

Chapter 14

Markets for Factor Inputs

■ Review Questions

1. **Why is a firm's demand for labor curve more inelastic when the firm has monopoly power in the output market than when the firm is producing competitively?**

The firm's demand curve for labor is determined by the incremental revenue from hiring an additional unit of labor, known as the marginal revenue product of labor. $MRP_L = (MP_L)(MR)$ is the additional output ("product") that the last worker produced, times the additional revenue earned by selling that output. In a competitive industry, the marginal revenue curve is perfectly elastic and equal to price. For a monopolist, marginal revenue is downward sloping. As more labor is hired and more output is produced, the monopolist will charge a lower price and marginal revenue will diminish. All else the same, marginal revenue product will therefore fall more quickly for the monopolist. This implies that the marginal revenue product curve (the demand curve for labor) will be steeper for the monopolist and hence more inelastic than for the competitive firm.

2. **Why might a labor supply curve be backward bending?**

A backward-bending supply curve for labor may occur when the income effect of an increase in the wage rate dominates the substitution effect. Individuals make labor supply decisions by choosing the most satisfying combination of income (with which to consume goods and services) and leisure. With a larger wage, the individual can afford to work fewer hours: the income effect. But as the wage rate increases, the value of leisure time (the opportunity cost of leisure) increases, thus inducing the individual to consume less leisure and work longer hours: the substitution effect. Because the two effects work in opposite directions, the labor supply curve is backward bending if the income effect triggered by a higher wage is greater than the substitution effect of the higher wage.

3. **How is a computer company's demand for computer programmers a derived demand?**

A computer company's demand for inputs, including programmers, depends on how many computers it sells. The firm's demand for programming labor depends on (is derived from) the demand it faces in its market for computers. As demand for computers shifts, the demand for programmers shifts.

4. **Compare the hiring choices of a monopsonistic and a competitive employer of workers. Which will hire more workers, and which will pay the higher wage? Explain.**

Since the decision to hire another worker means the monopsonist must pay a higher wage to *all* workers, and not just to the last worker hired, its marginal expenditure curve lies above the input supply curve (the average expenditure curve). The monopsonist's profit-maximizing input demand,

where the marginal expenditure curve intersects the marginal revenue product curve, will be less than the competitor's profit-maximizing input choice, where the average expenditure curve intersects

the demand curve, assuming that both firms have the same demand curve for labor. Therefore, the monopsonist hires less labor, and the wage paid will be less than in a competitive market.

5. Rock musicians sometimes earn several million dollars per year. Can you explain such large incomes in terms of economic rent?

Economic rent is the difference between the actual payment to the factor of production and the minimum amount that the factor is willing to accept. In this case, you might assume that there are a limited number of top-quality rock musicians who will continue to play rock music almost no matter what they are paid. This results in a perfectly inelastic supply curve, or something close to it. Given the high demand for rock music, the wage will be very high and there will be a lot of economic rent. If there was a larger supply of top-quality rock musicians, or a more elastic supply, then the economic rent would be smaller.

6. What happens to the demand for one input when the use of a complementary input increases?

If the demand for the complementary input increases, the demand for the given input will increase as well. When demand for the complementary input increases, there is an increase in the quantity hired and possibly the price paid. Both of these changes will increase the *MRP* of the given input, and hence will increase the quantity hired and possibly the price paid. Whether the prices of the inputs increase depends on the degree of monopsony power of the input buyers.

7. For a monopsonist, what is the relationship between the supply of an input and the marginal expenditure on it?

The decision to increase employment means the monopsonist must pay *all* units the higher price, and not just the last unit hired. Therefore, its marginal expenditure curve lies above the input supply curve (the average expenditure curve). Hiring more labor will increase the marginal expenditure, which will increase the average expenditure. If the average expenditure is increasing, then the marginal expenditure must be greater than the average expenditure.

8. Currently the National Football League has a system for drafting college players by which each player is picked by only one team. The player must sign with that team or not play in the league. What would happen to the wages of both newly drafted and more experienced football players if the draft system were repealed and all teams could compete for college players?

The National Football League draft and reserve clause creates a monopsonist cartel among the owners of NFL teams. If the draft system were repealed, competition among teams would increase wages of new football players to the point where the marginal revenue product of each player would be equal to the player's wage. It might not have much effect on experienced players because they already have the right to become free agents and sell their services to the team willing to pay the most.

9. The government wants to encourage individuals on welfare to become employed. It is considering two possible incentive programs:

- a. Give firms \$2 per hour for every individual on welfare who is hired.
- b. Give each firm that hires one or more welfare workers a payment of \$1000 per year, irrespective of the number of hires.

To what extent is each of these programs likely to be effective at increasing the employment opportunities for welfare workers?

Firms will hire additional labor as long as the extra benefit is greater than the extra cost of hiring an additional worker, or until $MRP_L = w$. Option a would be effective because if the firm receives \$2 per hour for every welfare worker hired, then the effective wage paid falls to $w - 2$ and the firm will find it optimal to hire more labor until the benefits (MRP_L) again equal the costs ($w - 2$) at the margin. Option b would also increase employment among welfare workers. However, it is not likely to be as effective as option a because the firm receives one lump sum payment regardless of the number of welfare workers hired. In this case the firm has an incentive to hire only one welfare worker.

- 10. A small specialty cookie company whose only variable input is labor finds that the average worker can produce 50 cookies per day, the cost of the average worker is \$64 per day, and the price of a cookie is \$1. Is the company maximizing its profit? Explain.**

The marginal product of labor is 50 (cookies per day) and the cookie price is \$1 (per cookie) so the marginal revenue product is \$50/day. Since this is less than the wage of \$64 per day the cookie company is not maximizing profit. They are employing too much labor since the cost of labor (\$64) is greater than the benefit of labor (\$50) at the margin, and they are therefore also producing too many cookies.

- 11. A firm uses both labor and machines in production. Explain why an increase in the average wage rate causes both a movement along the labor demand curve and a shift of the curve.**

An increase in the wage rate causes a movement up and to the left along the labor demand curve (the marginal revenue product curve), because the firm will want to hire fewer workers when the wage increases. However, when the wage increases, the marginal cost of producing the firm's product increases, and the firm will reduce output. When output falls, the firm will demand fewer machines, and the reduction in number of machines used will cause the marginal product of labor curve to shift to the left, assuming machines and labor are complementary. This reduces the demand for labor (shifts MRP_L to the left) and causes the firm to hire even less labor at the new wage rate.

■ Exercises

- 1. Suppose that the wage rate is \$16 per hour and the price of the product is \$2. Values for output and labor are in units per hour.**

q	L
0	0
20	1
35	2
47	3
57	4
65	5
70	6

a. Find the profit-maximizing quantity of labor.

From the information given above, calculate the marginal product of labor (the extra output produced by hiring one more unit of labor) and then multiply by price to get the marginal revenue product of labor. To maximize profit, the firm should hire labor only as long as the marginal revenue product of labor is greater than or equal to the wage of \$16. From the table below, the firm will hire 5 units of labor per hour.

q	L	MP_L	MRP_L
0	0	—	—
20	1	20	\$40
35	2	15	\$30
47	3	12	\$24
57	4	10	\$20
65	5	8	\$16
70	6	5	\$10

b. Suppose that the price of the product remains at \$2 but that the wage rate increases to \$21. Find the new profit-maximizing level of L .

The above table does not change for this part of the problem. However, the firm no longer wants to hire 5 units of labor because the benefit of the 5th unit (\$16 per hour) is less than the cost of the 5th unit (\$21 per hour). The firm would hire only 3 units of labor per hour since the benefit exceeds the cost at this level. The firm would not hire 4 units because the cost (\$21) is greater than the benefit (\$20). If the firm could hire fractional units of labor, some amount between 3 and 4 units per hour would be optimal.

c. Suppose that the price of the product increases to \$3 and the wage remains at \$16 per hour. Find the new profit-maximizing L .

A change in the price of the product will not change the marginal product of labor, but it will change the marginal revenue product of labor. The new marginal revenue product of labor is given in the table below. The firm will still want to hire 5 units of labor, as in part a above. It will not hire the 6th unit because the extra benefit (\$15) is less than the extra cost (\$16). Profit will be greater than in part a.

q	L	MP_L	MRP_L
0	0	—	—
20	1	20	60
35	2	15	45
47	3	12	36
57	4	10	30
65	5	8	24
70	6	5	15

- d. Suppose that the price of the product remains at \$2 and the wage at \$16, but that there is a technological breakthrough that increases output by 25% for any given level of labor. Find the new profit-maximizing L .

The technological breakthrough changes the number of units of output produced by any given number of units of labor, and hence changes the marginal product and the marginal revenue product of labor. The new output values are found by multiplying the old values by 1.25. This new information is given in the table below. The firm will still choose to hire 5 units of labor because $MRP_L > w$ when $L = 5$ while $MRP_L < w$ when $L = 6$. Profit will be greater than in part a.

q	L	MP_L	MRP_L
0	0	—	—
25	1	25	50
43.75	2	18.75	37.5
58.75	3	15	30
71.25	4	12.5	25
81.25	5	10	20
87.5	6	6.25	12.5

2. Assume that workers whose incomes are less than \$10,000 currently pay no federal income taxes. Suppose a new government program guarantees each worker \$5000, whether or not he or she earns any income. For all earned income up to \$10,000, the worker must pay a 50% tax. Draw the budget line facing the worker under this new program. How is the program likely to affect the labor supply curve of workers?

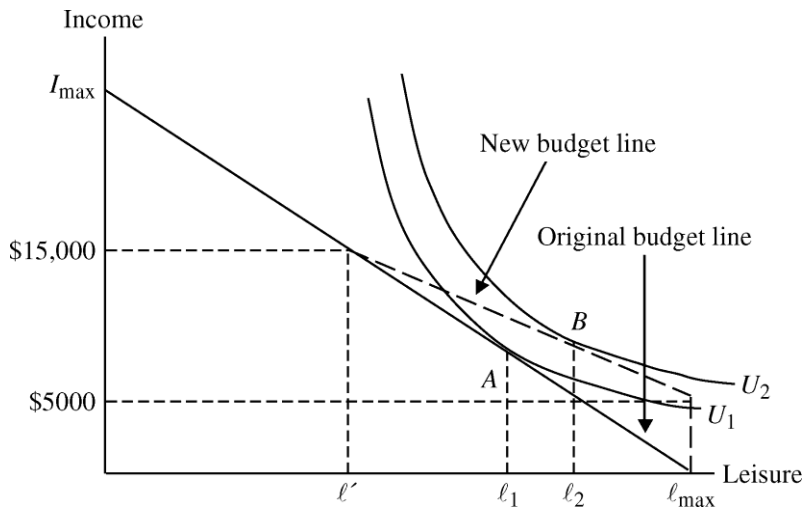
Initially the first \$10,000 of income was untaxed. We are not told what the tax rate was for incomes above \$10,000, so let's assume it was zero to make things simple.

With the new program, everyone gets \$5000 regardless of earned income, and this \$5000 is not taxed. However, the first \$10,000 of earned income is taxed at the 50% rate. Again, for simplicity, assume that earned income above \$10,000 is untaxed.

The worker's original income-leisure budget line before the new program is shown as the solid line in the diagram below. With the new program, the budget line (dashed line) shifts up by the \$5000 government grant when the worker does no work at all and takes the maximum amount of leisure, ℓ_{\max} . As the number of hours worked increases (i.e., leisure decreases), the budget line has half the slope of the original line because earned income is taxed at 50%. When the worker earns \$10,000 (so that total income is \$15,000 including the \$5000 grant), the new budget line coincides with the original line. This occurs at leisure level ℓ in the diagram below. For levels of leisure below that (i.e., for a greater number of hours worked) the two budget lines are identical. The result is that the new program will have no effect if the worker originally earned more than \$15,000 per year, but will probably reduce the amount of time worked (i.e., increase leisure) if the worker earned less than \$15,000.

To see the effect of the new program, draw indifference curves that originally lead the worker to choose more than ℓ of leisure. Indifference curve U_1 in the diagram is tangent to the original budget line at point A , and the worker chooses ℓ_1 hours of leisure. After the new program goes into effect, the worker's utility increases to U_2 , which is tangent to the new budget line at point B where the worker chooses ℓ_2 hours of leisure. The new program induces the worker to take more hours of leisure and

hence to work fewer hours. This is what we would expect, because the \$5000 grant triggers an income effect, which causes the worker to work fewer hours. In addition, by taxing earned income, the effective wage rate is cut in half. This reduces the cost of leisure, and leads the worker to substitute leisure for income, and thus work fewer hours. So both the income and substitution effects lead to less work.



3. Using your knowledge of marginal revenue product, explain the following:

- a. A famous tennis star is paid \$200,000 for appearing in a 30-second television commercial. The actor who plays his doubles partner is paid \$500.**

Marginal revenue product of labor, MRP_L , is equal to marginal revenue from an incremental unit of output multiplied by the marginal product from an incremental unit of labor, or in other words, the extra revenue generated by having the tennis star appear in the ad. The famous tennis star is able to help increase revenues far more than the actor, so he is paid much more than the actor. The wage of the actor is determined by the supply and demand of actors willing to play tennis with tennis stars.

- b. The president of an ailing savings and loan is paid *not* to stay in his job for the last two years of his contract.**

The marginal revenue product of the president of the ailing savings and loan is either low or negative, and therefore the savings and loan is better off by paying the president not to show up. They have calculated that they will lose less (or gain more) by paying the president to leave and hiring someone else whose MRP is much greater.

- c. A jumbo jet carrying 400 passengers is priced higher than a 250-passenger model even though both aircraft cost the same to manufacture.**

The marginal product of the jumbo jet is 400 while that of the smaller jet is only 250. This means the jumbo jet's MRP is greater, so it will generate more revenue per flight than the smaller jet. This makes the jumbo jet more valuable to the airline, and therefore the airline is willing to pay more for it.

- 4. The demands for the factors of production listed below have increased. What can you conclude about changes in the demands for the related consumer goods? If demands for the consumer goods remain unchanged, what other explanation is there for an increase in derived demands for these items?**

a. Computer memory chips

In general, an increase in the demand for a good increases the demand for its factor inputs. The converse is not necessarily true; i.e., an increase in the demand for factor inputs does not necessarily mean there was an increase in the demand for the final product. The demand for an input may increase due to a change in the use of other inputs in the production process. As the price of another input increases, the quantity demanded of that input falls, and the demand for substitutable inputs rises.

In this case, the increase in demand for computer memory chips was probably caused by an increase in the demand for computers, tablets, and other such devices, assuming that computer memory chips are used only in these products and that there are no substitutes for the memory chips. If the demand for the final products did not change, then perhaps the prices of other inputs fell, making it less costly to produce the products. This would cause the supply of the products to increase, which would result in a drop in their prices and an increase in the quantity sold. With an increase in sales, the demand for all inputs, including memory chips, would increase.

b. Jet fuel for passenger planes

There are no substitutes for jet fuel, so the increase in demand for jet fuel most likely was caused by an increase in the demand for jet travel. Another possibility would be if other input prices, such as wages of airline employees, decreased. This would reduce the cost of flying and lead airlines to supply more flights that would, in turn, increase the demand for jet fuel.

c. Paper used for newsprint

Given that the paper is being used to print newspapers, it seems likely that there was an increase in the demand for newspapers. However, if not, perhaps the cause was a drop in other input prices such as ink and wages. As in parts a and b, this would increase the supply of newspapers, and hence the demand for newsprint.

d. Aluminum used for beverage cans

With an increase in demand for cold drinks in the summer, the seasonal demand for aluminum increases, so this is one possible explanation. Alternatively, if glass or plastic containers have become more expensive, then the demand for aluminum would increase. Finally, changes in the market for recycled aluminum may affect the demand for new aluminum.

- 5. Suppose there are two groups of workers, unionized and nonunionized. Congress passes a law that requires all workers to join the union. What do you expect to happen to the wage rates of formerly nonunionized workers? Of those workers who were originally unionized? What have you assumed about the union's behavior?**

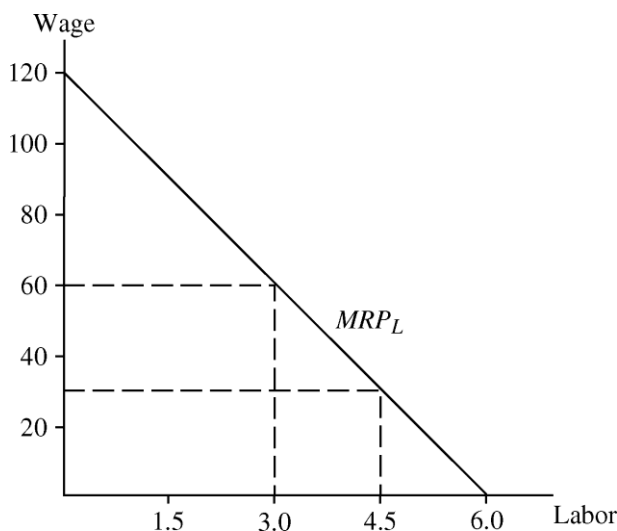
In general, we expect that nonunionized workers are earning lower wages than unionized workers. If all workers are forced to join the union, it would be reasonable to expect that the formerly nonunionized workers will now receive higher wages and the unionized workers will receive a wage that could go either way. There are a couple of issues to consider. First, the union now has more monopoly power because there are no nonunion workers to act as substitutes for union workers. This gives more power to the union, which means higher wages can be negotiated. However, the union now has more members

to satisfy. If wages are kept at a high level, there will be fewer jobs, and hence some previously nonunionized workers may end up with no job. The union may wish to trade off some of the wage for a guarantee of more jobs. The average income of all workers will rise if labor demand is inelastic and will fall if labor demand is elastic.

6. Suppose a firm's production function is given by $Q = 12L - L^2$, for $L = 0$ to 6, where L is labor input per day and Q is output per day. Derive and draw the firm's demand for labor curve if the firm's output sells for \$10 in a competitive market. How many workers will the firm hire when the wage rate is \$30 per day? \$60 per day? (*Hint: The marginal product of labor is $12 - 2L$.*)

The marginal revenue product of labor is the demand for labor and is equal to marginal revenue multiplied by the marginal product of labor: $MRP_L = (MR)(MP_L)$. In a competitive market, price is equal to marginal revenue, so $MR = 10$. We are given $MP_L = 12 - 2L$ (the slope of the production function). Therefore, the $MRP_L = (10)(12 - 2L) = 120 - 20L$, as shown in the diagram.

The firm's profit-maximizing quantity of labor occurs where $MRP_L = w$. If $w = 30$, then $30 = 120 - 20L$ at the optimum. Solving for L yields 4.5 hours per day as shown in the diagram. Similarly, if $w = 60$, solving for L yields 3 hours per day.



7. The only legal employer of military soldiers in the United States is the federal government. If the government uses its knowledge of its monopsonistic position, what criteria will it employ when determining how many soldiers to recruit? What happens if a mandatory draft is implemented?

Acting as a monopsonist in hiring soldiers, the federal government would hire soldiers until the marginal value of the last soldier is equal to the marginal expenditure of hiring the last soldier. There are two implications of the government's monopsony power: fewer soldiers are hired, and they are paid less than their marginal value. If a mandatory draft is implemented, the government can "hire" (i.e., draft) as many soldiers as it wants at whatever wage it offers. We would expect the government to pay a lower wage to draftees than to volunteer soldiers and to hire up to the point where the marginal value of the last draftee is equal to the draftee wage. This would result in a larger number of soldiers than under the volunteer system.

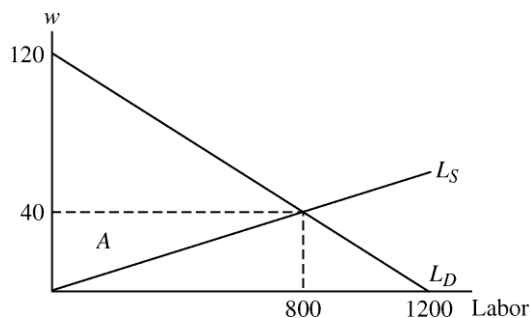
8. The demand for labor by an industry is given by the curve $L = 1200 - 10w$, where L is the labor demanded per day and w is the wage rate. The supply curve is given by $L = 20w$. What is the equilibrium wage rate and quantity of labor hired? What is the economic rent earned by workers?

Set the supply of labor equal to the demand for labor, and solve for the equilibrium wage rate:

$$20w = 1200 - 10w, \text{ or } w = \$40.$$

Substitute into either the labor supply or labor demand equation to find the equilibrium quantity of labor. For example, $L_D = 1200 - 10(40) = 800$.

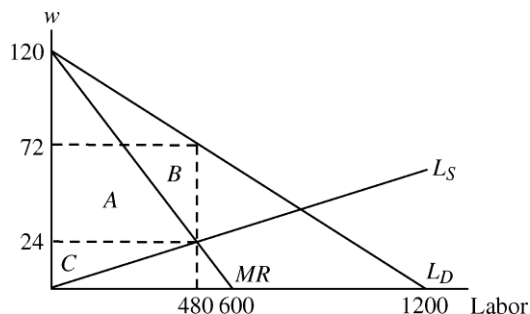
Economic rent is area A in the diagram. This triangle's area is $(0.5)(800)(\$40) = \$16,000$.



9. Using the same information as in Exercise 8, suppose now that the only labor available is controlled by a monopolistic labor union that wishes to maximize the rent earned by union members. What will be the quantity of labor employed and the wage rate? How does your answer compare with your answer to Exercise 8? Discuss. (*Hint: The union's marginal revenue curve is given by $MR = 120 - 0.2L$.*)

To maximize rent, the union will choose the number of labor-days so that the marginal revenue of the last day of labor "sold" (the additional wages earned) is equal to the extra cost of inducing a worker to work the additional day. This involves choosing the quantity of labor at the point where the marginal revenue curve crosses the labor supply curve. To find marginal revenue, first find the inverse demand for labor:

$$w = 120 - 0.1L.$$



Marginal revenue has twice the slope of the labor demand curve, so $MR = 120 - 0.2L$ as given in the hint. Now solve the labor supply function for w : $w = 0.05L$.

Setting MR equal to labor supply yields the rent-maximizing quantity of labor:

$$120 - 0.2L = 0.05L, \text{ or } L = 480.$$

Therefore, to maximize the rent that its members earn, the union should limit employment to 480 members.

The wage that the union should charge for its members' labor is found from the labor demand curve:

$$w = 120 - 0.1(480) = \$72 \text{ per day.}$$

Marginal revenue (\$24) is less than the wage, because when more workers are hired, all workers receive a lower wage.

The total rent that employed union members will receive is equal to area $A + B + C$:

$$\text{Rent} = (480)(72 - 24) + (0.5)(480)(24) = \$28,800.$$

So total rent and the wage are considerably higher, and the number of workers employed is much less than in the competitive case (Exercise 8).

10. A firm uses a single input, labor, to produce output q according to the production function $q = 8\sqrt{L}$. The commodity sells for \$150 per unit and the wage rate is \$75 per hour.

a. Find the profit-maximizing quantity of L .

There are two (equivalent) methods of solving this problem. Most generally, define the profit function, where revenues and costs are expressed in terms of the input, calculate the first order necessary condition (the first derivative of the profit function), and solve for the optimal quantity of the input. Alternatively, use the rule that the firm will hire labor up until the point where the marginal revenue product ($p \times MP_L$) equals the wage rate. Using the first method:

$$\begin{aligned}\pi &= TR - TC = pq - wL \\ \pi &= 150(8L^{0.5}) - 75L \\ \frac{d\pi}{dL} &= 600L^{-0.5} - 75 = 0 \\ L &= \frac{600^2}{75^2} = 64\end{aligned}$$

b. Find the profit-maximizing quantity of q .

From part a, the profit maximizing quantity of labor is 64. Substitute this quantity of labor into the production function to find $q = 8L^{0.5} = 8\sqrt{64} = 64$.

c. What is the maximum profit?

Profit is total revenue minus total cost or $= (150)(64) - (75)(64) = \4800 .

d. Suppose now that the firm is taxed \$30 per unit of output and that the wage rate is subsidized at a rate of \$15 per hour. Assume that the firm is a price taker, so the price of the product remains at \$150. Find the new profit-maximizing levels of L , q , and profit.

After the \$30 tax per unit of output is paid, the firm receives $\$150 - \$30 = \$120$ per unit of output sold. This is the relevant price for the profit maximizing decision. The input cost is now $\$75 - \$15 = \$60$ per unit of labor after the subsidy is received. The profit maximizing values can be found as in parts a–c above:

$$\pi = TR - TC = pq - wL$$

$$\pi = 120(8L^{0.5}) - 60L$$

$$\frac{d\pi}{dL} = 480L^{-0.5} - 60 = 0$$

$$L = \frac{480^2}{60^2} = 64$$

The optimal quantity of labor is still 64 hours, and thus the optimal output remains at $q = 64$ units. The company's profit is $= (120)(64) - (60)(64) = \3840 . So the combination of tax and subsidy leads the firm to produce the same output as before, but the firm's profit is less.

- e. Now suppose that the firm is required to pay a 20% tax on its profits. Find the new profit-maximizing levels of L , q , and profit.**

Assuming that the tax and subsidy in part d no longer apply, the product's price is \$150 and the wage rate is \$75 as in parts a–c. The profit maximizing values can be found as above; only here after-tax profit is 80% of total revenue minus total cost.

$$\pi = 0.8(TR - TC) = 0.8(pq - wL)$$

$$\pi = 0.8(150(8L^{0.5}) - 75L) = 120(8L^{0.5}) - 60L$$

$$\frac{d\pi}{dL} = 480L^{-0.5} - 60 = 0$$

$$L = \frac{480^2}{60^2} = 64$$

The 20% tax on profit leads the firm to use the same amount of labor and produce the same level of output ($q = 64$) as before. The firm's after-tax profit is now $= 0.8[(150)(64) - (75)(64)] = \3840 . So the firm earns the same profit after taxes as it does under the tax and subsidy scheme in part d.