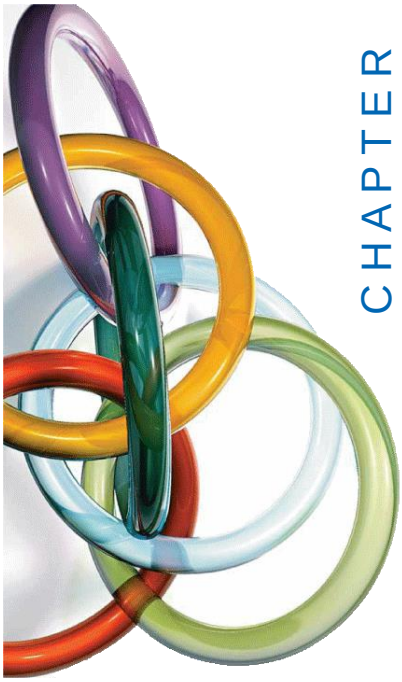


CHAPTER 14

Markets for Factor Inputs

CHAPTER 14 OUTLINE

14 MARKETS FOR FACTOR INPUTS

We will examine three different factor market structures:

1. Perfectly competitive factor markets;
2. Markets in which buyers of factors have monopsony power;
3. Markets in which sellers of factors have monopoly power.

14.1 COMPETITIVE FACTOR MARKETS

Demand for a Factor Input When Only One Input Is Variable

- **derived demand** Demand for an input that depends on, and is derived from, both the firm's level of output and the cost of inputs.
- **marginal revenue product** Additional revenue resulting from the sale of output created by the use of one additional unit of an input.

How do we measure the MRP_L? It's *the additional output obtained from the additional unit of this labor, multiplied by the additional revenue from an extra unit of output.*

$$MRP_L = (MR)(MP_L) \qquad \textbf{(14.1)}$$

This important result holds for any competitive factor market, whether or not the output market is competitive.

Let $f(L)$ be the production function, where L is the unique input.

Usually we assume that $f' > 0$ and $f'' < 0$

Then the quantity produced is $q = f(L)$

Let $p(q)$ be the inverse demand function characterizing the market

Case 1: competitive market, the single firm is price takers

Its problem is:

$$\max_{L} p\, f(L) - w\, L$$

The function to maximize is concave, then FOC are necessary and sufficient for a maximum

FOC: $p\, f'(L) - w = 0$

Note:

$p\, f'(L)$ is the marginal revenue product.

p is the marginal revenue

$f'(L)$ is the *marginal product of the labour*

Case 2: Monopoly

Its problem is:

$$\max_L p(q)\, f(L) - w\, L$$

Replacing $q = f(L)$:

$$\max_L p(f(L))\, f(L) - w\, L$$

The function to maximize is concave, then FOC are necessary and sufficient for a maximum

FOC: $p'\big(f(L)\big)f'(L)f(L) + f'(L)p(f(L)) - w = 0$

Replacing $f(L) = q$

$$p'(q)f'(L)q + f'(L)p(q) - w = 0$$
$$f'(L)(p'(q)q + p(q)) = w$$

Note:

$the\ LHS$ is the marginal revenue product.

$(p'(q)q + p(q))$ is the marginal revenue

$f'(L)$ is the *marginal product of the labour*

14.1 COMPETITIVE FACTOR MARKETS

Demand for a Factor Input When Only One Input Is Variable

In a competitive output market, a firm will sell all its output at the market price *P*.

In this case, the marginal revenue product of labor is equal to the marginal product of labor times the price of the product:

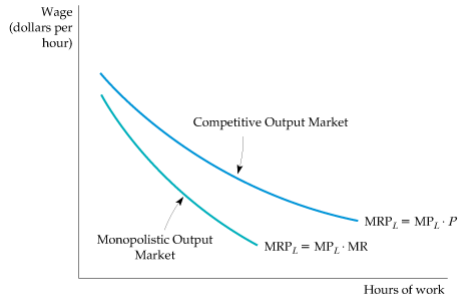
$$\mathrm{MRP}_L = (\mathrm{MP}_L)(\mathrm{P}) \qquad \textbf{(14.2)}$$

Figure 14.1

Marginal Revenue Product

In a competitive factor market in which the producer is a price taker, the buyer's demand for an input is given by the marginal revenue product curve. The MRP curve falls because the marginal product of labor falls as hours of work increase.

When the producer of the product has monopoly power, the demand for the input is also given by the MRP curve. In this case, however, the MRP curve falls because both the marginal product of labor and marginal revenue fall.



14.1 COMPETITIVE FACTOR MARKETS

Demand for a Factor Input When Only One Input Is Variable

$$\text{MRP}_L = w \qquad \textbf{(14.3)}$$

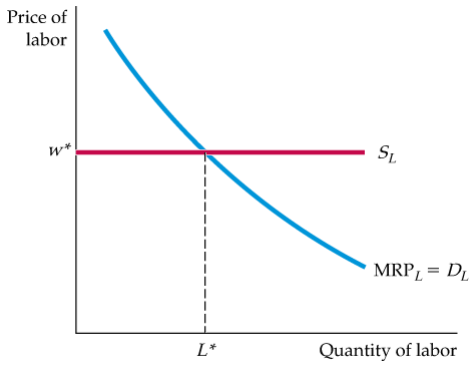
Figure 14.2

Hiring by a Firm in the Labor Market (with Fixed Capital)

In a competitive labor market, a firm faces a perfectly elastic supply of labor S_L and can hire as many workers as it wants at a wage rate w^*.

The firm's demand for labor D_L is given by its marginal revenue product of labor MRP_L.

The profit-maximizing firm will hire L^* units of labor at the point where the marginal revenue product of labor is equal to the wage rate.



14.1 COMPETITIVE FACTOR MARKETS

Demand for a Factor Input When Only One Input Is Variable

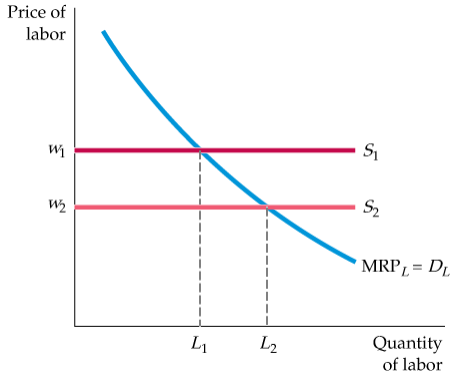
Figure 14.3

A Shift in the Supply of Labor

When the supply of labor facing the firms is S_1, the firm hires L_1 units of labor at wage w_1.

But when the market wage rate decreases and the supply of labor shifts to S_2, the firm maximizes its profit by moving along the demand for labor curve until the new wage rate w_2 is equal to the marginal revenue product of labor.

As a result, L_2 units of labor are hired.



Recall that $\text{MRP}_L = (\text{MP}_L)(\text{MR})$ and divide both sides of $\text{MRP}_L = w$ by the marginal product of labor. Then,

$$\text{MR} = w/\text{MP}_L \qquad \textbf{(14.4)}$$

14.1 COMPETITIVE FACTOR MARKETS

Demand for a Factor Input When Only One Input Is Variable

Recall that MRP_L = (MPL)(MR) and divide both sides of equation by the marginal product of labor. Then,

$$MR = w / MP_L \qquad \textbf{(14.4)}$$

Equation (14.4) shows that *both the hiring and output choices of the firm follow the same rule: Inputs or outputs are chosen so that marginal revenue (from the sale of output) is equal to marginal cost (from the purchase of inputs).*

This principle holds in both competitive and noncompetitive markets.

14.1 COMPETITIVE FACTOR MARKETS

Demand for a Factor Input When Several Inputs Are Variable

Figure 14.4

Firm's Demand Curve for Labor (with Variable Capital)

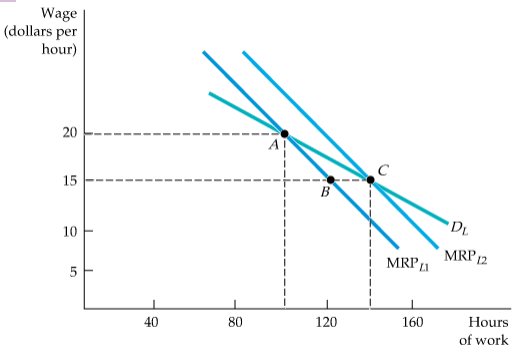
When two or more inputs are variable, a firm's demand for one input depends on the marginal revenue product of both inputs.

When the wage rate is $20, *A* represents one point on the firm's demand for labor curve.

When the wage rate falls to $15, the marginal product of capital rises, encouraging the firm to rent more machinery and hire more labor.

As a result, the MRP curve shifts from MRP_{L1} to MRP_{L2}, generating a new point *C* on the firm's demand for labor curve.

Thus *A* and *C* are on the demand for labor curve, but *B* is not.



Case 1: only one input (L) and firm is price taker

The production function is $f(L)$ with $f' > 0$ and $f'' < 0$

Let w be the price of L. Then its problem is to maximize profits:

$$\max_L p\, f(L) - w\, L$$

The solution is given by:

$$p\, f'(L) = w$$

that is the (inverse) firm's demand curve for L.

Example. Let be $f(L) = \ln(L+1)$ then the (inverse) firm's demand curve for L is:

$$w = \frac{p}{L+1}$$

Solving by L we get the demand for L:

$$L = \frac{p}{w} - 1$$

Case 2: two inputs (L and K), no interaction between inputs, and firm is price taker

In this case the production function is $f(L,K)$ and $\frac{df}{dL\, dK} = 0$

Example: The production function is

$$f(L,K) = \ln(L+1) + \ln(K+1)$$

Let w be the price of L and r the price of K. Then its problem is to maximize profits:

$$\max_L p\, [\ln(L+1) + \ln(K+1)] - w\, L - rK$$

The solution is given by:

$$w = \frac{p}{L+1} \quad r = \frac{p}{K+1}$$

that are the (inverse) firm's demand curves for L and K.

Note as each (inverse) demand is not affected by the other input

Case 3: two inputs (L and K), interaction between inputs, and firm is price taker. Complementarity effects between K and L

In this case the production function is $f(L,K)$ and $\frac{df}{dL\,dK} > 0$

Example: The production function is

$$f(L,K) = K^a L^b, \qquad a+b<1, \qquad a>0, \qquad b>0$$

Let w be the price of L and r the price of K. Then its problem is to maximize profits:

$$\max_L pK^a L^b - w\,L - rK$$

The solution is given by FOC's:

$$w = \frac{b\,p\,K^a}{L^{1-b}} \qquad r = \frac{a\,pL^b}{K^{1-a}}$$

that are the (inverse) firm's demand curves for L and K.

Note as each (inverse) demand is affected by the other input:

$$L = \left(\frac{b\,p\,K^a}{w}\right)^{\frac{1}{1-b}} \qquad K = \left(\frac{a\,pL^b}{r}\right)^{\frac{1}{1-a}}$$

Let be $p = 100, w = 10, r = 8, a = 0.4, b = 0.4$

$$L = \left(\frac{0.4\ 100\ K^{0.6}}{10}\right)^{\frac{1}{0.6}} \qquad K = \left(\frac{0.4\ 100 L^{0.4}}{8}\right)^{\frac{1}{0.6}}$$

The solution is:

$$K = 2000 \quad L = 1600$$

Suppose w decreases to 9, i.e. $w = 9$, all others parameters do not change. The solution is:

$$K = 2469.\ L = 2195$$

Both demands for K and L increase

Suppose K is fixed at 2000 and cannot change

Then the increases of L is smaller.

Indeed the optimal level of L when K cannot change is

$$L = 1907$$

14.1 COMPETITIVE FACTOR MARKETS

The Market Demand Curve

Determining Industry Demand

Figure 14.5

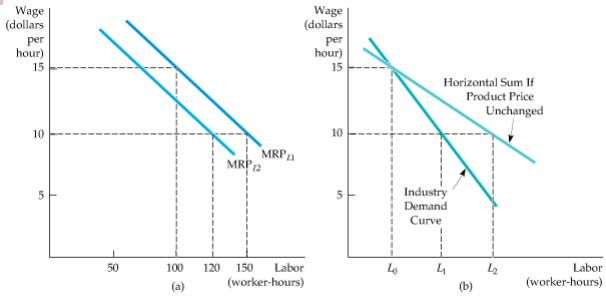
The Industry Demand for Labor

The demand curve for labor of a competitive firm, MRP_{L1} in **(a)**, takes the product price as given.

But as the wage rate falls from \$15 to \$10 per hour, the product price also falls.

Thus the firm's demand curve shifts downward to MRP_{L2}.

As a result, the industry demand curve, shown in **(b)**, is more inelastic than the demand curve that would be obtained if the product price were assumed to be unchanged.



This happens because:

1) Industry demands for labour is the sum of the firms demands
2) The wage falls for all firms
3) All firms hire more labor and produce more output
4) The supply increases and equilibrium price falls

14.1 COMPETITIVE FACTOR MARKETS

EXAMPLE 14.1 The Demand for Jet Fuel

Understanding the demand for jet fuel is important to managers of oil refineries, who must decide how much jet fuel to produce.

It is also crucial to managers of airlines, who must project fuel purchases and costs when fuel prices rise and decide whether to invest in more fuel-efficient planes.

The price elasticity of demand for jet fuel depends both on the ability to conserve fuel and on the elasticities of demand and supply of travel.

TABLE 14.1 Short-Run Price Elasticity of Demand for Jet Fuel

Airline	Elasticity	Airline	Elasticity
American	–.06	Delta	–.15
Continental	–.09	United	–.10
Northwest	–.07		

14.1 COMPETITIVE FACTOR MARKETS

EXAMPLE 14.1 The Demand for Jet Fuel (continued)

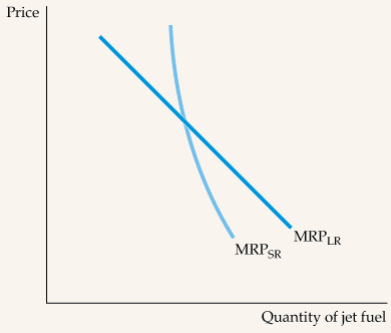
Figure 14.6

The Short- and Long-Run Demand for Jet Fuel

The short-run demand for jet fuel MRP_{SR} is more inelastic than the long-run demand MRP_{LR}.

In the short run, airlines cannot reduce fuel consumption much when fuel prices increase.

In the long run, however, they can switch to longer, more fuel-efficient routes and put more fuel-efficient planes into service.



14.1 COMPETITIVE FACTOR MARKETS

The Supply of Inputs to a Firm

Figure 14.7

A Firm's Input Supply in a Competitive Factor Market

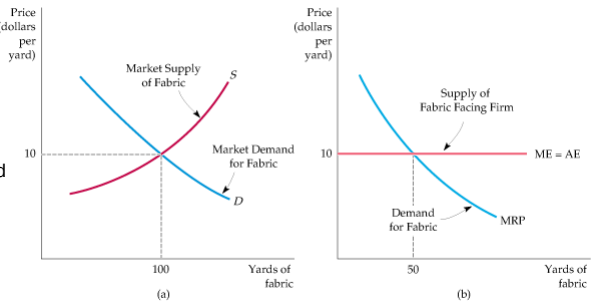
In a competitive factor market, a firm can buy any amount of the input it wants without affecting the price.

Therefore, the firm faces a perfectly elastic supply curve for that input.

As a result, the quantity of the input purchased by the producer of the product is determined by the intersection of the input demand and supply curves.

In **(a)**, the industry quantity demanded and quantity supplied of fabric are equated at a price of $10 per yard.

In **(b)**, the firm faces a horizontal marginal expenditure curve at a price of $10 per yard of fabric and chooses to buy 50 yards.



14.1 COMPETITIVE FACTOR MARKETS

The Supply of Inputs to a Firm

- **average expenditure curve** Supply curve representing the price per unit that a firm pays for a good.
- **marginal expenditure curve** Curve describing the additional cost of purchasing one additional unit of a good.

Profit maximization requires that *marginal revenue product be equal to marginal expenditure:*

$$ME = MRP \quad \textbf{(14.5)}$$

In the competitive case, the condition for profit maximization is that the price of the input be equal to marginal expenditure:

$$ME = w \quad \textbf{(14.6)}$$

14.1 COMPETITIVE FACTOR MARKETS

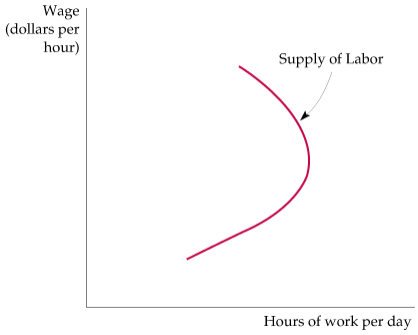
The Market Supply of Inputs

Figure 14.8

Backward-Bending Supply of Labor

When the wage rate increases, the hours of work supplied increase initially but can eventually decrease as individuals choose to enjoy more leisure and to work less.

The backward-bending portion of the labor supply curve arises when the income effect of the higher wage (which encourages more leisure) is greater than the substitution effect (which encourages more work).



14.1 COMPETITIVE FACTOR MARKETS

The Market Supply of Inputs

Figure 14.9

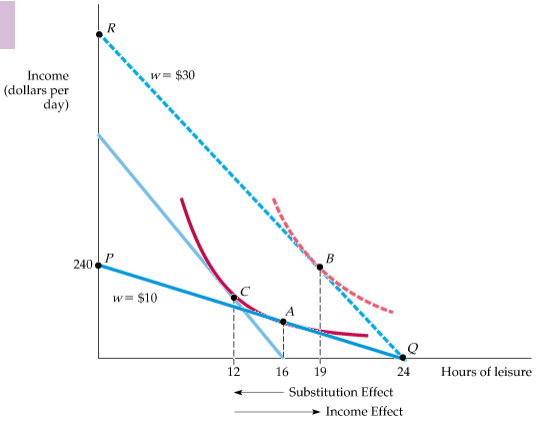
Substitution and Income Effects of a Wage Increase

When the wage rate increases from $10 to $30 per hour, the worker's budget line shifts from *PQ* to *RQ*.

In response, the worker moves from *A* to *B* while decreasing work hours from 8 to 5.

The reduction in hours worked arises because the income effect outweighs the substitution effect.

In this case, the supply of labor curve is backward bending.



14.1 COMPETITIVE FACTOR MARKETS

EXAMPLE 14.2 Labor Supply for One- and Two-Earner Households

The complex nature of the work choice was analyzed in a study that compared the work decisions of 94 unmarried females with the work decisions of heads of households and spouses in 397 families.

TABLE 14.2 Elasticities of Labor Supply (Hours Worked)

Group	Head's Hours with Respect to Head's Wage	Spouse's Hours with Respect to Spouse's Wage	Head's Hours with Respect to Spouse's Wage
Unmarried males, no children	.026		
Unmarried females, children	.106		
Unmarried females, no children	.011		
One-earner family, children	–.078		
One-earner family, no children	.007		
Two-earner family, children	–.002	–.086	–.004
Two-earner family, no children	–.107	–.028	–.059

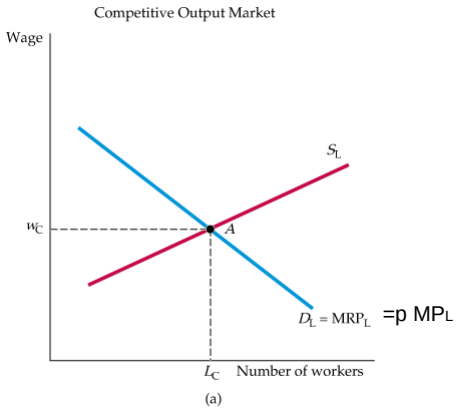
14.2 EQUILIBRIUM IN A COMPETITIVE FACTOR MARKET

Figure 14.10

Labor Market Equilibrium

In a competitive labor market in which the output market is competitive, the equilibrium wage w_c is given by the intersection of the demand for labor (marginal revenue product) curve and the supply of labor curve.

This is point *A*



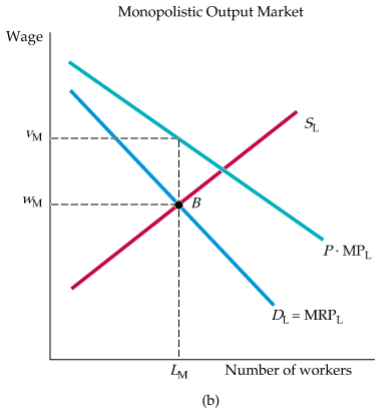
14.2 EQUILIBRIUM IN A COMPETITIVE FACTOR MARKET

Figure 14.10

Labor Market Equilibrium (continued)

it shows that when the producer has monopoly power,

the marginal value of a worker v_M is greater than the wage w_M. Thus too few workers are employed. (Point *B* determines the quantity of labor that the firm hires and the wage rate paid.)



14.2 EQUILIBRIUM IN A COMPETITIVE FACTOR MARKET

Economic Rent

For a factor market, *economic rent is the difference between the payments made to a factor of production and the minimum amount that must be spent to obtain the use of that factor.*

Figure 14.11

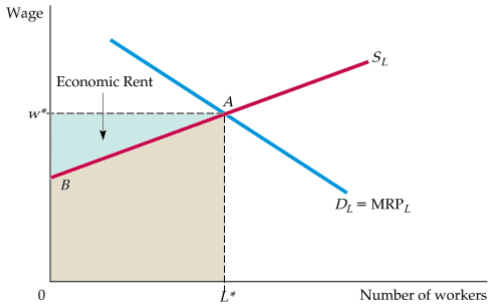
Economic Rent

The economic rent associated with the employment of labor is the excess of wages paid above the minimum amount needed to hire workers.

The equilibrium wage is given by *A*, at the intersection of the labor supply and labor demand curves.

Because the supply curve is upward sloping, some workers would have accepted jobs for a wage less than w^*.

The green-shaded area ABw^* is the economic rent received by all workers.



14.2 EQUILIBRIUM IN A COMPETITIVE FACTOR MARKET

Economic Rent

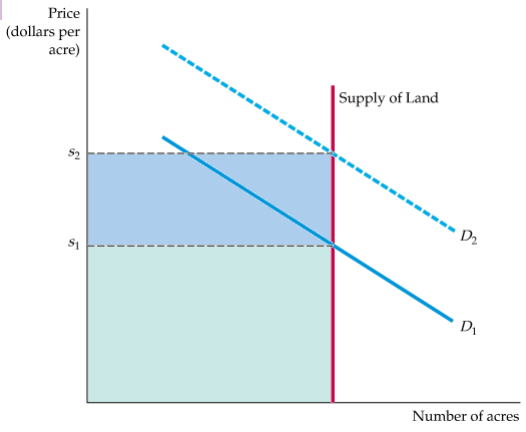
Figure 14.12

Land Rent

When the supply of land is perfectly inelastic, the market price of land is determined at the point of intersection with the demand curve. The entire value of the land is then an economic rent.

When demand is given by D_1, the economic rent per acre is given by s_1,

and when demand increases to D_2, rent per acre increases to s_2.



14.2 EQUILIBRIUM IN A COMPETITIVE FACTOR MARKET

EXAMPLE 14.3 Pay in the Military

During the Civil War, roughly 90 percent of the armed forces were unskilled workers involved in ground combat.

Since then, however, the nature of warfare has evolved.

Ground combat forces now make up only 16 percent of the armed forces.

Meanwhile, changes in technology have led to a severe shortage in skilled technicians, trained pilots, computer analysts, mechanics, and others needed to operate sophisticated military equipment.

14.2 EQUILIBRIUM IN A COMPETITIVE FACTOR MARKET

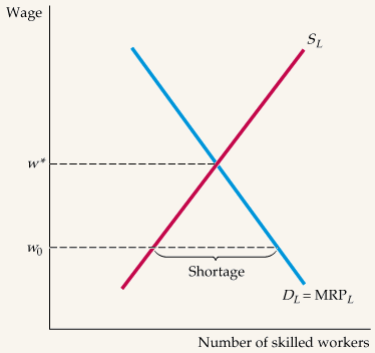
EXAMPLE 14.3 Pay in the Military (continued)

Figure 14.13

The Shortage of Skilled Military Personnel

When the wage w^* is paid to military personnel, the labor market is in equilibrium.

When the wage is kept below w^*, at w_0, there is a shortage of personnel because the quantity of labor demanded is greater than the quantity supplied.



14.3 FACTOR MARKETS WITH MONOPSONY POWER

Monopsony Power: Marginal and Average Expenditure

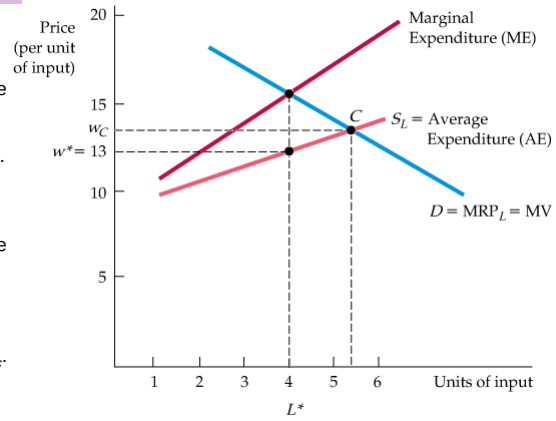
Figure 14.14

Marginal and Average Expenditure

When the buyer of an input has monopsony power, the marginal expenditure curve lies above the average expenditure curve because the decision to buy an extra unit raises the price that must be paid for all units, not just for the last one.

The number of units of input purchased is given by L^*, at the intersection of the marginal revenue product and marginal expenditure curves.

The corresponding wage rate w^* is lower than the competitive wage w_c.



14.3 FACTOR MARKETS WITH MONOPSONY POWER

Purchasing Decisions with Monopsony Power

A buyer with monopsony power maximizes net benefit (utility less expenditure) from a purchase by buying up to the point where marginal value (MV) is equal to marginal expenditure:

$$MV = ME$$

For a firm buying a factor input, MV is just the marginal revenue product of the factor MRP.

$$MRP = ME$$

Bargaining Power

The amount of bargaining power that a buyer or seller has is determined in part by the number of competing buyers and competing sellers. But it is also determined by the nature of the purchase itself.

14.3 FACTOR MARKETS WITH MONOPSONY POWER

EXAMPLE 14.4 Monopsony Power in the Market for Baseball Players

In the United States, major league baseball is exempt from the antitrust laws.

This exemption allowed baseball team owners (before 1975) to operate a monopsonistic cartel.

Fortunately for the players, and unfortunately for the owners, there was a strike in 1972 followed by a lawsuit by one player and an arbitrated labor-management agreement.

This process eventually led in 1975 to an agreement by which players could become free agents after playing for a team for six years.

14.3 FACTOR MARKETS WITH MONOPSONY POWER

EXAMPLE 14.5 Teenage Labor Markets and the Minimum Wage

In 1992 the New Jersey minimum wage was increased from $4.25 to $5.05 per hour.

Using a survey of 410 fast-food restaurants, David Card and Alan Krueger found that employment had actually *increased* by 13 percent after the minimum wage went up.

One explanation for this surprising event is that restaurants responded to the higher minimum wage by reducing fringe benefits.

An alternative explanation for the increased New Jersey employment holds that the labor market for teenage (and other) unskilled workers is not highly competitive.

14.4 FACTOR MARKETS WITH MONOPOLY POWER

Monopoly Power over the Wage Rate

Figure 14.15

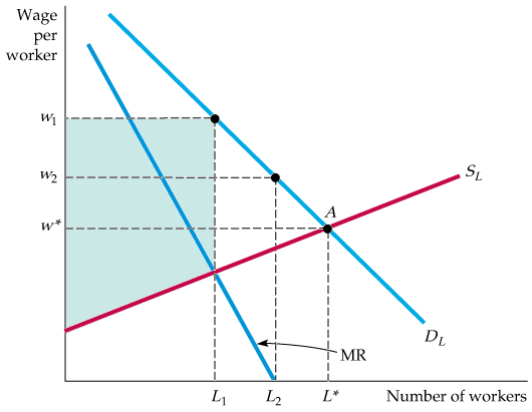
Monopoly Power of Sellers of Labor

When a labor union is a monopolist, it chooses among points on the buyer's demand for labor curve D_L.

The seller can maximize the number of workers hired, at L^*, by agreeing that workers will work at wage w^*.

The quantity of labor L_1 that maximizes the rent earned by employees is determined by the intersection of the marginal revenue and supply of labor curves; union members will receive a wage rate of w_1.

Finally, if the union wishes to maximize total wages paid to workers, it should allow L_2 union members to be employed at a wage rate of w_2. At that point, the marginal revenue to the union will be zero.



Chapter 14: Markets for Factor Inputs

14.4 FACTOR MARKETS WITH MONOPOLY POWER

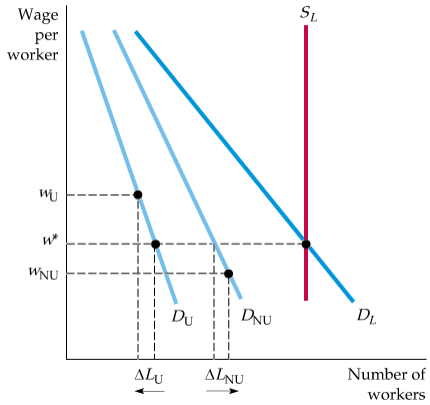
Unionized and Nonunionized Workers

Figure 14.16

Wage Discrimination in Unionized and Nonunionized Sectors

When a monopolistic union raises the wage in the unionized sector of the economy from w^* to w_U, employment in that sector falls, as shown by the movement along the demand curve D_U.

For the total supply of labor, given by S_L, to remain unchanged, the wage in the nonunionized sector must fall from w^* to w_{NU}, as shown by the movement along the demand curve D_{NU}.



Chapter 14: Markets for Factor Inputs

14.4 FACTOR MARKETS WITH MONOPOLY POWER

EXAMPLE 14.6 The Decline of Private-Sector Unionism

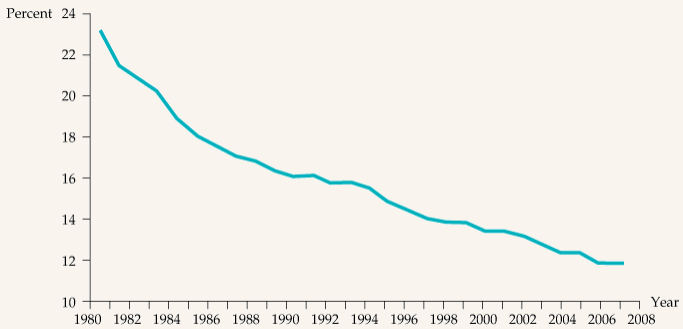


Figure 14.7

Union Workers as a Percentage of Total

The percentage of workers that are unionized has been declining steadily over the past 25 years.

14.4 FACTOR MARKETS WITH MONOPOLY POWER

EXAMPLE 14.7 Wage Inequality—Have Computers Changed the Labor Market?

While computer use increased from 1984 to 2003 for all workers, the largest increases were registered by workers with college degrees—from 42 to 82 percent.

Education and computer use have gone hand-in-hand to increase the demand for skilled workers.

A statistical analysis shows that, overall, the spread of computer technology is responsible for nearly half the increase in relative wages during this period.