do not need as many workers. The machinery can do some of the work that people were previously doing. And the additional machinery makes the remaining workers more productive. To simplify, **assume that the reduced need for labor lowers the average variable cost by \$0.15 per pound for each pound of oranges produced.** Calculate the new average fixed cost, the new average variable cost, and the new average total cost for the larger grove: (For the Average Variable Cost, subtract \$0.15 from the Average Variable Cost you calculated in Chapter 14.)

Quantity	Average Fixed Cost	Average Variable Cost	Average Total Cost
10,000			
40,000			
90,000			
130,000			
160,000			
180,000			
192,000			
198,000			
200,000			

Show the graph of the original average total cost curve and the new average total cost curve on graph paper. Up to _____ pounds per year, it is cheaper to produce with the smaller orange grove (the one used in Chapter 14). Above this quantity, it is cheaper to produce with the larger orange grove. Show the relevant portions of the two Average Total Cost curves in the graph. The portion you have shown is called the _____.

Economies of Scale

Notice that, at first, the long-run average total cost curve declines. Because the company is producing more houses per year, it will be a larger sized company (that is, it can afford to have more capital). *The larger company can produce at a lower cost per house than the smaller one.* This is a familiar phenomenon for many products. Albertsons and Vons can produce groceries cheaper per unit than Mom and Pop. General Motors can produce automobiles cheaper than a very small company. Anyone starting a new business knows that it is very hard to compete against companies that are much larger. This phenomenon is called "*economies of scale*" or "*increasing returns to scale*" ("scale" refers to size and to "economize" means to save). It means that companies with more capital can produce each unit of the product at a lower cost than companies with less capital.

There are several reasons that larger companies can produce at a lower cost than smaller companies. *One reason is that larger companies can take advantage of specialization.* Not only can they have more specialized workers, they can also have more specialized types of machinery. So in a small grocery store, the butcher may also work the cash register. But in a large grocery store, people specialize in one of these functions. *A second reason is that the use of a large machine may be more efficient*

than any other form of production. Steel and automobiles have been just two of the products that could not be produced cheaply without using large amounts of machinery. In some cases, a large amount of capital is necessary to be able to take advantage of a cost-reducing technology.

A concept related to economies of scale is the result of "learning by doing" or the "learning curve". The phenomenon was first noticed in the study of airframe manufacturing in the 1920s. It was found that the cost per unit decreases as the **CUMULATIVE** number of units produced increases. This means that, as companies produced more and more of a product, it became cheaper for them to produce that product. "Cumulative number of units produced" measures the experience the organization has had in producing this product. Since the mid-1960s, hundreds of products have been studied. **In every study, cost per unit declines as cumulative production increased.** *This phenomenon is known as "dynamic increasing returns to scale".* The word "**dynamic**" refers to the process occurring over time. Some of this learning may be individual. When I work at a new computer for the first time, I work very slowly while I learn how it works. As I do the same procedures over and over, I am able to do them faster and faster. The rest of this learning is organizational. Faced with a problem (such as how to meet or beat the competition), the members of the organization act as a team to solve it. In doing so, they learn much about the factors that will reduce costs. The solution may involve developing the ability to use lower-cost materials or parts. Or it may involve learning ways to organize the business more efficiently. Examples of dynamic increasing returns to scale are very common. Think of common household products. Most of these products were quite expensive when they first came on to the market. For every one of them, the product became cheaper over time. A VCR that once sold for \$1,500 (in today's prices) now sells for less than \$200. A color television that once sold for \$2,000 (again in today's prices) now sells for a few hundred dollars. Contact lenses that once sold for over \$2,000 (again in today's prices) now sell for less than \$100. A DVR sold for \$900 in 2003 and for \$400 in 2004. If you wait to buy a high definition television, what do you think will happen to the price?

Test Your Understanding

1. San Marcos Market is a grocery store of about 5,000 square feet. Albertsons is a grocery store of about 20,000 square feet. Albertsons can sell groceries at a lower price than San Marcos Market because its costs of production are lower. Explain why Albertson's costs of production are lower. That is, what cost advantages does Albertsons (or Vons) have just because it is a larger company? (Remember you are considering the cost of production, not necessarily the price charged to the buyers.)
2. When new products first are introduced, they are very expensive. So, for example, the first HDTV sets sold several thousands of dollars. In the text, it was expected that after the HDTV sets are on the market for awhile, the prices will fall greatly. Use the principles of **economies of scale** and **dynamic increasing returns to scale** to explain why the decrease in price might occur.
3. Recently, there have been many mergers. Large banks have merged with other large banks. Computer companies have merged with other computer companies. These mergers are justified by the cost savings that occur if the two competing companies become one. In this question, let us consider gas stations. Exxon and Mobil, have merged together into one company, as have Chevron and Texaco. Use the principle of **economies of scale** to explain why there might be a reduction in the cost of production of selling gasoline if these companies merge into one.

Diseconomies of Scale

When you examine the long-run average cost curve, you see that it does not continue to fall indefinitely. At some point, it levels off and then begins to rise. *When companies become so large, the cost per unit of producing the product rises. This phenomenon is known as "diseconomies of scale".*

There are several reasons that diseconomies of scale may exist. First, if we are referring to a company that manufactures a product, as the factory becomes larger, the company may have to ship its production over a longer distance. **Transportation costs may rise.**

Second, there is what is called the **principal – agent problem**. A principal (the owners) hires an agent (the management) to act in the interest of the principal (assumed to be the company's profits). But the agent (the management) may have different personal goals. Managers may desire a very high salary, many perquisites (a company plane or a very luxurious office), job security, power over other people, status and prestige, and so forth. Often, these goals conflict. *The principal - agent problem is the problem of finding ways for the principal to motivate the agent to act in the best interests of the principal.* Many large corporations have failed to solve this problem. The managers often act in their own interest and against the interest of the owners. Two examples illustrate this. One example is companies buying other companies. In many cases, the value of the stock of the company that did the buying actually fell. The owners of the company were worse off by buying the other company. But the managers of that company were better off because they had more people to manage (empire building), had more power and prestige, and so forth. A second example is that there have been many charges that Chief Executive Officers have granted themselves pay that is much higher than the owners would have chosen. The point here is that, in a large company, the managers can act in their own self-interest. In doing so, they may act in a way that increases costs of production.

Third, there is **the shirking problem**. As a company becomes larger, it requires more workers. This makes it easier for workers to get away with shirking on the job. The company must hire more supervisors, coordinators, and managers in response. These extra people increase costs of production.

Fourth, is the problem related to **bureaucracy**. We described government bureaucracies in Chapter 11. Business bureaucracies face some of the same problems as government bureaucracies. When the company is larger, there are more layers to the management hierarchy. As a result, **communication and coordination are impaired**. Some of the information going up or down the hierarchy becomes lost or distorted. Poor decisions are made as a result. This acts to increase costs of production. Under the 1940s, Ford Motor Company was an example of a company whose costs of production increased as the company became larger. All decisions had to be approved at the top. Information was lost and poor decisions were made. Ford lost its position as the top American automobile producer, a position it has never regained.

We will encounter diseconomies of scale when we consider the problem of the former communist economist economies in Chapter 28.

Test Your Understanding

It has been argued that (perhaps) the Post Office experiences diseconomies of scale. First, what would this mean? Second, from what you might know about the Post Office and the explanation of this chapter, why might this be true (if indeed it is true)?

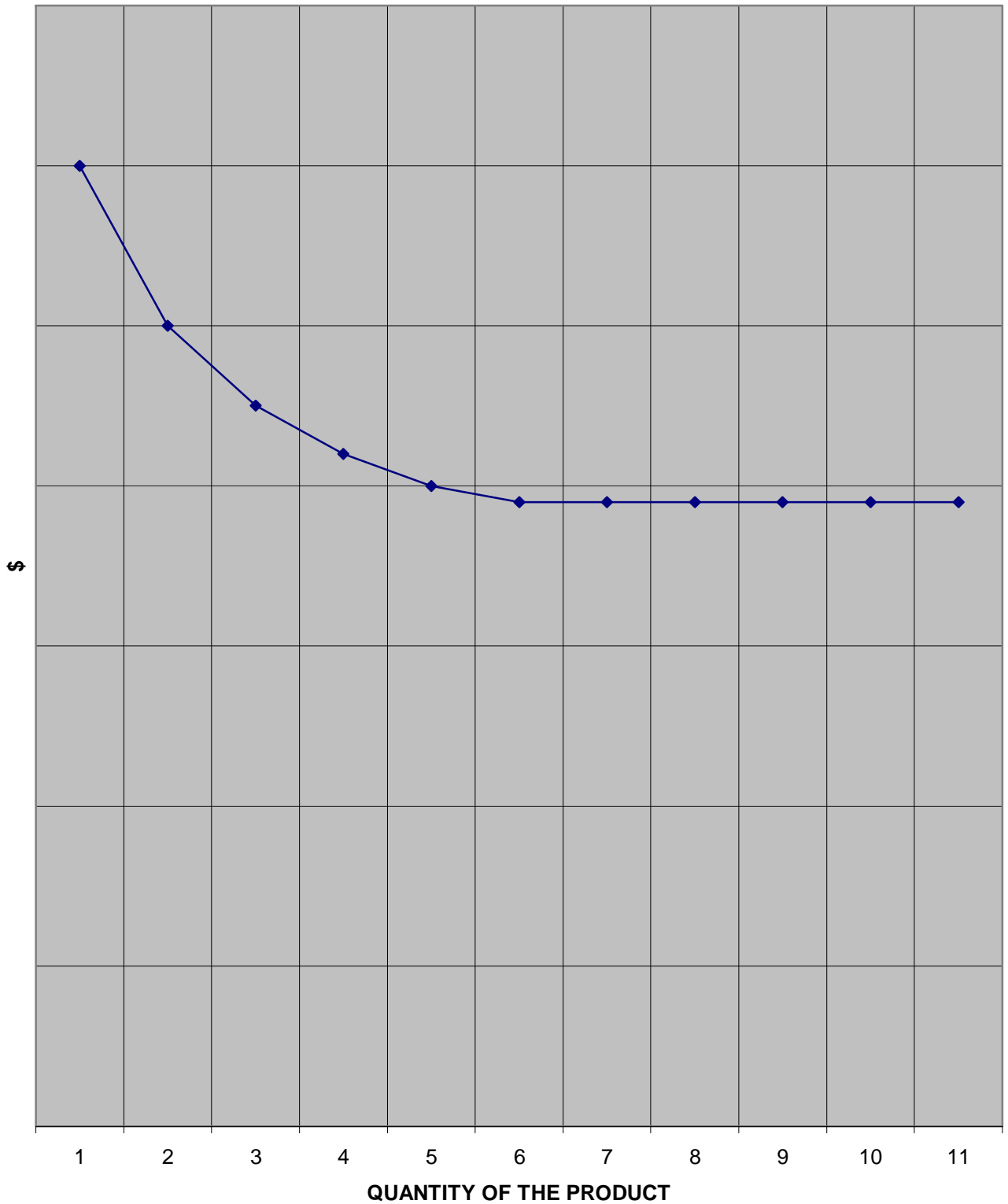
Constant Returns to Scale and the Minimum Efficient Scale

As has been said, we expect that the long-run average total cost will be U - shaped for most companies (economies of scale followed by diseconomies of scale). Many studies have been done of this phenomenon. Virtually, contrary to expectations, every study concludes that the long-run average costs looks as shown in the graph on the next page. Notice that these studies do conclude that economies of scale exist. However, *rather than rising after a certain size is reached, the long-run average cost is horizontal. This means that, as companies become larger and larger beyond a certain size, the cost per unit of producing the product stays the same. This phenomenon is called "constant returns to scale"*. We still expect diseconomies of scale to exist; as companies become larger and larger, the cost per unit will eventually rise. **But the evidence shows that companies do not actually become large enough to experience diseconomies of scale.**

On the graph, 6 is the lowest number of houses that must be produced to be able to produce a house at the lowest possible cost. This quantity is known as the "minimum efficient scale". If we produce fewer than 6 houses, we will have less capital and the cost of producing each house will be greater. If we produce 6 or more houses, we can afford more capital. However, the cost of producing each house neither falls nor rises. *Any company that can produce 6 houses can produce houses as cheaply as any competitor.*

Studies have shown that the minimum efficient scale is smaller than most people might believe. For example, by one estimate, the minimum efficient scale for automobiles is 500,000 automobiles (350,000 automobiles if we make only small cars). Any automobile company producing less than 500,00 automobiles will produce automobiles at a higher cost. But once the company can produce at least 500,000 automobiles, that company can produce automobiles as cheaply as any larger company. Considering that the market for automobiles in the U.S. is commonly about 15 to 17 million automobiles a year, a company that can obtain 3% to 4% of the market (500,000 automobiles) should be able to compete with anyone. Put another way, we could have 25 or more automobile companies, each producing 500,000 automobiles, and the cost of making an automobile would be the same as it is today. For the citrus groves in San Diego County, one estimate is that the minimum efficient scale occurs with a grove of ten acres. This is relatively small. However, for wheat farmers, a farm of 150 to 200 acres is needed to reach the minimum efficient scale. For grocery stores, the minimum efficient scale has been estimated to occur with a store of about 20,000 square feet. This is about the size of the typical grocery store today. Larger stores have no cost advantage.

Not only is the minimum efficient scale relatively low, but it has been falling. This means that relatively small companies can compete more effectively with larger ones on the basis of costs. Just look at the typical mall. At one time, the small specialty stores were being driven out of business by the large department stores. More recently,

LONG RUN AVERAGE TOTAL COST

the reverse has been occurring. Today, competition is less likely to be based on cost and more likely to be based on differences between products. Consider high fashion apparel shops, microbreweries, and gourmet coffee as examples.

Test Your Understanding

In the chapter, it was argued that **the minimum efficient scale has been falling** in many industries over the past twenty years. What changes have occurred over the past 20 years to bring this about? (That is, why were small companies unable to compete with the larger companies in the past but are better able to compete now?)

Economies of Scope

Occasionally, there are cost savings that occur if a company produces more than one product. These cost savings are called "*economies of scope*". These are likely to occur when the different products use common factors of production. (An obvious example is that a cow will produce both meat and leather.) The factor that has perhaps become the most important today is knowledge (human capital). Knowledge useful for one product is often useful for many other products. This transferability often lowers the costs of production for larger companies. Economies of scope are important in the high-technology, knowledge-based industries (see below).

Test Your Understanding

It has been argued that stores like Costco or Wal-Mart have an advantage over stores like Albertsons or Vons. **The advantage is NOT due to economies of scale but IS due to economies of scope.** First, what does this statement mean? Second, why might this statement be true? (That is, why would Costco or Wal-Mart not have economies of scale? And why would they have economies of scope?) If you are not familiar with these, visit the nearest Costco or Wal-Mart and the nearest large grocery store.

First Mover Advantages

The long-run average total cost is a very important concept. If we own a company and we know there are considerable economies of scale or economies of scope, we would desire to become large as quickly as possible. This might even mean charging a very low price to gain customers (called "*predatory pricing*"). Even if we lose money for awhile, we will gain in the future as our costs of production fall. Perhaps we can even drive most of our competitors out of business? ***Companies that are knowledge-based are those likely to have economies of scale, dynamic increasing returns to scale, or economies of scope (review these definitions).*** These include companies in computers, pharmaceuticals, aircraft, software, telecommunications equipment, and fiber optics. These companies require that large initial amounts of money are spent on research, development, and equipment (generating economies of scale). Experience gained with one product or technology may make it easier to produce new products using related technologies (generating economies of scope). Because producing more of the product lowers the costs per unit, the company that can first increase its production can produce at a lower cost than its competitors. Because it can produce at a lower cost, it can charge the buyer less than its competitors and possibly can eliminate most if not all of its competition. This phenomenon is called a "*first mover advantage*". It explains in part how the VHS format drove out the Beta format in the videocassette market. It also explains in part the dominance of Microsoft, whose history we will examine in Chapter 20. We will also examine this phenomenon again when we analyze public utilities such

as San Diego Gas and Electric, Pacific Gas and Electric, SBC, and so forth (Chapter 19). And we will consider it yet again in the chapter on international trade (Chapter 27). In that chapter, we will consider whether the American government should provide support to those American companies that would have considerable economies of scale, dynamic increasing returns to scale, and economies of scope in order to shut out the companies of other countries. (This is called a "*strategic trade policy*".)

Summary

This chapter completes our analysis of the costs of production. There are many new terms here. In Chapter 15, we examined the costs of production in the **long-run** --- when the amount of capital can be changed. We derived the **Long-run Average Total Cost**, showing the cost per unit to produce each quantity of the product given that the company can change the amount of capital it has. We saw that this is likely to decline, a phenomenon called **economies of scale (or increasing returns to scale)**. Up to some quantity, larger companies can produce each unit of the product at a lower cost than smaller companies. This phenomenon ends, however. Beyond that quantity, larger companies produce at the same cost per unit as smaller ones. This is called **constant returns to scale**. That quantity produced at which economies of scale end, called **the minimum efficient scale**, is smaller than most people might think and has become even smaller over time. We expect that when companies become too large, the cost per unit will eventually increase. This is called **diseconomies of scale**. However, we do not observe American companies becoming large enough for this to occur. We have also considered how the cost per unit of producing the product might decrease over time (called **dynamic increasing returns to scale**) and might decrease if a company produces different, but related products (called **economies of scope**). These concepts are very important to our analysis of business behavior. But to fully analysis businesses, we need to bring in the revenues. As noted in Chapter 14, revenues will be determined differently for different companies depending on the type of industry the company is in. So we start our analysis of revenues in Chapter 16.

Practice Quiz for Chapter 15

- In the **long-run**, all factors of production are
 - fixed
 - variable
- “The cost of every unit, allowing the company to use the quantity of land and capital that can produce that quantity as cheaply as possible” is called the
 - short-run average total cost
 - long run average total cost
 - long run marginal cost
- “When the quantity produced increases, the amount of capital used can also increase. With a greater amount of capital, the cost per unit of producing the product falls.” This statement describes:
 - economies of scale
 - diseconomies of scale
 - constant returns to scale
 - economies of scope
- “When the quantity produced increases, the amount of capital used can also increase. With a greater amount of capital, the cost per unit of producing the product rises.” This statement describes:
 - economies of scale
 - diseconomies of scale
 - constant returns to scale
 - economies of scope

5. “When the quantity produced increases, the amount of capital used can also increase. With a greater amount of capital, the cost per unit of producing the product stays the same.” This statement describes:
a. economies of scale b. diseconomies of scale c. constant returns to scale d. economies of scope
6. “Because the company does many different, but related tasks, the cost per unit of producing the product falls.” This statement describes:
a. economies of scale b. diseconomies of scale c. constant returns to scale d. economies of scope
7. “As the **cumulative** production of the products increases over time, the cost per unit falls.” This statement describes:
a. constant returns to scale c. diseconomies of scale
b. economies of scope d. dynamic increasing returns to scale
8. **Diseconomies of scale** may exist because of:
a. the principal agent problem b. shirking c. poor communication d. all of the above
9. The minimum quantity that must be produced to be able to produce as cheaply as possible is called the:
a. economies of scale b. minimum efficient scale c. predatory pricing d. first mover advantage
10. If we examine actual **long-run average total cost curves** for specific industries, we usually observe
a. economies of scale throughout c. economies of scale followed by constant returns to scale
b. diseconomies of scale throughout d. economies of scale followed by diseconomies of scale

Answers: 1. B 2. B 3. A 4. B 5. C 6. D 7. D 8. D 9. B 10. C