section 13

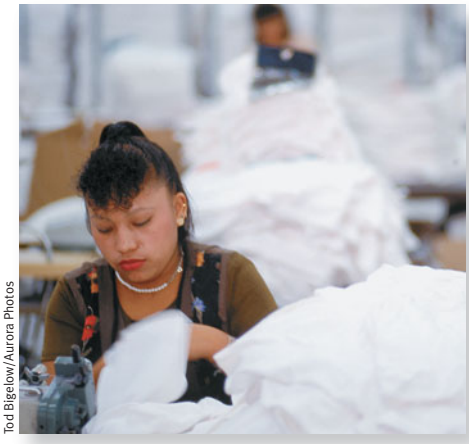
Factor Markets

Does higher education pay? Yes, it does: In the modern economy, employers are willing to pay a premium for workers with more education. And the size of that premium has increased a lot over the last few decades. Back in 1973 workers with advanced degrees, such as law degrees or MBAs, earned only 76% more than those who had only graduated from high school. By 2009, the premium for an advanced degree had risen to over 112%.

Who decided that the wages of workers with advanced degrees would rise so much compared with those of high school grads? The answer, of course, is that nobody decided it. Wage rates are prices, the prices of different kinds of labor; and they are decided, like other prices, by supply and demand.

Still, there is a qualitative difference between the wage rate of high school grads and the price of used textbooks: the wage rate isn't the price of a *good;* it's the price of a *factor of production.* And although markets for factors of production are in many ways similar to those for goods, there are also some important differences.

In this section, we examine *factor markets,* the markets in which the factors of production such as labor, land, and capital are traded. Factor markets, like goods markets, play a crucial role in the economy: they allocate productive resources to firms and help ensure that those resources are used efficiently.



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If you've ever had doubts about attending college, consider this: factory workers with only high school degrees will make much less than college grads. The present discounted value of the difference in lifetime earnings is as much as $300,000.

What you will learn in this **Module:**

- How factors of production—resources like land, labor, and capital—are traded in factor markets
- How factor markets determine the factor distribution of income
- How the demand for a factor of production is determined

Module 69 Introduction and Factor Demand

The Economy's Factors of Production

You may recall that we have already defined a factor of production in the context of the circular-flow diagram; it is any resource that is used by firms to produce goods and services, items that are consumed by households. The markets in which factors of production are bought and sold are called *factor markets,* and the prices in factor markets are known as *factor prices.*

What are these factors of production, and why do factor prices matter?

The Factors of Production

Economists divide factors of production into four principal classes. The first is *labor,* the work done by human beings. The second is *land,* which encompasses resources provided by nature. The third is capital, which can be divided into two categories: **physical capital**—often referred to simply as "capital"—consists of manufactured resources such as equipment, buildings, tools, and machines. In the modern economy, **human capital,** the improvement in labor created by education and knowledge, and embodied in the workforce, is at least equally significant. Technological progress has boosted the importance of human capital and made technical sophistication essential to many jobs, thus helping to create the premium for workers with advanced degrees. The final factor of production, *entrepreneurship,* is a unique resource that is not purchased in an easily identifiable factor market like the other three. It refers to risk-taking activities that bring together resources for innovative production.

Physical capital—often referred to simply as "capital"—consists of manufactured productive resources such as equipment, buildings, tools, and machines.

Human capital is the improvement in labor created by education and knowledge that is embodied in the workforce.

Why Factor Prices Matter: The Allocation of Resources

The factor prices determined in factor markets play a vital role in the important process of allocating resources among firms.

Consider the example of Mississippi and Louisiana in the aftermath of Hurricane Katrina, the costliest hurricane ever to hit the U.S. mainland. The states had an urgent

need for workers in the building trades—everything from excavation to roofing—to repair or replace damaged structures. What ensured that those needed workers actually came? The factor market: the high demand for workers drove up wages. During 2005, the average U.S. wage grew at a rate of around 6%. But in areas heavily affected by Katrina, the average wage during the fall of 2005 grew by 30% more than the national rate, and some areas saw twice that rate of increase. Over time, these higher wages led large numbers of workers with the right skills to move temporarily to these states to do the work.

In other words, the market for a factor of production—construction workers—allocated that factor of production to where it was needed.

In this sense factor markets are similar to goods markets, which allocate goods among consumers. But there are two features that make factor markets special. Unlike in a goods market, demand in a factor market is what we call **derived demand.** That is, demand for the factor is derived from demand for the firm's output. The second feature is that factor markets are where most of us get the largest shares of our income (government transfers being the next largest source of income in the economy).

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In the months after Hurricane Katrina, home repair signs like these were abundant throughout New Orleans.

Factor Incomes and the Distribution of Income

Most American families get most of their income in the form of wages and salaries—that is, they get their income by selling labor. Some people, however, get most of their income from physical capital: when you own stock in a company, what you really own is a share of that company's physical capital. Some people get much of their income from rents earned on land they own. And successful entrepreneurs earn income in the form of profits.

Obviously, then, the prices of factors of production have a major impact on how the economic "pie" is sliced among different groups. For example, a higher wage rate, other things equal, means that a larger proportion of the total income in the economy goes to people who derive their income from labor and less goes to those who derive their income from capital, land, or entrepreneurship. Economists refer to how the economic pie is sliced as the "distribution of income." Specifically, factor prices determine the **factor distribution of income**—how the total income of the economy is divided among labor, land, capital, and entrepreneurship.

The factor distribution of income in the United States has been quite stable over the past few decades. In other times and places, however, large changes have taken place in the factor distribution. One notable example: during the Industrial Revolution, the share of total income earned by landowners fell sharply, while the share earned by capital owners rose.

The Factor Distribution of Income in the United States

When we talk about the factor distribution of income, what are we talking about in practice?

In the United States, as in all advanced economies, payments to labor account for most of the economy's total income. Figure 69.1 on the next page shows the factor distribution of income in the United States in 2009: in that year, 70.9% of total income in the economy took the form of "compensation of employees"—a number that includes

The demand for a factor is a **derived demand.** It results from (that is, it is derived from) the demand for the output being produced.

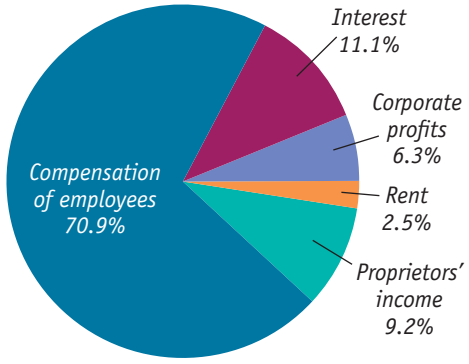
The **factor distribution of income** is the division of total income among land, labor, capital, and entrepreneurship.

figure 69.1

Factor Distribution of Income in the United States in 2009

In 2009, compensation of employees accounted for most income earned in the United States—70.9% of the total. Most of the remainder—consisting of earnings paid in the form of interest, corporate profits, and rent—went to owners of physical capital. Finally, proprietors' income—9.2% of the total—went to individual owners of businesses as compensation for their labor, entrepreneurship, and capital expended in their businesses.

Source: Bureau of Economic Analysis.



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both wages and benefits such as health insurance. This number has been quite stable over the long run; 37 years earlier, in 1972, compensation of employees was very similar, at 72.2% of total income.

Much of what we call compensation of employees is really a return on human capital. A surgeon isn't just supplying the services of a pair of ordinary hands (at least the patient hopes not!): that individual is also supplying the result of many years and hundreds of thousands of dollars invested in training and experience. We can't directly measure what fraction of wages is really a payment for education and training, but many economists believe that labor resources created through additional human capital has become *the* most important factor of production in modern economies.

Marginal Productivity and Factor Demand

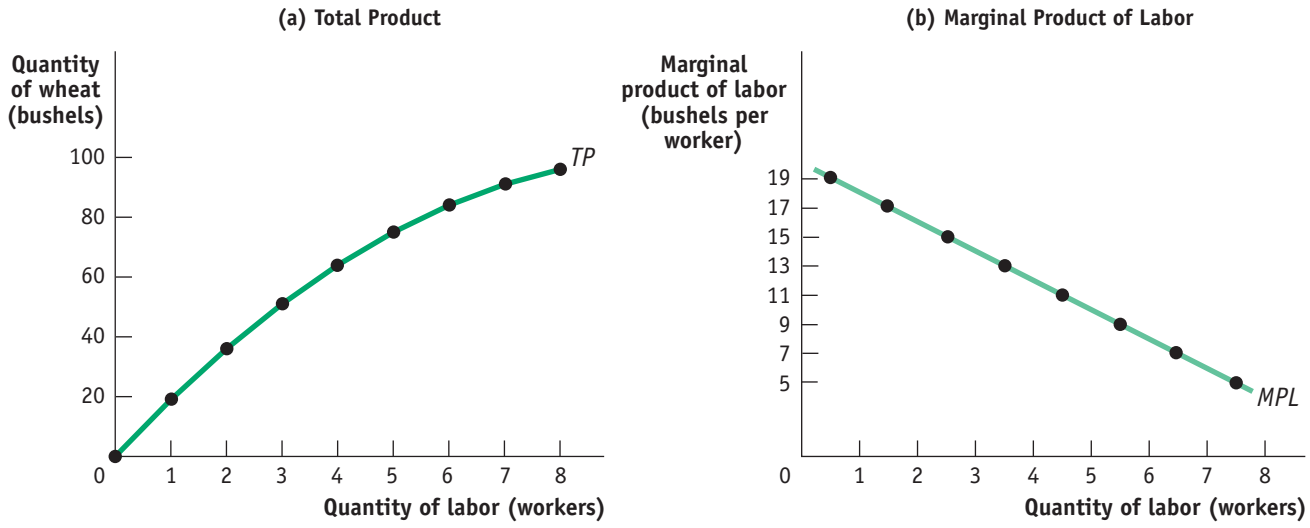
All economic decisions are about comparing costs and benefits—and usually about comparing marginal costs and marginal benefits. This goes both for a consumer, deciding whether to buy more goods or services, and for a firm, deciding whether to hire an additional worker.

Although there are some important exceptions, most factor markets in the modern American economy are perfectly competitive. This means that most buyers and sellers of factors are price-takers because they are too small relative to the market to do anything but accept the market price. And in a competitive labor market, it's clear how to define the marginal cost an employer pays for a worker: it is simply the worker's wage rate. But what is the marginal benefit of that worker? To answer that question, we return to the production function, which relates inputs to output. For now we assume that all firms are price-takers in their output markets—that is, they operate in a perfectly competitive industry.

Value of the Marginal Product

Figure 69.2 shows the production function for wheat on George and Martha's farm, as introduced in Module 54. Panel (a) uses the total product curve to show how total wheat production depends on the number of workers employed on the farm; panel (b) shows how the *marginal product of labor,* the increase in output from employing one more worker, depends on the number of workers employed. Table 69.1 shows the

figure 69.2 The Production Function for George and Martha's Farm



Panel (a) shows how the quantity of output of wheat on George and Martha's farm depends on the number of workers employed.

Panel (b) shows how the marginal product of labor depends on the number of workers employed.

numbers behind the figure. Note: sometimes the marginal product (*MP*) is called the *marginal physical product* or *MPP*. These two terms are the same; the extra "P" just emphasizes that the term refers to the quantity of physical output being produced, not the monetary value of that output.

If workers are paid $200 each and wheat sells for $20 per bushel, how many workers should George and Martha employ to maximize profit?

table 69.1

Employment and Output for George and Martha's Farm

Quantity of labor *L* (workers)	Quantity of wheat *Q* (bushels)	Marginal product of labor $MPL = \frac{\Delta Q}{\Delta L}$ (bushels per worker)
0	0	
		19
1	19	
		17
2	36	
		15
3	51	
		13
4	64	
		11
5	75	
		9
6	84	
		7
7	91	
		5
8	96	

The **value of the marginal product** of a factor is the value of the additional output generated by employing one more unit of that factor.

The **value of the marginal product curve** of a factor shows how the value of the marginal product of that factor depends on the quantity of the factor employed.

Earlier we showed how to answer this question in several steps. First, we used information from the production function to derive the firm's total cost and its marginal cost. Then we used the *price-taking firm's optimal output rule:* a price-taking firm's profit is maximized by producing the quantity of output at which the marginal cost is equal to the market price. Having determined the optimal quantity of output, we went back to the production function to find the optimal number of workers—which was simply the number of workers needed to produce the optimal quantity of output.

As you might have guessed, marginal analysis provides a more direct way to find the number of workers that maximizes a firm's profit. This alternative approach is just a different way of looking at the same thing. But it gives us more insight into the demand for factors as opposed to the supply of goods.

To see how this alternative approach works, suppose that George and Martha are deciding whether to employ another worker. The increase in *cost* from employing another worker is the wage rate, *W*. The *benefit* to George and Martha from employing another worker is the value of the extra output that worker can produce. What is this value? It is the marginal product of labor, *MPL,* multiplied by the price per unit of output, *P*. This amount—the extra value of output generated by employing one more unit of labor—is known as the **value of the marginal product** of labor, or *VMPL*:

(69-1) Value of the marginal product of labor = $VMPL = P \times MPL$

So should George and Martha hire another worker? Yes, if the value of the extra output is more than the cost of the additional worker—that is, if $VMPL > W$. Otherwise, they should not.

The hiring decision is made using marginal analysis, by comparing the marginal benefit from hiring another worker (*VMPL*) with the marginal cost (*W*). And as with any decision that is made on the margin, the optimal choice is made by equating marginal benefit with marginal cost (or if they're never equal, by continuing to hire until the marginal cost of one more unit would exceed the marginal benefit). That is, to maximize profit, George and Martha will employ workers up to the point at which, for the last worker employed,

(69-2) $VMPL = W$.

This rule isn't limited to labor; it applies to any factor of production. The value of the marginal product of any factor is its marginal product times the price of the good it produces. And as a general rule, profit-maximizing, price-taking firms will keep adding more units of each factor of production until the value of the marginal product of the last unit employed is equal to the factor's price.

This rule is consistent with our previous analysis. We saw that a profit-maximizing firm chooses the level of output at which the price of the good it produces equals the marginal cost of producing that good. It turns out that if the level of output is chosen so that price equals marginal cost, then it is also true that with the amount of labor required to produce that output level, the value of the marginal product of labor will equal the wage rate.

Now let's look more closely at why choosing the level of employment to equate *VMPL* and *W* works, and at how it helps us understand factor demand.

Value of the Marginal Product and Factor Demand

Table 69.2 shows the value of the marginal product of labor on George and Martha's farm when the price of wheat is $20 per bushel. In Figure 69.3, the horizontal axis shows the number of workers employed; the vertical axis measures the value of the marginal product of labor *and* the wage rate. The curve shown is the **value of the marginal product curve** of labor. This curve, like the marginal product of labor curve, slopes downward because of diminishing returns to labor in production. That is, the value of the

table **69.2**

Value of the Marginal Product of Labor for George and Martha's Farm

Quantity of labor *L* (workers)	Marginal product of labor *MPL* (bushels per worker)	Value of the marginal product of labor *VMPL* = *P* × *MPL*
0		
	19	$380
1		
	17	340
2		
	15	300
3		
	13	260
4		
	11	220
5		
	9	180
6		
	7	140
7		
	5	100
8		

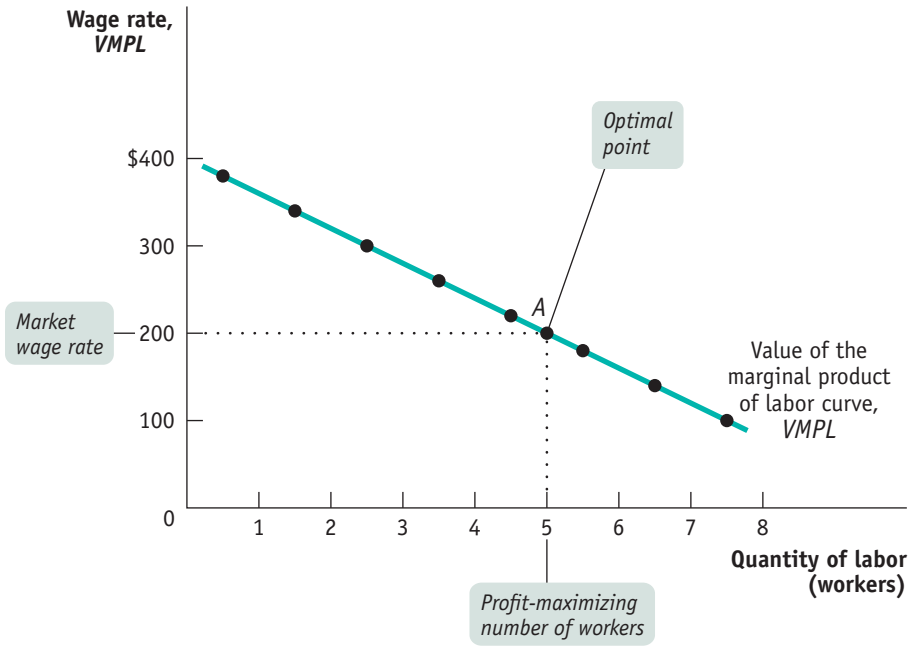
marginal product of each worker is less than that of the preceding worker because the marginal product of each worker is less than that of the preceding worker.

We have just seen that to maximize profit, George and Martha hire workers until the wage rate is equal to the value of the marginal product of the last worker employed. Let's use the example to see how this principle really works.

figure **69.3**

The Value of the Marginal Product Curve

This curve shows how the value of the marginal product of labor depends on the number of workers employed. It slopes downward because of diminishing returns to labor in production. To maximize profit, George and Martha choose the level of employment at which the value of the marginal product of labor is equal to the market wage rate. For example, at a wage rate of $200 the profit-maximizing level of employment is 5 workers, shown by point *A*. The value of the marginal product curve of a factor is the producer's individual demand curve for that factor.



Assume that George and Martha currently employ 3 workers and that these workers must be paid the market wage rate of $200. Should they employ an additional worker?

Looking at Table 69.2, we see that if George and Martha currently employ 3 workers, the value of the marginal product of an additional worker is $260. So if they employ an additional worker, they will increase the value of their production by $260 but increase their cost by only $200, yielding an increased profit of $60. In fact, a firm can always increase profit by employing one more unit of a factor of production as long as the value of the marginal product produced by that unit exceeds the factor price.

Alternatively, suppose that George and Martha employ 8 workers. By reducing the number of workers to 7, they can save $200 in wages. In addition, the value of the marginal product of the 8th worker is only $100. So, by reducing employment by one worker, they can increase profit by $200 − $100 = $100. In other words, a firm can always increase profit by employing one less unit of a factor of production as long as the value of the marginal product produced by that unit is less than the factor price.

Using this method, we can see from Table 69.2 that the profit-maximizing employment level is 5 workers, given a wage rate of $200. The value of the marginal product of the 5th worker is $220, so adding the 5th worker results in $20 of additional profit. But George and Martha should not hire more than 5 workers: the value of the marginal product of the 6th worker is only $180, $20 less than the cost of that worker. So, to maximize profit, George and Martha should employ workers up to but not beyond the point at which the value of the marginal product of the last worker employed is equal to the wage rate.

Look again at the value of the marginal product curve in Figure 69.3. To determine the profit-maximizing level of employment, we set the value of the marginal product of labor equal to the price of labor—a wage rate of $200 per worker. This means that the profit-maximizing level of employment is at point *A*, corresponding to an employment level of 5 workers. If the wage rate were higher, we would simply move up the curve and decrease the number of workers employed: if the wage rate were lower than $200, we would move down the curve and increase the number of workers employed.

Koki Iino/Getty Images

Firms keep hiring more workers until the value of the marginal product of labor equals the wage rate.

In this example, George and Martha have a small farm in which the potential employment level varies from 0 to 8 workers, and they hire workers up to the point at which the value of the marginal product of another worker would fall below the wage rate. For a larger farm with many employees, the value of the marginal product of labor falls only slightly when an additional worker is employed. As a result, there will be some worker whose value of the marginal product almost exactly equals the wage rate. (In keeping with the George and Martha example, this means that some worker generates a value of the marginal product of approximately $200.) In this case, the firm maximizes profit by choosing a level of employment at which the value of the marginal product of the last worker hired *equals* (to a very good approximation) the wage rate.

In the interest of simplicity, we will assume from now on that firms use this rule to determine the profit-maximizing level of employment. *This means that the value of the marginal product of labor curve is the individual firm's labor demand curve.* And in general, a firm's value of the marginal product curve for any factor of production is that firm's individual demand curve for that factor of production.

Shifts of the Factor Demand Curve

As in the case of ordinary demand curves, it is important to distinguish between movements along the factor demand curve and shifts of the factor demand curve. What causes factor demand curves to shift? There are three main causes:

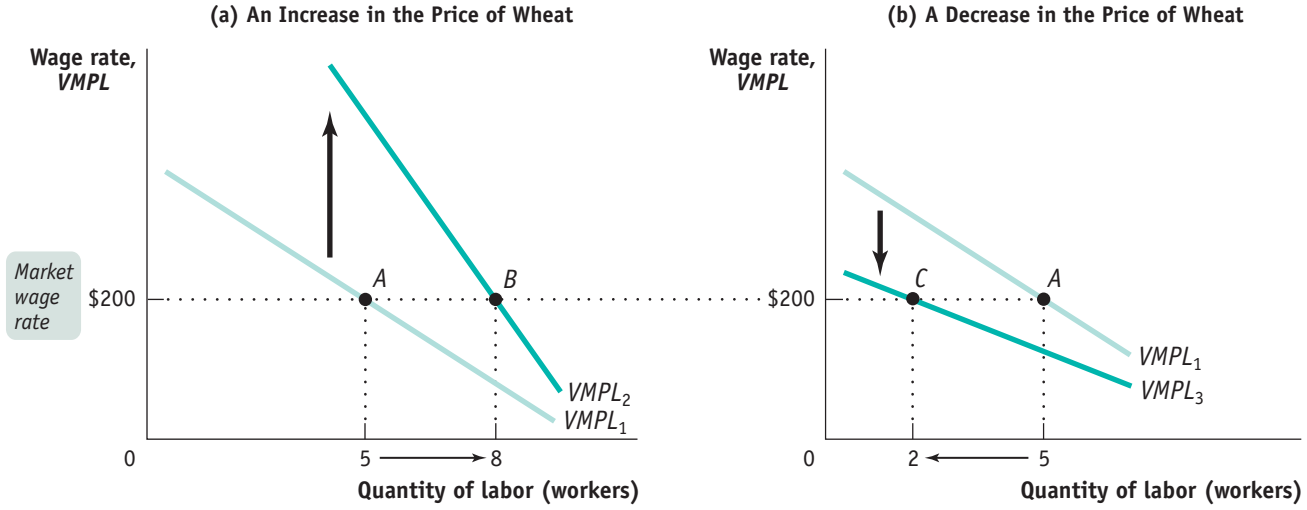
- Changes in the prices of goods
- Changes in the supply of other factors
- Changes in technology

Changes in the Prices of Goods Remember that factor demand is derived demand: if the price of the good that is produced with a factor changes, so will the value of the marginal product of the factor. That is, in the case of labor demand, if P changes, $VMPL = P \times MPL$ will change at any given level of employment.

Figure 69.4 illustrates the effects of changes in the price of wheat, assuming that $200 is the current wage rate. Panel (a) shows the effect of an *increase* in the price of wheat. This shifts the value of the marginal product of labor curve upward because *VMPL* rises at any given level of employment. If the wage rate remains unchanged at $200, the optimal point moves from point *A* to point *B*: the profit-maximizing level of employment rises.

Panel (b) shows the effect of a *decrease* in the price of wheat. This shifts the value of the marginal product of labor curve downward. If the wage rate remains unchanged at $200, the optimal point moves from point *A* to point *C*: the profit-maximizing level of employment falls.

figure 69.4 Shifts of the Value of the Marginal Product Curve



Panel (a) shows the effect of an increase in the price of wheat on George and Martha's demand for labor. The value of the marginal product of labor curve shifts upward, from $VMPL_1$ to $VMPL_2$. If the market wage rate remains at $200, profit-maximizing employment rises from 5 workers to 8 workers, shown by the movement from point *A* to point *B*. Panel (b) shows the effect of a decrease in the price of wheat. The value of the marginal product of labor curve shifts downward, from $VMPL_1$ to $VMPL_3$. At the market wage rate of $200, profit-maximizing employment falls from 5 workers to 2 workers, shown by the movement from point *A* to point *C*.

Changes in the Supply of Other Factors Suppose that George and Martha acquire more land to cultivate—say, by clearing a woodland on their property. Each worker now produces more wheat because each one has more land to work with. As a result, the marginal product of labor on the farm rises at any given level of employment. This has the same effect as an increase in the price of wheat, which is illustrated in panel (a) of Figure 69.4: the value of the marginal product of labor curve shifts upward, and at any given wage rate the profit-maximizing level of employment rises. Similarly, suppose

George and Martha cultivate less land. This leads to a fall in the marginal product of labor at any given employment level. Each worker produces less wheat because each has less land to work with. As a result, the value of the marginal product of labor curve shifts downward—as in panel (b) of Figure 69.4—and the profit-maximizing level of employment falls.

Changes in Technology In general, the effect of technological progress on the demand for any given factor can go either way: improved technology can either increase or decrease the demand for a given factor of production.

How can technological progress decrease factor demand? Consider horses, which were once an important factor of production. The development of substitutes for horse power, such as automobiles and tractors, greatly reduced the demand for horses.

The usual effect of technological progress, however, is to increase the demand for a given factor, often because it raises the marginal product of the factor. In particular, although there have been persistent fears that machinery would reduce the demand for labor, over the long run the U.S. economy has seen both large wage increases and large increases in employment, suggesting that technological progress has greatly increased labor demand.

Module 69 AP Review

Solutions appear at the back of the book.

Check Your Understanding

1. Suppose that the government places price controls on the market for college professors, imposing a wage that is lower than the market wage. Describe the effect of this policy on the production of college degrees. What sectors of the economy do you think would be adversely affected by this policy? What sectors of the economy might benefit?
2. a. Suppose service industries, such as retailing and banking, experience an increase in demand. These industries use relatively more labor than nonservice industries. Does the demand curve for labor shift to the right, shift to the left, or remain unchanged?
   b. Suppose diminishing fish populations off the coast of Maine lead to policies restricting the use of the most productive types of nets in that area. The result is a decrease in the number of fish caught per day by commercial fishers in Maine. The price of fish is unaffected. Does the demand curve for fishers in Maine shift to the right, shift to the left, or remain unchanged?

Tackle the Test: Multiple-Choice Questions

1. Which of the following is an example of *physical* capital?
   a. manual labor
   b. welding equipment
   c. farm land
   d. lumber
   e. education
2. Which of the following can shift the factor demand curve to the right?
   I. an increase in the price of the good being produced
   II. an increase in the factor's marginal productivity
   III. a technological advance
   a. I only
   b. II only
   c. III only
   d. I and II only
   e. I, II, and III
3. Factor market demand is called a *derived* demand because it
   a. derives its name from the Latin *factorus*.
   b. is derived from the market wage received by workers.
   c. is derived from the productivity of workers.
   d. is derived from the product market.
   e. derives its shape from the price of the factor.
4. Which factor of production receives the largest portion of income in the United States?
   a. land
   b. labor
   c. physical capital
   d. entrepreneurship
   e. interest

5. The individual firm's demand curve for labor is
   a. the *VMPL* curve.
   b. upward sloping.
   c. horizontal at the level of the product price.
   d. vertical.
   e. equal to the *MPL* curve.

Tackle the Test: Free-Response Questions

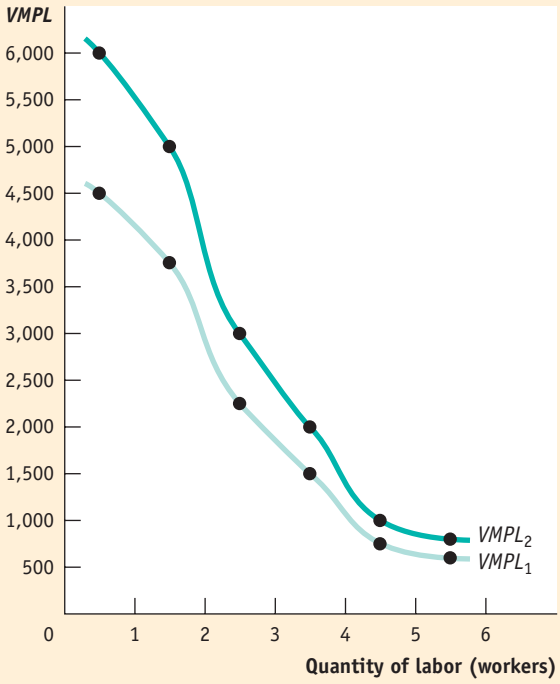
1. Refer to the table below. Assume the firm can sell all of the output it produces at a price of $15.

Quantity of labor (workers)	*Quantity of output*
0	0
1	300
2	550
3	700
4	800
5	850
6	890

   a. What is the value of the marginal product of labor of the 3rd worker?
   b. Draw a correctly labeled graph showing the firm's demand curve for labor.
   c. What happens to the demand curve for labor if the price of the product increases to $20? Show the result on your graph from part b.
   d. Assume that a technological advance doubles the productivity of workers. Calculate the total quantity that will now be produced with each quantity of workers.

Answer (7 points)

1 point: *VMPL* = 150 × $15 = $2,250



1 point: Axes are correctly labeled.

1 point: *VMPL* is downward sloping and labeled.

1 point: *VMPL* is plotted using correct numbers (see graph).

1 point: The demand curve for labor shifts to the right.

1 point: *VMPL* curve is shown shifted to the right.

1 point: The new quantities produced are 600; 1,100; 1,400; 1,600; 1,700; and 1,780.

2. Draw a separate, correctly labeled graph illustrating the effect of each of the following changes on the demand for labor. Adopt the usual *ceteris paribus* assumption that all else remains unchanged in each case.
   a. The price of the product being produced decreases.
   b. Worker productivity increases.
   c. Firms invest in more capital to be used by workers.

What you will learn in this **Module:**

- How to determine supply and demand in the markets for land and capital
- How to find equilibrium in the land and capital markets
- How the demand for factors leads to the marginal productivity theory of income distribution

Module 70
The Markets for Land and Capital

In Figure 69.1 we saw the factor distribution of income and found that approximately 70% of total income in the economy took the form of compensation for employees. Because labor is such an important resource, it is often used as the example in discussions of factor markets. But land and capital are critical resources as well, and their markets have unique characteristics worthy of examination. In this module we look more closely at the markets for land and capital before moving on to discuss the labor market further in Module 71.

Land and Capital

In the previous module we used a labor market example to explain why a firm's individual demand curve for a factor is its value of the marginal product curve. Now we look at the distinguishing characteristics of demand and supply in land and capital markets, and how the equilibrium price and quantity of these factors are determined.

Demand in the Markets for Land and Capital

If we maintain the assumption that the markets for goods and services are perfectly competitive, the result that we derived for demand in the labor market also applies to other factors of production. Suppose, for example, that a farmer is considering whether to rent an additional acre of land for the next year. He or she will compare the cost of renting that acre with the value of the additional output generated by employing an additional acre—the value of the marginal product of an acre of land. To maximize profit, the farmer will rent more land up until the value of the marginal product of an acre of land is equal to the rental rate per acre. The same is true for capital: the decision of whether to rent an additional piece of equipment comes down to a comparison of the additional cost of the equipment with the value of the additional output it generates.

What if the farmer already owns the land or the firm already owns the equipment? As discussed in Module 52 in the context of Babette's Cajun Café, even if you own land

or capital, there is an implicit cost—the opportunity cost—of using it for a given activity because it could be used for something else, such as renting it out to other firms at the market rental rate. So a profit-maximizing firm employs additional units of land and capital until the cost of the last unit employed, explicit or implicit, is equal to the value of the marginal product of that unit. We call the explicit cost of renting a unit of land or capital for a set period of time its **rental rate.**

The **rental rate** of either land or capital is the cost, explicit or implicit, of using a unit of that asset for a given period of time.

As with labor, due to diminishing returns, the value of the marginal product curve and therefore the individual firm's demand curves for land and capital slope downward.

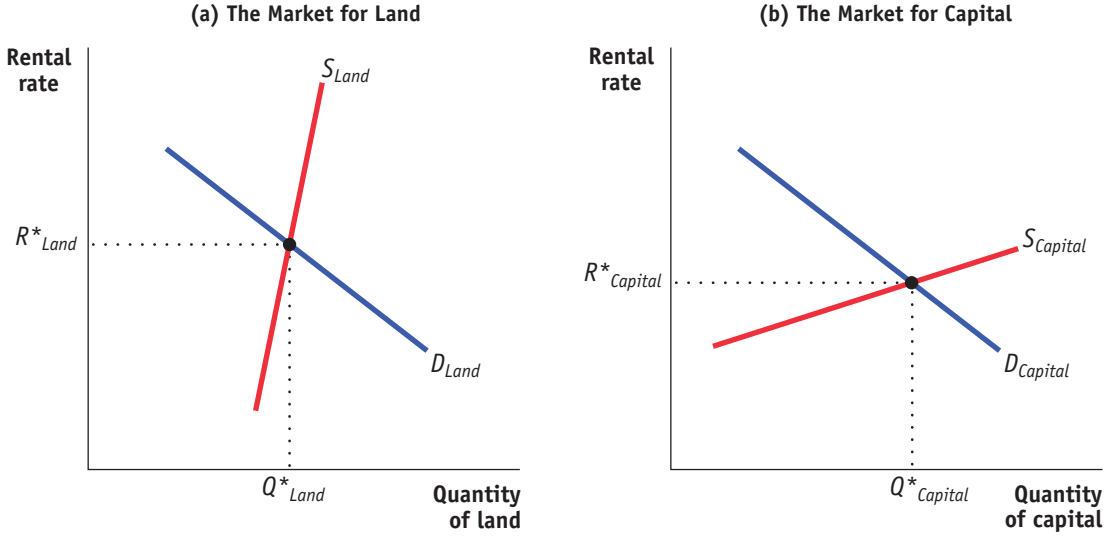
Supply in the Markets for Land and Capital

Figure 70.1 illustrates the markets for land and capital. The red curve in panel (a) is the supply curve for land. As we have drawn it, the supply curve for land is relatively steep and therefore relatively inelastic. This reflects the fact that finding new supplies of land for production is typically difficult and expensive—for example, creating new farmland through expensive irrigation.

The red curve in panel (b) is the supply curve for capital. In contrast to the supply curve for land, the supply curve for capital is relatively flat and therefore relatively elastic. That's because the supply of capital is relatively responsive to price: capital is typically paid for with the savings of investors, and the amount of savings that investors make available is relatively responsive to the rental rate for capital.

As in the case of supply curves for goods and services, the supply curve for a factor of production will shift as the factor becomes more or less available. For example, the supply of farmland could decrease as a result of a drought or the supply of capital could increase as a result of a government policy to promote investment. Because of diminishing returns, when the supply of land or capital changes, its marginal product will change.

figure 70.1 Equilibria in the Land and Capital Markets



Panel (a) illustrates equilibrium in the market for land; panel (b) illustrates equilibrium in the market for capital. The supply curve for land is relatively steep, reflecting the high cost of increasing the quantity of productive land. The supply curve for capital, in contrast, is relatively flat, due to the relatively high responsiveness of savings to changes in the rental rate for capital. The equilibrium rental rates for land and capital, as well as the equilibrium quantities transacted, are given by the intersections of the demand and supply curves. In a competitive land market, each unit of land will be paid the equilibrium value of the marginal product of land, R^*_{Land}. Likewise, in a competitive capital market, each unit of capital will be paid the equilibrium value of the marginal product of capital, $R^*_{Capital}$.

According to the **marginal productivity theory of income distribution,** every factor of production is paid the equilibrium value of its marginal product.

When the supply of land or capital decreases, the marginal product and rental rate increase. For example, if the number of available delivery trucks decreased, the additional benefit from the last truck used would be higher than before—it would serve more critical delivery needs—and firms would pay more for it. Likewise, when the supply of land or capital increases, the marginal product and rental rate decrease.

Equilibrium in Land and Capital Markets

The equilibrium rental rate and quantity in the land and capital markets are found at the intersection of the supply and demand curves in Figure 70.1. Panel (a) shows the equilibrium in the market for land. Summing all of the firm demand curves for land gives us the market demand curve for land. The equilibrium rental rate for land is R^*_{Land}, and the equilibrium quantity of land employed in production is Q^*_{Land}. In a competitive land market, each unit of land will be paid the equilibrium value of the marginal product of land.

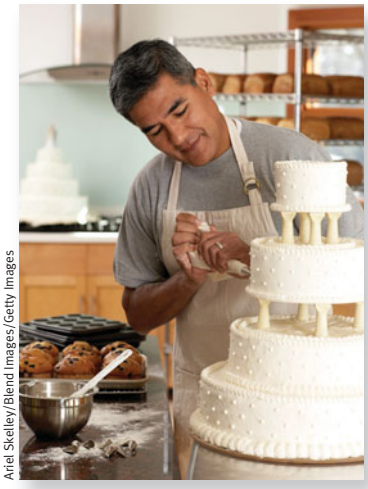
Panel (b) shows the equilibrium in the market for capital. The equilibrium rental rate for capital is $R^*_{Capital}$, and the equilibrium quantity of capital employed in production is $Q^*_{Capital}$. In a competitive capital market, each unit of capital will be paid the equilibrium value of the marginal product of capital.

Now that we know how equilibrium rental rates and quantities are determined in land and capital markets, we can learn how these markets influence the factor distribution of income. To do this, we look more closely at marginal productivity in factor markets.

Marginal Productivity Theory

The **marginal productivity theory of income distribution** sums up what we have learned about payments to factors when goods markets and factor markets are perfectly competitive. According to this theory, each factor is paid the value of the output generated by the last unit of that factor employed in the factor market as a whole—its equilibrium value of the marginal product. To understand why the marginal productivity theory of income distribution is important, look back at Figure 69.1, which shows the factor distribution of income in the United States, and ask yourself this question: who or what determined that labor would get 70.9% of total U.S. income? Why not 90% or 50%?

The answer, according to this theory, is that the division of income among the economy's factors of production isn't arbitrary: in the economy-wide factor market, the price paid for each factor is equal to the increase in the value of output generated by the last unit of that factor employed in the market. If a unit of labor is paid more than a unit of capital, it is because at the equilibrium quantity of each factor, the value of the marginal product of labor exceeds the value of the marginal product of capital.



Ariel Skelley/Blend Images/Getty Images

So far we have treated factor markets as if every unit of each factor were identical. That is, as if all land were identical, all labor were identical, and all capital were identical. But in reality factors differ considerably with respect to productivity. For instance, land resources differ in their ability to produce crops and workers have different skills and abilities. Rather than thinking of one land market for all land resources in an economy, and similarly one capital market and one labor market, we can instead think of different markets for different types of land, capital, and labor. For example, the market for computer programmers is different from the market for pastry chefs.

When we consider that there are separate factor markets for different types of factors, the marginal productivity theory of income distribution still holds. That is, when the labor market for computer programmers is in equilibrium, the wage rate earned by all computer programmers is equal to the market's equilibrium value of the marginal product—the value of the marginal product of the last computer programmer hired in that market. The

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Help Wanted!

Hamill Manufacturing of Pennsylvania makes precision components for military helicopters and nuclear submarines. Their highly skilled senior machinists are well paid compared to other workers in manufacturing, earning nearly $70,000 in 2006, excluding benefits. Like most skilled machinists in the United States, Hamill's machinists are very productive: according to the National Mechanists Association, in 2006 each skilled American machinist generated approximately $120,000 in yearly revenue.

But there is a $50,000 difference between the salary paid to Hamill machinists and the revenue they generate. Does this mean that the marginal productivity theory of income distribution doesn't hold? Doesn't the theory imply that machinists should be paid $120,000, the average revenue that each one generates? The answer is no, for two reasons. First, the $120,000 figure is averaged over *all machinists currently employed.* The theory says that machinists will be paid the value of the marginal product of the *last machinist hired,* and due to diminishing returns to labor, that value will be lower than the average over all machinists currently employed. Second, a worker's equilibrium wage rate includes other costs, such as employee benefits, that have to be added to the $70,000 salary. The marginal productivity theory of income distribution says that workers are paid a wage rate, *including all benefits,* equal to the value of the marginal product. At Hamill, the machinists have job security and good benefits, which add to their salary. Including these benefits, machinists' total compensation will be equal to the value of the marginal product of the last machinist employed.

In Hamill's case, there is yet another factor that explains the $50,000 gap: there are not enough machinists at the current wage rate. Although the company increased the number of employees from 85 in 2004 to 110 in 2006, they would like to hire more. Why doesn't Hamill raise its wages in order to attract more skilled machinists? The problem is that the work they do is so specialized that it is hard to hire from the outside, even when the company raises wages as an inducement. To address this problem, Hamill is now spending a significant amount of money training each new hire. In the end, it does appear that the marginal productivity theory of income distribution holds.

Source: Courtesy U.S. Air Force

marginal productivity theory can explain the distribution of income among different types of land, labor, and capital as well as the distribution of income among the factors of production. In Module 73 we look more closely at the distribution of income between different types of labor and the extent to which the marginal productivity theory of income distribution explains differences in workers' wages.

Module 70 AP Review

Solutions appear at the back of the book.

Check Your Understanding

1. Explain how each of the following events would affect the equilibrium rental rate and the equilibrium quantity in the land market.
   a. Developers improve the process of filling in coastal waters with rocks and soil to form large new areas of land.
   b. New fertilizers improve the productivity of each acre of farmland.
2. Explain the following statement: "When firms in different industries all compete for the same land, the value of the marginal product of the last unit of land rented will be equal across all firms, regardless of whether they are in different industries."

Tackle the Test: Multiple-Choice Questions

1. The implicit cost of capital that you own is
   a. the rental rate.
   b. greater than the rental rate.
   c. the original purchase price of the capital.
   d. greater than the original purchase price of the capital.
   e. zero because you already own it.

2. Which of the following is true in relation to a very steep supply curve for land?
   I. It is relatively elastic.
   II. The quantity of land is very responsive to price changes.
   III. Finding new supplies of land is relatively expensive and difficult.
   a. I only
   b. II only
   c. III only
   d. I and II only
   e. I, II, and III

3. The explicit cost of land you don't own is equal to the
   a. rental rate.
   b. interest rate.
   c. profit received from using that land.
   d. market wage rate.
   e. marginal product of land.

4. A firm will continue to employ more land until its value of the marginal product of land is
   a. zero.
   b. maximized.
   c. equal to the rental rate.
   d. equal to the wage rate.
   e. equal to the value of the marginal product of labor and capital.

5. According to the marginal productivity theory of income distribution,
   a. each unit of a factor will be paid the value of its marginal product.
   b. as more of a factor is used, its marginal productivity increases.
   c. factors that receive higher payments are less productive.
   d. capital should receive the highest portion of factor income.
   e. each factor is paid the equilibrium value of its marginal product.

Tackle the Test: Free-Response Questions

1. Refer to the table below. Assume that the price of the product is \$10 and the rental rate for capital is \$100 per unit.

Quantity of capital (units)	*Quantity of output*
0	0
1	30
2	55
3	70
4	78
5	85
6	89

   a. What is the *VMP* of the 2nd unit of capital?
   b. Will the firm employ the 2nd unit of capital? Explain.
   c. How many units of capital will the firm hire? Explain.

Answer (5 points)

1 point: $VMP = 25 \times \$10 = \$250$

1 point: Yes

1 point: Because the *VMP* of \$250 is greater than the rental rate of \$100

1 point: 3

1 point: Because the *VMP* exceeds the rental rate for the first 3 units

2. Draw a correctly labeled graph showing how the market rental rate and quantity of land are determined in the land market. On your graph, be sure to include each of the following: the supply and demand curves for land, the equilibrium rental rate, the equilibrium quantity of land employed, and correct labels on the axes.

Module 71
The Market for Labor

What you will learn in this Module:

- The way in which a worker's decision about time preference gives rise to labor supply
- How to find equilibrium in the labor market

In Module 69 we looked at the determinants of labor demand and how the wage rate influences the quantity of labor demanded by firms. Now we complete our development of the labor market model by adding the supply of labor and exploring the determination of equilibrium wage and quantity in the labor market.

The Supply of Labor

There are only 24 hours in a day, so to supply labor is to give up leisure, which presents a dilemma of sorts. For this and other reasons, as we'll see, the labor market looks different from markets for goods and services.

Work versus Leisure

In the labor market, the roles of firms and households are the reverse of what they are in markets for goods and services. A good such as wheat is supplied by firms and demanded by households; labor, though, is demanded by firms and supplied by households. How do people decide how much labor to supply?

As a practical matter, most people have limited control over their work hours: sometimes a worker has little choice but to take a job for a set number of hours per week. However, there is often flexibility to choose among different careers and employment situations that involve varying numbers of work hours. There is a range of part-time and full-time jobs; some are strictly 9:00 A.M. to 5:00 P.M., others have much longer or shorter work hours. Some people work two jobs; others don't work at all. And self-employed people have many work-hour options. To simplify our study of labor supply, we will imagine an individual who can choose to work as many or as few hours as he or she likes.

Why wouldn't such an individual work as many hours as possible? Because workers are human beings, too, and have other uses for their time. An hour spent on the job is an hour not spent on other, presumably more pleasant, activities. So the decision about how much labor to supply involves making a decision about **time allocation**—how many hours to spend on different activities.

By working, people earn income that they can use to buy goods. The more hours an individual works, the more goods he or she can afford to buy. But this increased purchasing

Decisions about labor supply result from decisions about **time allocation:** how many hours to spend on different activities.

power comes at the expense of a reduction in **leisure,** the time spent not working. (Leisure doesn't necessarily mean time goofing off. It could mean time spent with one's family, pursuing hobbies, exercising, and so on.) And though purchased goods yield utility, so does leisure. Indeed, we can think of leisure itself as a normal good, which most people would like to consume more of as their incomes increase.


istockphoto

How does a rational individual decide how much leisure to consume? By making a marginal comparison, of course. In analyzing consumer choice, we asked how a utility-maximizing consumer uses a marginal *dollar*. In analyzing labor supply, we ask how an individual uses a marginal *hour*.

Consider Clive, an individual who likes both leisure and the goods money can buy. Suppose that his wage rate is $10 per hour. In deciding how many hours he wants to work, he must compare the marginal utility of an additional hour of leisure with the additional utility he gets from $10 worth of goods. If $10 worth of goods adds more to his total utility than an additional hour of leisure, he can increase his total utility by giving up an hour of leisure in order to work an additional hour. If an extra hour of leisure adds more to his total utility than $10 worth of goods, he can increase his total utility by working one fewer hour in order to gain an hour of leisure.

At Clive's optimal level of labor supply, then, the marginal utility he receives from one hour of leisure is equal to the marginal utility he receives from the goods that his hourly wage can purchase. This is very similar to the *optimal consumption rule* we encountered previously, except that it is a rule about time rather than money.

Our next step is to ask how Clive's decision about time allocation is affected when his wage rate changes.

Wages and Labor Supply

Suppose that Clive's wage rate doubles, from $10 to $20 per hour. How will he change his time allocation?

You could argue that Clive will work longer hours because his incentive to work has increased: by giving up an hour of leisure, he can now gain twice as much money as before. But you could equally well argue that he will work less because he doesn't need to work as many hours to generate the income required to pay for the goods he wants.

As these opposing arguments suggest, the quantity of labor Clive supplies can either rise or fall when his wage rate rises. To understand why, let's recall the distinction between *substitution effects* and *income effects*. We have seen that a price change affects consumer choice in two ways: by changing the opportunity cost of a good in terms of other goods (the substitution effect) and by making the consumer richer or poorer (the income effect).

Now think about how a rise in Clive's wage rate affects his demand for leisure. The opportunity cost of leisure—the amount of money he gives up by taking an hour off instead of working—rises. That substitution effect gives him an incentive, other things equal, to consume less leisure and work longer hours. Conversely, a higher wage rate makes Clive richer—and this income effect leads him, other things equal, to want to consume *more* leisure and supply less labor because leisure is a normal good.

So in the case of labor supply, the substitution effect and the income effect work in opposite directions. If the substitution effect is so powerful that it dominates the income effect, an increase in Clive's wage rate leads him to supply *more* hours of labor. If the income effect is so powerful that it dominates the substitution effect, an increase in the wage rate leads him to supply *fewer* hours of labor.

We see, then, that the **individual labor supply curve**—the relationship between the wage rate and the number of hours of labor supplied by an individual worker—does not necessarily slope upward. If the income effect dominates, a higher wage rate will reduce the quantity of labor supplied.

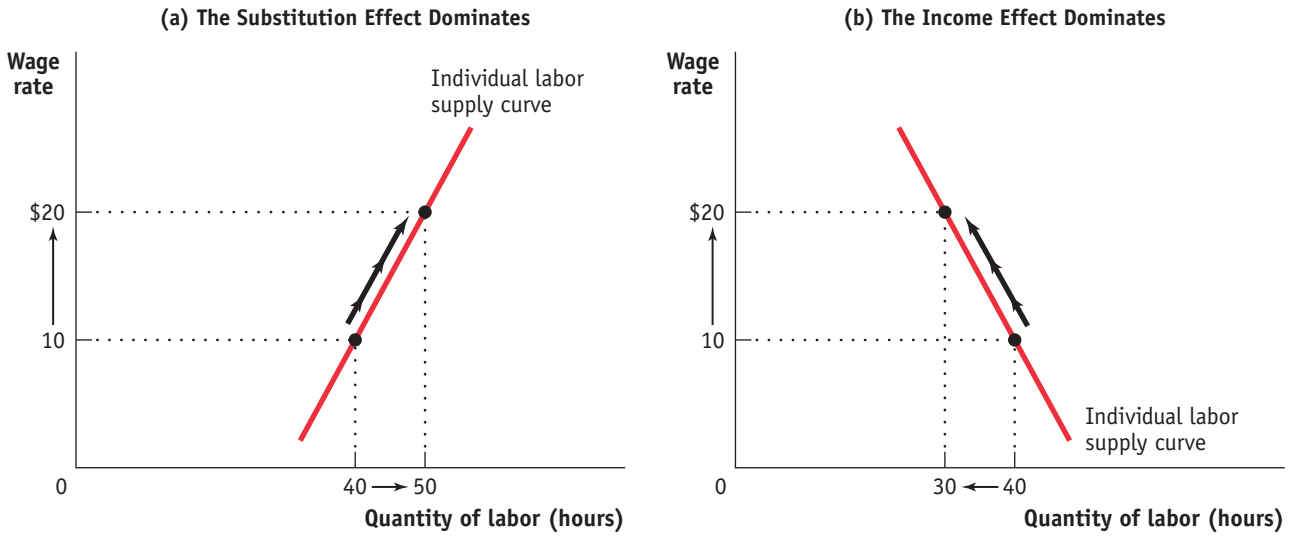
Leisure is time available for purposes other than earning money to buy marketed goods.

The **individual labor supply curve** shows how the quantity of labor supplied by an individual depends on that individual's wage rate.

Figure 71.1 illustrates the two possibilities for labor supply. If the substitution effect dominates the income effect, the individual labor supply curve slopes upward; panel (a) shows an increase in the wage rate from $10 to $20 per hour leading to a *rise* in the number of hours worked from 40 to 50. However, if the income effect dominates, the quantity of labor supplied goes down when the wage rate increases. Panel (b) shows the same rise in the wage rate leading to a *fall* in the number of hours worked from 40 to 30.

Economists refer to an individual labor supply curve that contains both upward-sloping and downward-sloping segments as a "backward-bending labor supply curve." At lower wage rates, the substitution effect dominates the income effect. At higher wage rates, the income effect eventually dominates the substitution effect.

figure 71.1 The Individual Labor Supply Curve



When the substitution effect of a wage increase dominates the income effect, the individual labor supply curve slopes upward, as in panel (a). Here a rise in the wage rate from $10 to $20 per hour increases the number of hours worked from 40 to 50. But when the income effect of a wage increase dominates the substitution effect, the individual labor supply curve slopes downward, as in panel (b). Here the same rise in the wage rate reduces the number of hours worked from 40 to 30.

Is a backward-bending labor supply curve a real possibility? Yes: many labor economists believe that income effects on the supply of labor may be somewhat stronger than substitution effects at high wage rates. The most compelling piece of evidence for this belief comes from Americans' increasing consumption of leisure over the past century. At the end of the nineteenth century, wages adjusted for inflation were only about one-eighth what they are today; the typical work week was 70 hours, and very few workers retired at age 65. Today the typical work week is less than 40 hours, and most people retire at age 65 or earlier. So it seems that Americans have chosen to take advantage of higher wages in part by consuming more leisure.

Shifts of the Labor Supply Curve

Now that we have examined how income and substitution effects shape the individual labor supply curve, we can turn to the market labor supply curve. In any labor market, the market supply curve is the horizontal sum of the individual labor supply curves of

all workers in that market. A change in any factor *other than the wage* that alters workers' willingness to supply labor causes a shift of the labor supply curve. A variety of factors can lead to such shifts, including changes in preferences and social norms, changes in population, changes in opportunities, and changes in wealth.

Changes in Preferences and Social Norms Changes in preferences and social norms can lead workers to increase or decrease their willingness to work at any given wage. A striking example of this phenomenon is the large increase in the number of employed women—particularly married, employed women—that has occurred in the United States since the 1960s. Until that time, women who could afford to largely avoided working outside the home. Changes in preferences and norms in post–World War II America (helped along by the invention of labor-saving home appliances such as washing machines, the trend for more people to live in cities, and higher female education levels) have induced large numbers of American women to join the workforce—a phenomenon often observed in other countries that experience similar social and technological changes.

Changes in Population Changes in the population size generally lead to shifts of the labor supply curve. A larger population tends to shift the labor supply curve rightward as more workers are available at any given wage; a smaller population tends to shift the labor supply curve leftward due to fewer available workers. Currently the size of the U.S. labor force grows by approximately 1% per year, a result of immigration from other countries and, in comparison to other developed countries, a relatively high birth rate. As a result, the labor supply curve in the United States is shifting to the right.

Changes in Opportunities At one time, teaching was the only occupation considered suitable for well-educated women. However, as opportunities in other professions opened up to women starting in the 1960s, many women left teaching and chose other careers.

Bill Truslow/Photodisc/Getty Images

Women now choose among myriad careers.

This generated a leftward shift of the supply curve for teachers, reflecting a fall in the willingness to work at any given wage and forcing school districts to pay more to maintain an adequate teaching staff. These events illustrate a general result: when superior alternatives arise for workers in another labor market, the supply curve in the original labor market shifts leftward as workers move to the new opportunities. Similarly, when opportunities diminish in one labor market—say, layoffs in the manufacturing industry due to increased foreign competition—the supply in alternative labor markets increases as workers move to these other markets.

Changes in Wealth A person whose wealth increases will buy more normal goods, including leisure. So when a class of workers experiences a general increase in wealth—say, due to a stock market boom—the income effect from the wealth increase will shift the labor supply curve associated with those workers leftward as workers consume more leisure and work less. Note that *the income effect caused by a change in wealth shifts the labor supply curve,* but *the income effect from a wage rate increase*—as we discussed in the case of the individual labor supply curve—*is a movement along the labor supply curve.* The following FYI illustrates how such a change in the wealth levels of many families during the late 1990s led to a shift of the market labor supply curve associated with their employable children.

Equilibrium in the Labor Market

Now that we have discussed the labor supply curve, we can use the supply and demand curves for labor to determine the equilibrium wage and level of employment in the labor market.

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The Decline of the Summer Job

Come summertime, resort towns along the New Jersey shore find themselves facing a recurring annual problem: a serious shortage of lifeguards. Traditionally, lifeguard positions, together with many other seasonal jobs, have been filled mainly by high school and college students. But in recent years a growing number of young Americans have chosen not to take summer jobs. In 1979, 71% of Americans between the ages of 16 and 19 were in the summer workforce. Twenty years later that number had fallen to 63%; and by 2009, it was 33%. Data show that young men in particular have become much less willing to take summer jobs.

One explanation for the decline in the summer labor supply is that more students feel they should devote their summers to additional study. But an important factor in the decline is increasing household affluence. As a result, many teenagers no longer feel pressured to contribute to household finances by taking a summer job; that is, the income effect leads to a reduced labor supply. Another factor points to the substitution effect: increased competition from immigrants, who are now doing the jobs typically done by teenagers (mowing lawns, delivering pizzas), has led to a decline in wages. So many teenagers forgo summer work and consume leisure instead.

Figure 71.2 illustrates the labor market as a whole. The *market labor demand curve,* like the market demand curve for a good, is the horizontal sum of all the individual labor demand curves of all the firms that hire labor. And recall that a price-taking firm's labor demand curve is the same as its value of the marginal product of labor curve. As discussed above, the labor supply curve is upward sloping.

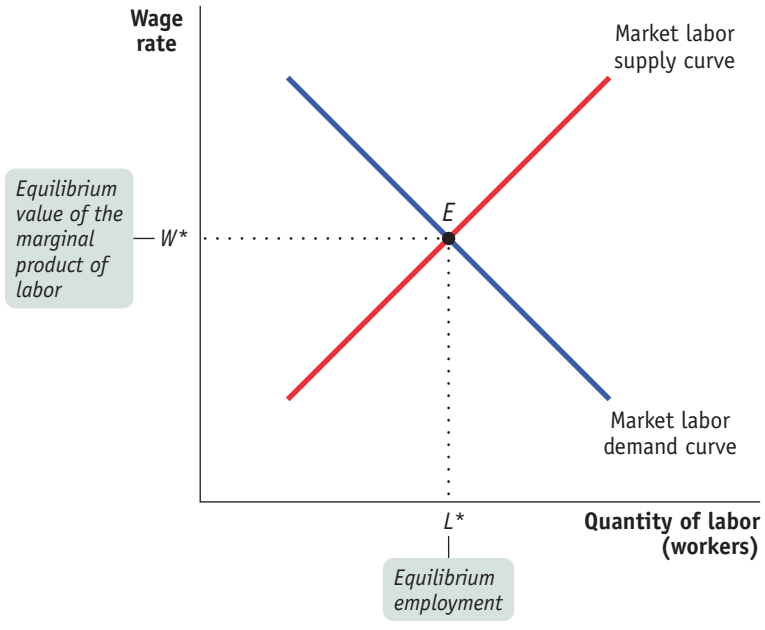
The equilibrium wage rate is the wage rate at which the quantity of labor supplied is equal to the quantity of labor demanded. In Figure 71.2, this leads to an equilibrium wage rate of W^* and the corresponding equilibrium employment level of L^*. (The equilibrium wage rate is also known as the market wage rate.)

But this labor market assumes we have perfect competition in both the product market and the factor market. What if either the product or factor market is not perfectly competitive?

figure 71.2

Equilibrium in the Labor Market

The market labor demand curve is the horizontal sum of the individual labor demand curves of all producers. Here the equilibrium wage rate is W^*, the equilibrium employment level is L^*, and every producer hires labor up to the point at which $VMPL = W^*$. So labor is paid its equilibrium value of the marginal product, that is, the value of the marginal product of the last worker hired in the labor market as a whole.



When the Product Market Is Not Perfectly Competitive

When the product market is perfectly competitive, the wage rate is equal to the value of the marginal product of labor at equilibrium. In other market structures this is not the case. For example, in a monopoly, the demand curve for the product faced by the monopolist slopes downward. This means that to sell an additional unit of output, the monopolist must lower the price. As a result, the additional revenue received from selling one more unit for a monopolist is not simply the price like it was for a perfect competitor. It is less than the price by the amount of the *price effect* explained previously—the decreased revenue on units that could have been sold at a higher price if the price hadn't been lowered to sell another unit. How does this affect hiring? To determine its demand for workers, the monopolist must multiply the marginal product of labor by the *marginal revenue* received from selling the additional output. This is called the **marginal revenue product of labor** or ***MRPL*.**

(71-1) $MRPL = MPL \times MR$

Table 71.1 shows the calculation of a firm's marginal revenue product of labor.

table **71.1**

Marginal Revenue Product of Labor with Imperfect Competition in the Product Market

Quantity of Labor (*L*)	Quantity of Output (*Q*)	Marginal Product of labor (*MPL*)	Product Price (*P*)	Total Revenue (*TR*) = *P* × *Q*	Marginal Revenue (*MR*) = Δ*TR*/Δ*Q*	Marginal Revenue Product of labor (*MRPL*) = *MPL* × *MR*
0	0			$0.00		
		10			$10.00	$100.00
1	10		$10.00	100.00		
		9			9.58	86.20
2	19		9.80	186.20		
		8			9.13	73.00
3	27		9.60	259.20		
		7			8.63	60.40
4	34		9.40	319.60		
		6			8.07	48.40
5	40		9.20	368.00		

For a perfectly competitive firm, marginal revenue equals price, so *VMPL* and *MRPL* are equivalent. The two concepts measure the same thing: the value to the firm of hiring an additional worker. The term *MRPL* is a more general term that applies to firms in both perfect competition and imperfect competition. The general rule is that *a profit-maximizing firm in an imperfectly competitive product market employs each factor of production up to the point at which the marginal revenue product of the last unit of the factor employed is equal to that factor's cost.*

In the case of a firm operating in an imperfectly competitive product market, the demand curve for a factor is the marginal revenue product curve, as shown in Figure 71.3.

The demand curve for labor for a firm operating in an imperfectly competitive product market is the marginal revenue product of labor curve. The **marginal revenue product of labor (*MRPL*)** is equal to the marginal product of labor times the marginal revenue received from selling the additional output. The marginal revenue product of land and the marginal revenue product of capital are equivalent concepts.

The **marginal factor cost of labor (*MFCL*)** is the additional cost of hiring an additional worker. The marginal factor cost of land and the marginal factor cost of capital are equivalent concepts.

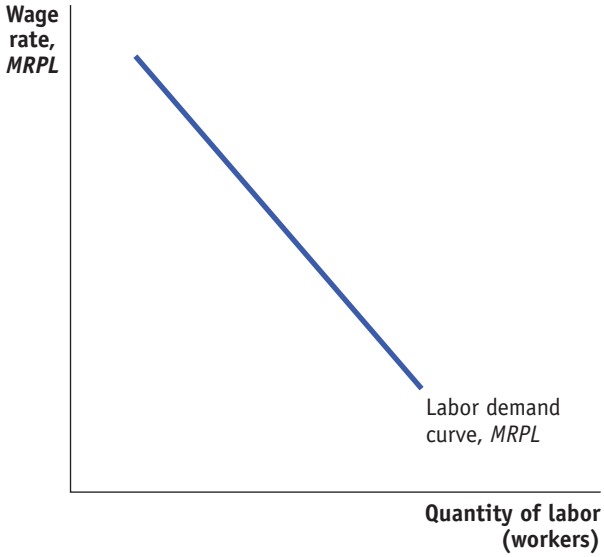
When the Labor Market Is Not Perfectly Competitive

There are also important differences when considering an imperfectly competitive *labor* market rather than a perfectly competitive labor market. One major difference is the *marginal factor cost.* The marginal factor cost is the additional cost of hiring one more unit of a factor of production. For example, the **marginal factor cost of labor (*MFCL*)** is the additional cost of hiring one more unit of labor. With perfect competition in the labor market, each firm is so small that it can hire as much labor as it wants at the market wage. The firm's hiring decision does not affect the market. This means

figure 71.3

Firm Labor Demand with Imperfect Competition

A firm's labor demand curve is the marginal revenue product of labor curve, which differs from the value of the marginal product of labor curve when there is imperfect competition in the product market (as with a monopoly, for example). With perfect competition, the marginal revenue product of labor ($MPL \times MR$) and the value of the marginal product of labor ($MPL \times P$) are the same because $MR = P$.



that with perfect competition in the labor market, the additional cost of hiring another worker (the *MFCL*) is always equal to the market wage, and the labor supply curve faced by an individual firm is horizontal, as shown in Figure 71.4.

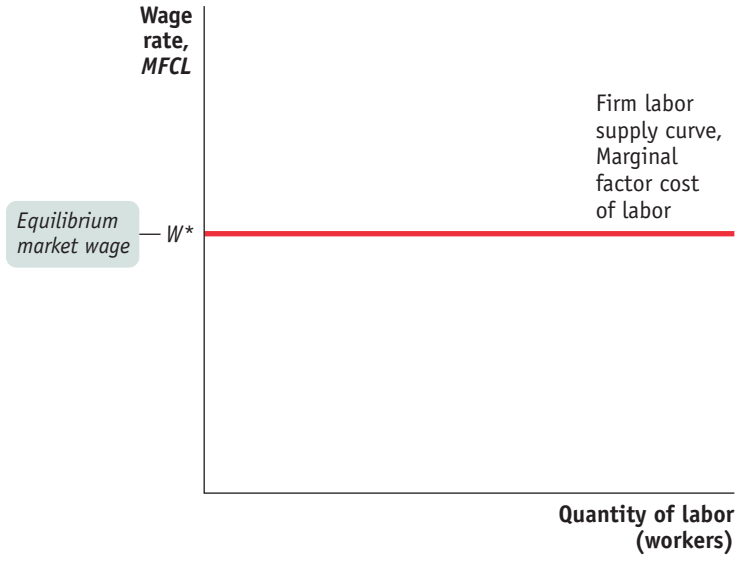
The labor supply curve faced by a firm is very different in a labor market characterized by imperfect competition: it is upward sloping and the marginal factor cost is above the market wage. Unlike a perfect competitor that is small and cannot affect the market, a firm in an imperfectly competitive labor market is large enough to affect the market wage. For example, a labor market in which there is only one firm hiring labor is called a **monopsony.** A **monopsonist** is the single buyer of a factor. Perhaps you've

A **monopsonist** is a single buyer in a factor market. A market in which there is a monopsonist is a **monopsony.**

figure 71.4

Firm Labor Supply in a Perfectly Competitive Labor Market

In a perfectly competitive labor market, the labor supply curve faced by an individual firm is horizontal at the market equilibrium wage because the firm is so small relative to the market that it can hire all the labor that it wants at the market wage. For this reason, the labor supply curve for a firm in a perfectly competitive labor market is equivalent to the marginal factor cost of labor curve.



seen a small town where one firm, such as a meatpacking company or a lumber mill, hires most of the labor—that's an example of a monopsony. Since the firm already hires most of the available labor in the town, if it wants to hire more workers it has to offer higher wages to attract them. The higher wages go to all workers, not just the workers hired last. Therefore, the additional cost of hiring an additional worker (*MFCL*) is *higher* than the wage: it is the wage plus the raises paid to all workers. The calculation of *MFCL* is shown in Table 71.2.

table **71.2**

Marginal Factor Cost of Labor with Imperfect Competition in the Labor Market

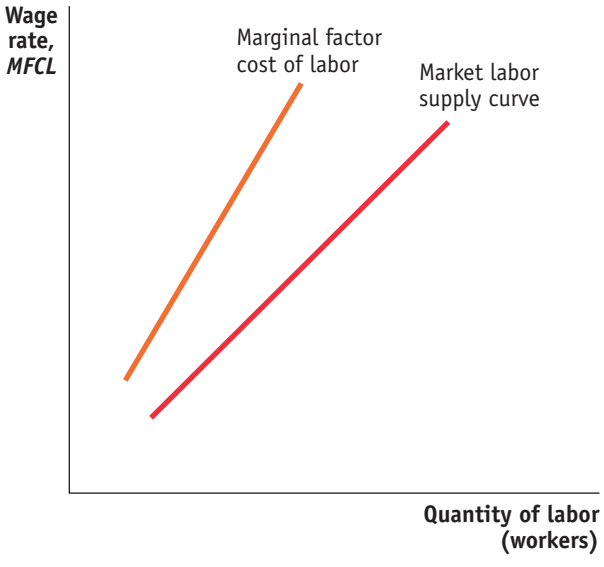
Quantity of Labor (*L*)	Wage (*W*)	Total Labor Cost (= *L* × *W*)	Marginal Factor Cost of Labor (*MFCL*)
0	$0	$0	
			$6
1	6	6	
			8
2	7	14	
			10
3	8	24	
			12
4	9	36	
			14
5	10	50	

The fact that a firm in an imperfectly competitive labor market must raise the wage to hire more workers means that the *MFCL* curve is *above* the labor supply curve, as shown in Figure 71.5. The explanation for this is similar to the explanation for why the monopolist's marginal revenue curve is below the demand curve. To sell one more, the monopolist has to lower the price, so the additional revenue is the price minus the losses on the units that would otherwise sell at the higher price.

figure **71.5**

Supply of Labor and Marginal Factor Cost in an Imperfectly Competitive Market

The marginal factor cost of labor curve is above the market labor supply curve because, to hire more workers in an imperfectly competitive labor market (such as a monopsony), the firm must raise the wage and pay everyone more. This makes the additional cost of hiring another worker higher than the wage rate.



Here, to hire an additional worker, the monopolist has to raise the wage, so the marginal factor cost is the wage plus the wage increase for those workers who could otherwise be hired at the lower wage.

Equilibrium in the Imperfectly Competitive Labor Market

In a perfectly competitive labor market, firms hire labor until the value of the marginal product of labor equals the market wage. With imperfect competition in a factor market, a firm will hire additional workers until the marginal revenue product of labor equals the marginal factor cost of labor. Note that the marginal revenue product of labor for a perfectly competitive firm is the same as the value of the marginal product of labor and that the marginal factor cost of labor for a perfectly competitive firm is the market wage. The terms *marginal revenue product* and *marginal factor cost* are generally applicable to the analysis of any market structure. The terms we used previously, *value of the marginal product* and *wage,* refer to the specific cases of perfect competition in the product market and labor market respectively. Thus, we can generalize and say that every firm hires workers up to the point at which the marginal revenue product of labor equals the marginal factor cost of labor:

(71-2) Hire workers until $MRPL = MFCL$

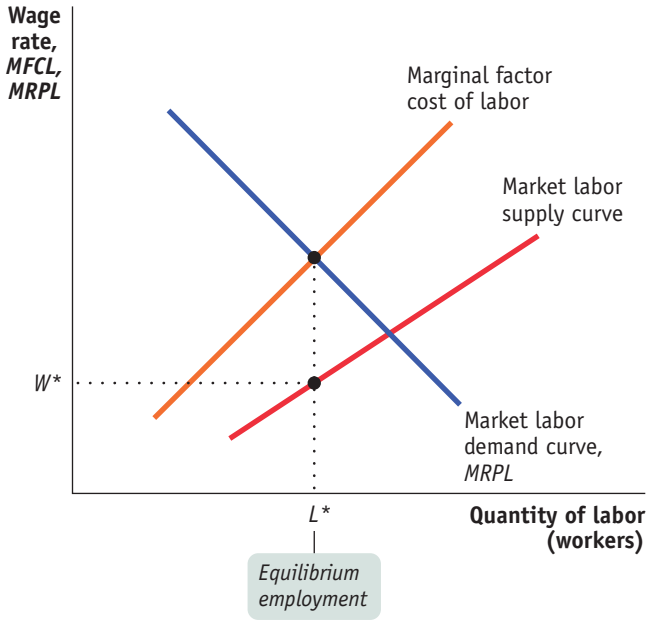
Equilibrium in the labor market with imperfect competition is shown in Figure 71.6. Once an imperfectly competitive firm has determined the optimal number of workers to hire, L^*, it finds the wage necessary to hire that number of workers by starting at the point on the labor supply curve above the optimal number of workers, and looking straight to the left to see the wage level at that point, W^*.

Let's put the information we just learned together, again referring to Figure 71.6: The labor demand curve is the marginal revenue product curve. In an imperfectly competitive labor market, the firm must offer a higher wage to hire more workers, so

figure 71.6

Equilibrium in the Labor Market with Imperfect Competition

The equilibrium quantity of labor is found where the marginal revenue product of labor equals the marginal factor cost, at L^*. The equilibrium wage, W^*, is found on the vertical axis at the height of the market supply curve directly above L^*.



the marginal factor cost curve is above the labor supply curve. The equilibrium quantity of labor is found where the marginal revenue product equals the marginal factor cost, as represented by L^* on the graph. The firm will pay the wage required to hire L^* workers, which is found on the supply curve above L^*. The labor supply curve shows that the quantity of labor supplied is equal to L^* at a wage of W^*. The equilibrium wage in the market is thus W^*. Note that, unlike the wage in a perfectly competitive labor market, the wage in the imperfectly competitive labor market is less than the marginal factor cost of labor.

In Modules 69–71 we have learned how firms determine the optimal amount of land, labor, or capital to hire in factor markets. But often there are different combinations of factors that a firm can use to produce the same level of output. In the next module, we look at how a firm chooses between alternative input combinations for producing a given level of output.

Module 71 AP Review

Solutions appear at the back of the book.

Check Your Understanding

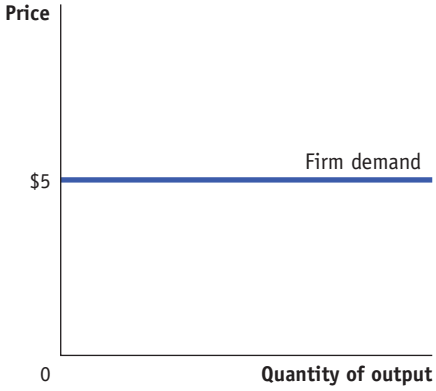
1. Formerly, Clive was free to work as many or as few hours per week as he wanted. But a new law limits the maximum number of hours he can work per week to 35. Explain under what circumstances, if any, he is made
   a. worse off.
   b. equally well off.
   c. better off.
2. Explain in terms of the income and substitution effects how a fall in Clive's wage rate can induce him to work more hours than before.

Tackle the Test: Multiple-Choice Questions

1. Which of the following is necessarily true if you work more when your wage rate increases?
   a. The income effect is large.
   b. The substitution effect is small.
   c. The income effect dominates the substitution effect.
   d. The substitution effect dominates the income effect.
   e. The income effect equals the substitution effect.
2. Which of the following will cause you to work more as your wage rate decreases?
   I. the income effect
   II. the substitution effect
   III. a desire for leisure
   a. I only
   b. II only
   c. III only
   d. I and II only
   e. I, II, and III
3. Which of the following will shift the supply curve for labor to the right?
   a. a decrease in the labor force participation rate of women
   b. a decrease in population
   c. an increase in wealth
   d. a decrease in the opportunity cost of leisure
   e. an increase in labor market opportunities for women
4. An increase in the wage rate will
   a. shift the labor supply curve to the right.
   b. shift the labor supply curve to the left.
   c. cause an upward movement along the labor supply curve.
   d. cause a downward movement along the labor supply curve.
   e. have no effect on the quantity of labor supplied.
5. The factor demand curve for a firm in an imperfectly competitive factor market is the same as which of the following curves?
   a. *VMP*
   b. *MPP*
   c. *MFC*
   d. *MRP*
   e. *MP*

Tackle the Test: Free-Response Questions

1. Assume the demand curve for a firm's product is as shown below and that the firm can hire as many workers as it wants for a wage of $80 per day.



   a. What is the market structure of the factor market in which the firm hires labor? Explain.
   b. What is the market structure of the product market in which the firm sells its good? Explain.
   c. Define marginal factor cost. What is the marginal factor cost of labor for this firm?
   d. If the last worker hired produces an additional 20 units of output, what is the last worker's *MRPL*? Explain.

Answer (8 points)

1 point: The firm hires labor in a perfectly competitive labor market.

1 point: The firm is a price-taker in the labor market. (It can hire all that it wants for $80 per day.)

1 point: The firm sells its good in a perfectly competitive product market.

1 point: The horizontal demand curve indicates that the firm is a price-taker in the product market (it can sell all the output it wants at the market price of $5).

1 point: the additional cost of hiring one more unit of a factor

1 point: $80

1 point: $100

1 point: $MRPL = MPL \times MR$, $MPL = 20$, $MR = \$5$, so $MRPL = 20 \times \$5 = \$100$.

2. a. Draw a correctly labeled graph showing a perfectly competitive labor market in equilibrium. On your graph, be sure to label the labor demand curve, the labor supply curve, marginal revenue product of labor, the equilibrium wage (W^*), and the equilibrium quantity of labor (L^*).
   b. On your graph, illustrate how a decrease in the price of the product made by the firm would affect the equilibrium wage and quantity of labor. Label the resulting wage rate W_2 and the resulting quantity of labor L_2.

What you will learn in this **Module:**

- How firms determine the optimal input mix
- The cost-minimizing rule for hiring inputs

Module 72
The Cost-Minimizing Input Combination

In the past three modules we discussed the markets for factors of production—land, capital, and labor—and how firms determine the optimal quantity of each factor to hire. But firms don't determine how much of each input to hire separately. Production requires multiple inputs, and firms must decide what *combination* of inputs to use to produce their output. In this module, we will look at how firms decide the optimal combination of factors for producing the desired level of output.

Alternative Input Combinations

In many instances a firm can choose among a number of alternative combinations of inputs that will produce a given level of output. For example, on George and Martha's wheat farm, the decision might involve labor and capital. To produce their optimal quantity of wheat, they could choose to have a relatively *capital-intensive* operation by investing in several tractors and other mechanized farm equipment and hiring relatively little labor. Alternatively, they could have a more *labor-intensive* operation by hiring a lot of workers to do much of the planting and harvesting by hand. The same amount of wheat can be produced using many different combinations of capital and labor. George and Martha must determine which combination of inputs will maximize their profits.

To begin our study of the optimal combination of inputs, we'll look at the relationship between the inputs used for production. Depending on the situation, inputs can be either substitutes or complements.

Substitutes and Complements in Factor Markets

In Section 2 we discussed substitutes and complements in the context of the supply and demand model. Two goods are *substitutes* if a rise in the price of one good makes consumers more willing to buy the other good. For example, an increase in the price of oranges will cause some buyers to switch from purchasing oranges to purchasing

tangerines. When buyers tend to consume two goods together, the goods are known as *complements*. For example, cereal and milk are considered complements because many people consume them together. If the price of cereal increases, people will buy less cereal and therefore need less milk. The decision about how much of a good to buy is influenced by the prices of related goods.

The concepts of substitutes and complements also apply to a firm's purchase of inputs. And just as the price of related goods affects consumers' purchasing decisions, the price of other inputs can affect a firm's decision about how much of an input it will use. In some situations, capital and labor are substitutes. For example, George and Martha can produce the same amount of wheat by substituting more tractors for fewer farm workers. Likewise, ATM machines can substitute for bank tellers.

istockphoto

Capital and labor can also be complements when more of one increases the marginal product of the other. For example, a farm worker is more productive when George and Martha buy a tractor, and each tractor requires a worker to drive it. Office workers are more productive when they can use faster computers, and doctors are more productive with modern X-ray machines. In these cases the quantity and quality of capital available affect the marginal product of labor, and thus the demand for labor. Given the relationship between inputs, how does a firm determine which of the possible combinations to use?

Determining the Optimal Input Mix

If several alternative input combinations can be used to produce the optimal level of output, a profit-maximizing firm will select the input combination with the lowest cost. This process is known as cost minimization.

Cost Minimization

How does a firm determine the combination of inputs that maximizes profits? Let's consider this question using an example.

Imagine you manage a grocery store chain and you need to decide the right combination of self-checkout stations and cashiers at a new store. Table 72.1 shows the alternative combinations of capital (self-checkout stations) and labor (cashiers) you can hire to check out customers shopping at the store. If the store puts in 20 self-checkout stations, you will need to hire 1 cashier to monitor every 5 stations for a total of 4 cashiers. However, trained cashiers are faster than customers at scanning goods, so the store could check out the same number of customers using 10 cashiers and only 10 self-checkout stations.

If you can check out the same number of customers using either of these combinations of capital and labor, how do you decide which combination of inputs to use? By finding the input combination that costs the least—the cost-minimizing input combination.

table **72.1**

Cashiers and Self-Checkout Stations

	Capital (self-checkout stations)	Labor (cashiers)
	Rental rate = $1,000/month	Wage rate = $1,600/month
a.	20	4
b.	10	10

Assume that the cost to rent, operate, and maintain a self-checkout station for a month is $1,000 and hiring a cashier costs $1,600 per month. The cost of each input combination from Table 72.1 is shown below.

a.	cost of capital	$20 \times \$1{,}000 = \$20{,}000$
	cost of labor	$4 \times \$1{,}600 = \$\ 6{,}400$
	TOTAL	$26,400
b.	cost of capital	$10 \times \$1{,}000 = \$10{,}000$
	cost of labor	$10 \times \$1{,}600 = \$16{,}000$
	TOTAL	$26,000

Clearly, your firm would choose the lower cost combination, combination b, and hire 10 cashiers and put in 10 self-checkout stations.

When firms must choose between alternative combinations of inputs, they evaluate the cost of each combination and select the one that minimizes the cost of production. This can be done by calculating the total cost of each alternative combination of inputs, as shown in this example. However, because the number of possible combinations can be very large, it is more practical to use marginal analysis to find the cost-minimizing level of output–which brings us to the cost-minimization rule.

Self-checkout lines have reduced the need for many stores to hire extra cashiers.

The Cost-Minimization Rule

We already know that the additional output that results from hiring an additional unit of an input is the marginal product (*MP*) of that input. Firms want to receive the highest possible marginal product from each dollar spent on inputs. To do this, firms adjust their hiring of inputs until the marginal product per dollar is equal for all inputs. This is the **cost-minimization rule.** When the inputs are labor and capital, this amounts to equating the marginal product of labor (*MPL*) per dollar spent on wages to the marginal product of capital (*MPK*) per dollar spent to rent capital:

(72-1) $MPL/\text{Wage} = MPK/\text{Rental rate}$

To understand why cost minimization occurs when the marginal product per dollar is equal for all inputs, let's start by looking at two counterexamples. Consider a situation in which the marginal product of labor per dollar is greater than the marginal product of capital per dollar. This situation is described by Equation 72-2:

(72-2) $MPL/\text{Wage} > MPK/\text{Rental rate}$

Suppose the marginal product of labor is 20 units and the marginal product of capital is 100 units. If the wage is $10 and the rental rate for capital is $100, then the marginal product per dollar will be 20/$10 = 2 units of output per dollar for labor and 100/$100 = 1 units of output per dollar for capital. The firm is receiving 2 additional units of output for each dollar spent on labor and only 1 additional unit of output for each dollar spent on capital. In this case, the firm gets more additional output for its money by hiring labor, so it should hire more labor and less capital. Because of diminishing returns, as the firm hires more labor, the marginal product of labor falls and as it hires less capital, the marginal product of capital rises. The firm will continue to substitute labor for capital until the falling marginal product of labor per dollar meets the rising marginal product of capital per dollar and the two are equivalent. That is, the firm will adjust its hiring of capital and labor until the marginal product per dollar spent on each input is equal, as in Equation 72-1.

Next, consider a situation in which the marginal product of capital per dollar is greater than the marginal product of labor per dollar. This situation is described by Equation 72-3:

(72-3) $MPL/\text{Wage} < MPK/\text{Rental rate}$

A firm determines the cost-minimizing combination of inputs using the **cost-minimization rule:** hire factors so that the marginal product per dollar spent on each factor is the same.

Let's continue with the assumption that the marginal product of labor for the last unit of labor hired is 20 units and the marginal product of capital for the last unit of capital hired is 100 units. If the wage is $10 and the rental rate for capital is $25, then the marginal product per dollar will be 20/$10 = 2 units of output per dollar for labor and 100/$25 = 4 units of output per dollar for capital. The firm is receiving 4 additional units of output for each dollar spent on capital and only 2 additional units of output for each dollar spent on labor. In this case, the firm gets more additional output for its money by hiring capital, so it should hire more capital and less labor. Because of diminishing returns, as the firm hires more capital, the marginal product of capital falls, and as it hires less labor, the marginal product of labor rises. The firm will continue to hire more capital and less labor until the falling marginal product of capital per dollar meets the rising marginal product of labor per dollar to satisfy the cost-minimization rule. That is, the firm will adjust its hiring of capital and labor until the marginal product per dollar spent on each input is equal.

The cost-minimization rule is analogous to the optimal consumption rule (introduced in Module 51), which has consumers maximize their utility by choosing the combination of goods so that the marginal utility per dollar is equal for all goods.

So far in this section we have learned how factor markets determine the equilibrium price and quantity in the markets for land, labor, and capital and how firms determine the combination of inputs they will hire. But how well do these models of factor markets explain the distribution of factor incomes in our economy? In Module 70 we considered how the marginal productivity theory of income distribution explains the factor distribution of income. In the final module in this section we look at the distribution of income in *labor* markets and consider to what extent the marginal productivity theory of income distribution explains wage differences.

Module 72 AP Review

Solutions appear at the back of the book.

Check Your Understanding

1. A firm produces its output using only capital and labor. Labor costs $100 per worker per day and capital costs $200 per unit per day. If the marginal product of the last worker employed is 500 and the marginal product of the last unit of capital employed is 1,000, is the firm employing the cost-minimizing combination of inputs? Explain.

Tackle the Test: Multiple-Choice Questions

1. An automobile factory employs either assembly line workers or robotic arms to produce automobile engines. In this case, labor and capital are considered
   a. independent.
   b. complements.
   c. substitutes.
   d. supplements.
   e. human capital.
2. If an increase in the amount of capital employed by a firm leads to an increase in the marginal product of labor, labor and capital are considered
   a. independent.
   b. complements.
   c. substitutes.
   d. supplements.
   e. human capital.
3. If the marginal product of labor per dollar is greater than the marginal product of capital per dollar, which of the following is true? The firm should
   a. not change its employment of capital and labor.
   b. hire more capital.
   c. hire more labor.
   d. hire less labor.
   e. hire more capital and labor.
4. The cost-minimization rule states that costs are minimized when
   a. *MP* per dollar is equal for all factors.
   b. ($MP \times P$) is equal for all factors.
   c. each factor's *MP* is the same.
   d. *MRP* is maximized.
   e. *MFC* is minimized.

5. A firm currently produces its desired level of output. Its marginal product of labor is 400, its marginal product of capital is 1,000, the wage rate is $20 and the rental rate of capital is $100. In that case, the firm should
   a. employ more capital and more labor.
   b. employ less labor and less capital.
   c. employ less labor and more capital.
   d. employ less capital and more labor.
   e. not change its allocation of capital and labor.

Tackle the Test: Free-Response Questions

1. Answer the following questions under the assumption that firms use only two inputs and seek to maximize profit.
   a. Would it be wise for a firm that does not have the cost-minimizing combination of inputs to hire more of the input with the highest marginal product and less of the input with the lowest marginal product? Explain.
   b. What is the cost-minimization rule?
   c. When a firm hires more labor and less capital, what happens to the marginal product of labor per dollar and the marginal product of capital per dollar? Explain.

Answer (5 points)

1 point: No

1 point: The input with the highest marginal product might be much more expensive than the input with the lowest marginal product, making the marginal product per dollar higher for the input with the lowest marginal product. When that is the case, costs would be lower if the firm hired more of the input with the lowest marginal product (but the highest marginal product per dollar) and less of the input with the highest marginal product (but the lowest marginal product per dollar.)

1 point: The cost-minimization rule says that firms should adjust their hiring of inputs to equalize the marginal product per dollar spent on each input.

1 point: The marginal product of labor per dollar decreases and the marginal product of capital per dollar increases.

1 point: Each factor has diminishing marginal returns. So when more labor is hired, the marginal product of labor (and thus the marginal product of labor per dollar) decreases. Likewise, when less capital is hired, the marginal product of capital (and thus the marginal product of capital per dollar) increases because the units of capital that are given up had a lower marginal product than those that remain.

2. Refer to the table below. Assume that the wage is $10 per day and the price of pencils is $1.

Quantity of labor (workers)	*Quantity of pencils produced*
0	0
1	40
2	90
3	120
4	140
5	150
6	160
7	166

   a. What is the *MPL* of the 4th worker?
   b. What is the *MPL* per dollar of the 5th worker?
   c. How many workers would the firm hire if it hired every worker for whom the marginal product per dollar is greater than or equal to 1 pencil per dollar?
   d. If the marginal product per dollar spent on labor is 1 pencil per dollar, the marginal product of the last unit of capital hired is 100 pencils per dollar, and the rental rate is $50 per day, is the firm minimizing its cost? Explain.

Module 73 Theories of Income Distribution

What you will learn in this Module:

- Labor market applications of the marginal productivity theory of income distribution
- Sources of wage disparities and the role of discrimination

In Module 70, we introduced the factor distribution of income and explained how the *marginal productivity theory of income distribution* helps to explain how income is divided among factors of production in an economy. We also considered how the markets for factors of production are broken down. There are different markets for different types of factors. For example, there are different labor markets for different types of labor, such as for computer programmers, pastry chefs, and economists. In this module, we look at the marginal productivity theory of income distribution and the extent to which it explains wage disparities between workers.

The Marginal Productivity Theory of Income Distribution

According to the marginal productivity theory of income distribution, the division of income among the economy's factors of production is determined by each factor's marginal productivity at the market equilibrium. If we consider an economy-wide factor market, the price paid for *all* factors in the economy is equal to the increase in the value of output generated by the last unit of the factor employed in the market. But what about the distribution of income among different labor markets and workers? Does the marginal productivity theory of income distribution help to explain why some workers earn more than others?

Marginal Productivity and Wage Inequality

A large part of the observed inequality in wages can be explained by considerations that are consistent with the marginal productivity theory of income distribution. In particular, there are three well-understood sources of wage differences across occupations and individuals.

The first is the existence of **compensating differentials:** across different types of jobs, wages are often higher or lower depending on how attractive or unattractive the

Compensating differentials are wage differences across jobs that reflect the fact that some jobs are less pleasant or more dangerous than others.

The **equilibrium value of the marginal product** of a factor is the additional value produced by the last unit of that factor employed in the factor market as a whole.

job is. Workers in unpleasant or dangerous jobs receive a higher wage than workers in jobs that require the same skill, training, and effort but lack the unpleasant or dangerous qualities. For example, truckers who haul hazardous chemicals are paid more than truckers who haul bread. For any *particular* job, the marginal productivity theory of income distribution generally holds true. For example, hazardous-load truckers are paid a wage equal to the **equilibrium value of the marginal product** of the last person employed in the market for hazardous-load truckers.

Arthur S. Aubry/Photodisc/Getty Images

A second reason for wage inequality that is clearly consistent with marginal productivity theory is differences in talent. People differ in their abilities: a high-ability person, by producing a better product that commands a higher price compared to a lower-ability person, generates a higher value of the marginal product. And these differences in the value of the marginal product translate into differences in earning potential. We all know that this is true in sports: practice is important, but 99.99% (at least) of the population just doesn't have what it takes to control a soccer ball like Lionel Messi or hit a tennis ball like Serena Williams. The same is true, though less obvious, in other fields of endeavor.

A third, very important reason for wage differences is differences in the quantity of *human capital*. Recall that human capital—education and training—is at least as important in the modern economy as physical capital in the form of buildings and machines. Different people "embody" quite different quantities of human capital, and a person with more human capital typically generates a higher value of the marginal product by producing more or better products. So differences in human capital account for substantial differences in wages. People with high levels of human capital, such as surgeons or engineers, generally receive high wages.

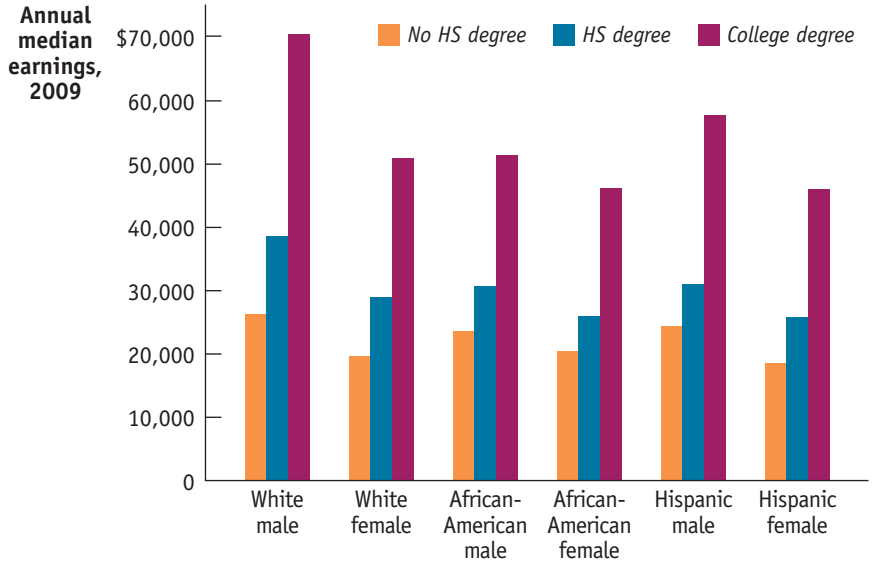
The most direct way to see the effect of human capital on wages is to look at the relationship between education levels and earnings. Figure 73.1 shows earnings differentials by gender, ethnicity, and three education levels for people 25 years or older in 2009. As you can see, regardless of gender or ethnicity, higher education is associated with higher median earnings. For example, in 2009 white females with 9 to 12 years of

figure 73.1

Earnings Differentials by Education, Gender, and Ethnicity, 2009

It is clear that, regardless of gender or ethnicity, education pays: those with a high school diploma earn more than those without one, and those with a college degree earn substantially more than those with only a high school diploma. Other patterns are evident as well: for any given education level, white males earn more than every other group, and males earn more than females for any given ethnic group.

Source: Bureau of Labor Statistics.



schooling but without a high school diploma had median earnings 30% less than those with a high school diploma and 60% less than those with a college degree—and similar patterns exist for the other five groups. Additional data show that surgeons—an occupation that requires steady hands and many years of formal training—earned an average of $219,770 in 2009.

Because even now men typically have had more years of education than women and whites more years than non-whites, differences in education level are part of the explanation for earnings differences.

It's also important to realize that formal education is not the only source of human capital; on-the-job training and experience are also very important. This point was highlighted by a 2003 National Science Foundation report on earnings differences between male and female scientists and engineers. The study was motivated by concerns over the male–female earnings gap: the median salary for women in science and engineering is about 24% less than the median salary for men. The study found that women in these occupations are, on average, younger than men and have considerably less experience than their male counterparts. This difference in age and experience, according to the study, explained most of the earnings differential. Differences in job tenure and experience can partly explain one notable aspect of Figure 73.1: that, across all ethnicities, women's median earnings are less than men's median earnings for any given education level.

But it's also important to emphasize that earnings differences arising from differences in human capital are not necessarily "fair." A society in which non-white children typically receive a poor education because they live in underfunded school districts, and then go on to earn low wages because they are poorly educated, may have labor markets that are well described by marginal productivity theory (and earnings consistent with the earnings differentials across ethnic groups shown in Figure 73.1). Yet many people would still consider the resulting distribution of income unfair.

Still, many observers think that actual wage differentials cannot be entirely explained by compensating differentials, differences in talent, and differences in human capital. They believe that market power, *efficiency wages,* and discrimination also play an important role. We will examine these forces next.

Unions are organizations of workers that try to raise wages and improve working conditions for their members by bargaining collectively.

Market Power

The marginal productivity theory of income distribution is based on the assumption that factor markets are perfectly competitive. In such markets we can expect workers to be paid the equilibrium value of their marginal product, regardless of who they are. But how valid is this assumption?

We studied markets that are *not* perfectly competitive in previous modules; now let's touch briefly on the ways in which labor markets may deviate from the competitive assumption.

One undoubted source of differences in wages between otherwise similar workers is **unions**—organizations that try to raise wages and improve working conditions for their members. Labor unions, when successful, replace one-on-one wage deals between workers and employers with "collective bargaining," in which the employer negotiates wages with union representatives. Without question, this leads to higher wages for those workers who are represented by unions. In 2009, the median weekly earnings of union members in the United States were $908, compared with $710 for workers not represented by unions—about a 22% difference.

Just as workers can sometimes organize to demand higher wages than they would otherwise receive, employers can sometimes organize to pay *lower* wages than would result from competition. For example, health care workers—doctors, nurses, and so on—sometimes argue that health maintenance organizations (HMOs) are engaged in a collective effort to hold down their wages.

STEPHANE DE SAKUTIN/AFP/Getty Images

Union members rally to demand higher wages.

Collective action, either by workers or by employers, is less common in the United States than it used to be. Several decades ago, around 30% of U.S. workers were union members. Today, however, union membership in the United States is relatively limited: less than 7.2% of the employees of private businesses are represented by unions. And although there are fields like health care in which a few large firms account for a sizable share of employment in certain geographical areas, the sheer size of the U.S. labor market and the ease with which most workers can move in search of higher-paying jobs probably mean that concerted efforts to hold wages below the unrestrained market equilibrium level rarely occur and even more rarely succeed.

Efficiency Wages

A second source of wage inequality is the phenomenon of *efficiency wages*—a type of incentive scheme used by employers to motivate workers to work hard and to reduce worker turnover. Suppose a worker performs a job that is extremely important but that the employer can observe how well the job is being performed only at infrequent intervals. This would be true, for example, for childcare providers. Then it often makes sense for the employer to pay more than the worker could earn in an alternative job—that is, more than the equilibrium wage. Why? Because earning a premium makes losing this job and having to take the alternative job quite costly for the worker. So a worker who happens to be observed performing poorly and is therefore fired is now worse off for having to accept a lower-paying job. The threat of losing a job that pays a premium motivates the worker to perform well and avoid being fired. Likewise, paying a premium also reduces worker turnover—the frequency with which an employee leaves a job voluntarily. Despite the fact that it may take no more effort and skill to be a childcare provider than to be an office worker, efficiency wages show why it often makes economic sense for a parent to pay a caregiver more than the equilibrium wage of an office worker.

The **efficiency-wage model** explains why we may observe wages offered above their equilibrium level. Like the price floors we studied in Module 8—and, in particular, much like the minimum wage—this phenomenon leads to a surplus of labor in labor markets that are characterized by the efficiency-wage model. This surplus of labor translates into unemployment—some workers are actively searching for a high-paying efficiency-wage job but are unable to get one, and other more fortunate but no more deserving workers are able to find work. As a result, two workers with exactly the same profile—the same skills and job history—may earn different wages: the worker who is lucky enough to get an efficiency-wage job earns more than the worker who gets a standard job (or who remains unemployed while searching for a higher-paying job). Efficiency wages are a response to a type of market failure that arises from the fact that some employees don't always perform as well as they should and are able to hide that fact. As a result, employers use above-equilibrium wages to motivate their employees, leading to an inefficient outcome.

Discrimination

It is an ugly fact that throughout history there has been discrimination against workers who are considered to be of the wrong race, ethnicity, gender, or other characteristics. How does this fit into our economic models?

The main insight economic analysis offers is that discrimination is *not* a natural consequence of market competition. On the contrary, market forces tend to work against discrimination. To see why, consider the incentives that would exist if social convention dictated that women be paid, say, 30% less than men with equivalent qualifications and experience. A company whose management was itself unbiased would then be able to reduce its costs by hiring women rather than men—and such companies would have an advantage over other companies that hired men despite their higher cost. The result would be to create an excess demand for female workers, which would tend to drive up their wages.

According to the **efficiency-wage model,** some employers pay an above-equilibrium wage as an incentive for better performance and loyalty.

But if market competition works against discrimination, how is it that so much discrimination has taken place? The answer is twofold. First, when labor markets don't work well, employers may have the ability to discriminate without hurting their profits. For example, market interferences (such as unions or minimum-wage laws) or market failures (such as efficiency wages) can lead to wages that are above their equilibrium levels. In these cases, there are more job applicants than there are jobs, leaving employers free to discriminate among applicants. In research published in the *American Economic Review,* two economists, Marianne Bertrand and Sendhil Mullainathan, documented discrimination in hiring by sending fictitious résumés to prospective employers on a random basis. Applicants with "white-sounding" names such as Emily Walsh were 50% more likely to be contacted than applicants with "African-American-sounding" names such as Lakisha Washington. Also, applicants with white-sounding names and good credentials were much more likely to be contacted than those without such credentials. By contrast, potential employers seemed to ignore the credentials of applicants with African-American-sounding names.

Second, discrimination has sometimes been institutionalized in government policy. This institutionalization has made it easier to maintain discrimination against market pressure. For example, at one time in the United States, African-Americans were barred from attending "whites-only" public schools and universities in many parts of the country and forced to attend inferior schools. Although market competition tends to work against *current* discrimination, it is not a remedy for past discrimination, which typically has had an impact on the education and experience of its victims and thereby reduces their income. The following FYI illustrates the way in which government policy enforced discrimination in the world's most famous racist regime, that of the former government of South Africa.

Wage Disparities in Practice

Wage rates in the United States cover a very wide range. In 2009, hundreds of thousands of workers received the legal federal minimum of $7.25 per hour. At the other extreme, the chief executives of several companies were paid more than $100 million for

fyi

The Economics of Apartheid

The Republic of South Africa is the richest nation in Africa, but it also has a harsh political history. Until the peaceful transition to majority rule in 1994, the country was controlled by its white minority, Afrikaners, the descendants of European (mainly Dutch) immigrants. This minority imposed an economic system known as apartheid, which overwhelmingly favored white interests over those of native Africans and other groups considered "non-white," such as Asians.

The origins of apartheid go back to the early years of the twentieth century, when large numbers of white farmers began moving into South Africa's growing cities. There they discovered, to their horror, that they did not automatically earn higher wages than other races. But they had the right to vote—and non-whites did not. And so the South African government instituted "job-reservation" laws designed to ensure that only whites got jobs that paid well. The government also set about creating jobs for whites in government-owned industries. As Allister Sparks notes in *The Mind of South Africa* (1990), in its efforts to provide high-paying jobs for whites, the country "eventually acquired the largest amount of nationalized industry of any country outside the Communist bloc."

In other words, racial discrimination was possible because it was backed by the power of the government, which prevented markets from following their natural course. A postscript: in 1994, in one of the political miracles of modern times, the white regime

Time & Life Pictures/Getty Images

ceded power and South Africa became a full-fledged democracy. Apartheid was abolished. Unfortunately, large racial differences in earnings remain. The main reason is that apartheid created huge disparities in human capital, which will persist for many years to come.

the year, which works out to $20,000 per hour even if they worked 100-hour weeks. Leaving out these extremes, there is still a huge range of wage rates. Are people really that different in their marginal productivities?

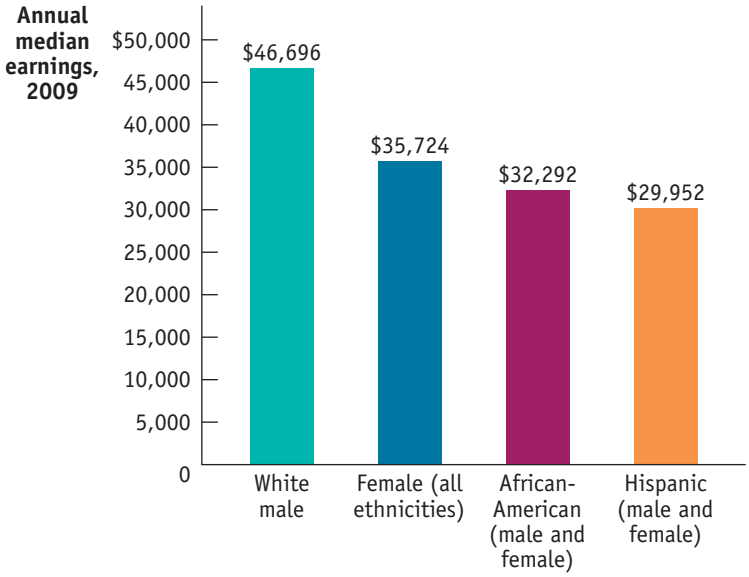
A particular source of concern is the existence of systematic wage differences across gender and ethnicity. Figure 73.2 compares annual median earnings in 2009 of workers 25 years or older classified by gender and ethnicity. As a group, white males had the highest earnings. Women (averaging across all ethnicities) earned only about 76% as much; African-American workers (male and female combined) only 69% as much; and Hispanic workers only 64% as much.

figure 73.2

Median Earnings by Gender and Ethnicity, 2009

The U.S. labor market continues to show large differences across workers according to gender and ethnicity. Women are paid substantially less than men; African-American and Hispanic workers are paid substantially less than white male workers.

Source: Bureau of Labor Statistics.



We are a nation founded on the belief that all men are created equal—and if the Constitution were rewritten today, we would say that *all people* are created equal. So why do they receive such unequal pay? In part, the pay differences may be due to differences in marginal productivity, but we also must allow for the possible effects of other influences.

Is the Marginal Productivity Theory of Income Distribution Really True?

Although the marginal productivity theory of income distribution is a well-established part of economic theory, closely linked to the analysis of markets in general, it is a source of some controversy. There are two main objections to it.

First, in the real world we see large disparities in income between workers who, in the eyes of some observers, should receive the same payment. Perhaps the most conspicuous examples in the United States are the large differences in the average wages between women and men and among various racial and ethnic groups. Do these wage differences really reflect differences in marginal productivity, or is something else going on?

Second, many people wrongly believe that the marginal productivity theory of income distribution gives a *moral* justification for the distribution of income, implying

that the existing distribution is fair and appropriate. This misconception sometimes leads other people, who believe that the current distribution of income is unfair, to reject marginal productivity theory.

So Does Marginal Productivity Theory Work?

The main conclusion you should draw from this discussion is that the marginal productivity theory of income distribution is not a perfect description of how factor incomes are determined but that it works pretty well. The deviations are important. But, by and large, in a modern economy with well-functioning labor markets, factors of production are paid the equilibrium value of the marginal product—the value of the marginal product of the last unit employed in the market as a whole.

It's important to emphasize, once again, that this does not mean that the factor distribution of income is morally justified.

Module 73 AP Review

Solutions appear at the back of the book.

Check Your Understanding

1. Assess each of the following statements. Do you think they are true, false, or ambiguous? Explain.
   a. The marginal productivity theory of income distribution is inconsistent with the presence of income disparities associated with gender, race, or ethnicity.
   b. Companies that engage in workplace discrimination but whose competitors do not are likely to earn less profit as a result of their actions.
   c. Workers who are paid less because they have less experience are not the victims of discrimination.

Tackle the Test: Multiple-Choice Questions

1. Which group of U.S. workers had the highest median earnings in 2009?
   a. white males
   b. females (all ethnicities)
   c. African-Americans (males and female)
   d. Hispanics
   e. African-American males

2. Which of the following sources of wage differences is/are consistent with the marginal productivity theory of income distribution?
   I. talent
   II. discrimination
   III. efficiency wages
   a. I only
   b. II only
   c. III only
   d. I and II only
   e. I, II, and III

3. Compensating differentials mean that which of the following leads to higher wages for some jobs?
   a. danger
   b. discrimination
   c. marginal productivity
   d. market power
   e. a surplus of labor

4. Which of the following is a result in the efficiency-wage model?
   a. compensating differentials
   b. surpluses of labor
   c. shortages of labor
   d. discrimination
   e. increased productivity

5. Which of the following statements regarding the marginal productivity theory of income distribution is correct?
   a. Each worker should earn a wage based on his or her marginal productivity.
   b. The wage rate should equal the rental rate.
   c. Workers with higher marginal products always receive a higher wage than workers with lower marginal products.
   d. The factor distribution of income is morally justified.
   e. With well-functioning labor markets, each factor is paid the equilibrium value of the marginal product of that factor.

Tackle the Test: Free-Response Questions

1. For each of the following situations in which similar workers are paid different wages, provide the most likely reason for the differences and explain why that reason applies.
   a. Test pilots for new jet aircraft earn higher wages than airline pilots.
   b. College graduates usually have higher earnings in their first year on the job than workers without college degrees have in their first year on the job.
   c. Experienced AP teachers command higher salaries than new AP teachers for teaching the same class.

Answer (6 points)

1 point: Compensating differentials

1 point: Being a test pilot is more dangerous.

1 point: Differences in human capital

1 point: Education leads to higher productivity.

1 point: Differences in human capital

1 point: On-the-job experience increases the marginal product of experienced teachers.

2. List three different economic concepts that explain wage differences when the marginal productivity theory of income distribution does not. Explain each.

Section 13 Review

Summary

1. Just as there are markets for goods and services, there are markets for factors of production, including labor, land, and both **physical capital** and **human capital.** These markets determine the **factor distribution of income.**

2. A profit-maximizing, price-taking firm will keep employing more units of a factor until the factor's price is equal to the **value of the marginal product**—the marginal product of the factor multiplied by the price of the output it produces. The **value of the marginal product curve** is therefore the price-taking firm's demand curve for a factor. Factor demand is often referred to as a **derived demand** because it is derived from the demand for the producer's output.

3. The market demand curve for labor is the horizontal sum of the individual demand curves of firms in that market. It shifts for three main reasons: changes in output price, changes in the supply of other factors, and technological changes.

4. When a competitive labor market is in equilibrium, the market wage is equal to the **equilibrium value of the marginal product** of labor, the additional value produced by the last worker hired in the labor market as a whole. The same principle applies to other factors of production: the **rental rate** of land or capital is equal to the equilibrium value of the marginal product. This insight leads to the **marginal productivity theory of income distribution,** according to which each factor is paid the value of the marginal product of the last unit of that factor employed in the factor market as a whole.

5. Labor supply is the result of decisions about **time allocation,** with each worker facing a trade-off between **leisure** and work. An increase in the hourly wage rate tends to increase work hours via the substitution effect but decrease work hours via the income effect. If the net result is that a worker increases the quantity of labor supplied in response to a higher wage, the **individual labor supply curve** slopes upward. If the net result is that a worker decreases work hours, the individual labor supply curve—unlike supply curves for goods and services—slopes downward.

6. The market labor supply curve is the horizontal sum of the individual labor supply curves of all workers in that market. It shifts for four main reasons: changes in preferences and social norms, changes in population, changes in opportunities, and changes in wealth.

7. When a firm is not a price-taker in a factor market, the firm will consider the **marginal revenue product** and the **marginal factor cost** when determining how much of a factor to hire. These concepts are equivalent to the value of the marginal product and the wage (or the price of the factor) in a perfectly competitive market.

8. A **monopsonist** is the single buyer of a factor. A market in which there is a monopsonist is a **monopsony.**

9. Firms will determine the optimal input combination using the **cost-minimization rule:** When a firm uses the cost-minimizing combination of inputs, the marginal product of labor divided by the wage rate is equal to the marginal product of capital divided by the rental rate.

10. Large disparities in wages raise questions about the validity of the marginal productivity theory of income distribution. Many disparities can be explained by

compensating differentials and by differences in talent, job experience, and human capital across workers. Market interference in the forms of **unions** and collective action by employers also creates wage disparities. The **efficiency-wage model,** which arises from a type of market failure, shows how wage disparities can result from employers' attempts to increase worker performance. Free markets tend to diminish discrimination, but discrimination remains a real source of wage disparity. Discrimination is typically maintained either through problems in labor markets or (historically) through institutionalization in government policies.

Key Terms

Physical capital, p. 680
Human capital, p. 680
Derived demand, p. 681
Factor distribution of income, p. 681
Value of the marginal product, p. 684
Value of the marginal product curve, p. 684
Rental rate, p. 691
Marginal productivity theory of income distribution, p. 692
Time allocation, p. 695
Leisure, p. 696
Individual labor supply curve, p. 696
Marginal revenue product of labor, p. 700
Marginal factor cost of labor, p. 700
Monopsonist, p. 701
Monopsony, p. 701
Cost-minimization rule, p. 708
Compensating differentials, p. 711
Equilibrium value of the marginal product, p. 712
Unions, p. 713
Efficiency-wage model, p. 714

Problems

1. In 2007, national income in the United States was $11,186.9 billion. In the same year, 137 million workers were employed, at an average wage of $57,526 per worker per year.

a. How much compensation of employees was paid in the United States in 2007?

b. Analyze the factor distribution of income. What percentage of national income was received in the form of compensation to employees in 2007?

c. Suppose that a huge wave of corporate downsizing leads many terminated employees to open their own businesses. What is the effect on the factor distribution of income?

d. Suppose the supply of labor rises due to an increase in the retirement age. What happens to the percentage of national income received in the form of compensation of employees?

2. Marty's Frozen Yogurt has the production function per day shown in the accompanying table. The equilibrium wage rate for a worker is $80 per day. Each cup of frozen yogurt sells for $2.

Quantity of labor (workers)	Quantity of frozen yogurt (cups)
0	0
1	110
2	200
3	270
4	300
5	320
6	330

a. Calculate the marginal product of labor for each worker and the value of the marginal product of labor per worker.

b. How many workers should Marty employ?

3. Patty's Pizza Parlor has the production function per hour shown in the accompanying table. The hourly wage rate for each worker is $10. Each pizza sells for $2.

Quantity of labor (workers)	Quantity of pizza
0	0
1	9
2	15
3	19
4	22
5	24

a. Calculate the marginal product of labor for each worker and the value of the marginal product of labor per worker.

b. Draw the value of the marginal product of labor curve. Use your diagram to determine how many workers Patty should employ.

c. Now the price of pizza increases to $4. Calculate the value of the marginal product of labor per worker, and draw the new value of the marginal product of labor curve in your diagram. Use your diagram to determine how many workers Patty should employ now.

4. The production function for Patty's Pizza Parlor is given in the table in Problem 3. The price of pizza is $2, but the hourly wage rate rises from $10 to $15. Use a diagram to determine how Patty's demand for workers responds as a result of this wage rate increase.

5. Patty's Pizza Parlor initially had the production function given in the table in Problem 3. A worker's hourly wage rate was $10, and pizza sold for $2. Now Patty buys a new high-tech pizza oven that allows her workers to become twice as productive as before. That is, the first worker now produces 18 pizzas per hour instead of 9, and so on.

a. Calculate the new marginal product of labor and the new value of the marginal product of labor.

b. Use a diagram to determine how Patty's hiring decision responds to this increase in the productivity of her workforce.

6. Jameel runs a driver education school. The more driving instructors he hires, the more driving lessons he can sell. But because he owns a limited number of training automobiles, each additional driving instructor adds less to Jameel's output of driving lessons. The accompanying table shows Jameel's production function per day. Each driving lesson can be sold at $35 per hour.

Quantity of labor (driving instructors)	Quantity of driving lessons (hours)
0	0
1	8
2	15
3	21
4	26
5	30
6	33

Determine Jameel's labor demand schedule (his demand schedule for driving instructors) for each of the following daily wage rates for driving instructors: $160, $180, $200, $220, $240, and $260.

7. Dale and Dana work at a self-service gas station and convenience store. Dale opens up every day, and Dana arrives later to help stock the store. They are both paid the current market wage of $9.50 per hour. But Dale feels he should be paid much more because the revenue generated from the gas pumps he turns on every morning is much higher than the revenue generated by the items that Dana stocks. Assess this argument.

8. A *New York Times* article published in September 2007 observed that the wage of farmworkers in Mexico is $11 an hour but the wage of immigrant Mexican farmworkers in California is $9 an hour.

a. Assume that the output sells for the same price in the two countries. Does this imply that the marginal product of labor of farmworkers is higher in Mexico or in California? Explain your answer, and illustrate with a diagram that shows the demand and supply curves for labor in the respective markets. In your diagram, assume that the quantity supplied of labor for any given wage rate is the same for Mexican farmworkers as it is for immigrant Mexican farmworkers in California.

b. Now suppose that farmwork in Mexico is more arduous and more dangerous than farmwork in California. As a result, the quantity supplied of labor for any given wage rate is not the same for Mexican farmworkers as it is for immigrant Mexican farmworkers in California. How does this change your answer to part a? What concept best accounts for the difference between wage rates between Mexican farmworkers and immigrant Mexican farmworkers in California?

c. Illustrate your answer to part b with a diagram. In this diagram, assume that the quantity of labor demanded for any given wage rate is the same for Mexican employers as it is for Californian employers.

9. Kendra is the owner of Wholesome Farms, a commercial dairy. Kendra employs labor, land, and capital. In her operations, Kendra can substitute between the amount of labor she employs and the amount of capital she employs. That is, to produce the same quantity of output she can use more labor and less land; similarly, to produce the same quantity of output she can use less labor and more land. However, if she uses more land, she must use more of both labor and capital; if she uses less land, she can use less of both labor and capital. Let w^* represent the annual cost of labor in the market, let r_L^* represent the annual cost of a unit of land in the market, and let r_K^* represent the annual cost of a unit of capital in the market.

a. Suppose that Kendra can maximize her profits by employing less labor and more capital than she is currently using but the same amount of land. What three conditions must now hold for Kendra's operations (involving her value of the marginal product of labor, land and capital) for this to be true?

b. Kendra believes that she can increase her profits by renting and using more land. What three conditions must hold (involving her value of the marginal product of labor, land, and capital) for this to be true?

10. Research consistently finds that despite nondiscrimination policies, African-American workers on average receive lower wages than white workers do. What are the possible reasons for this? Are these reasons consistent with marginal productivity theory?

11. Greta is an enthusiastic amateur gardener and spends a lot of her free time working in her yard. She also has demanding and well-paid employment as a freelance advertising consultant. Because the advertising business is going through a difficult time, the hourly consulting fee Greta can charge falls. Greta decides to spend more time gardening and less time consulting. Explain her decision in terms of income and substitution effects.

12. Wendy works at a fast-food restaurant. When her wage rate was $5 per hour, she worked 30 hours per week. When her wage rate rose to $6 per hour, she decided to work 40 hours. But when her wage rate rose further to $7, she decided to work only 35 hours.

a. Draw Wendy's individual labor supply curve.

b. Is Wendy's behavior irrational, or can you find a rational explanation? Explain your answer.

13. You are the governor's economic policy adviser. The governor wants to put in place policies that encourage employed people to work more hours at their jobs and that encourage unemployed people to find and take jobs. Assess each of the following policies in terms of reaching that goal. Explain your reasoning in terms of income and substitution effects, and indicate when the impact of the policy may be ambiguous.

a. The state income tax rate is lowered, which has the effect of increasing workers' after-tax wage rate.

b. The state income tax rate is increased, which has the effect of decreasing workers' after-tax wage rate.

c. The state property tax rate is increased, which reduces workers' after-tax income.

14. A study by economists at the Federal Reserve Bank of Boston found that between 1965 and 2003 the average American's leisure time increased by between 4 and 8 hours a week. The study claims that this increase is primarily driven by a rise in wage rates.

a. Use the income and substitution effects to describe the labor supply for the average American. Which effect dominates?

b. The study also finds an increase in female labor force participation—more women are choosing to hold jobs rather than exclusively perform household tasks. For the average woman who has newly entered the labor force, which effect dominates?

c. Draw typical individual labor supply curves that illustrate your answers to part a and part b above.