CHAPTER 12: THE DEMAND FOR RESOURCES

Introduction
In terms of the circular flow model, the focus of study thus far has been the product market, where households buy products from firms. This chapter begins a four-chapter study of the factor (resource) market, where firms buy the land, labor, capital, and entrepreneurial resources necessary to produce products. Chapter 12 explains the demand for resources, focusing specifically on the labor market. Principles from this chapter help to explain wage determination and markets for other productive resources. Material from Chapter 12 consistently appears in a few multiple-choice questions and frequently appears as a free-response question on the AP microeconomics exam.

The Perfectly Competitive Resource Market
An understanding of resource markets is important to understanding incomes, costs of production, the allocation of resources to produce goods, and public policy decisions. We begin our analysis with the assumption that the firm is producing in a perfectly competitive market and hires workers from a perfectly competitive labor market. Like the perfectly competitive product market, the individual firm in the perfectly competitive labor market is a wage-taker that must accept the wage set in the industry. The firm can hire as many workers as it needs without affecting the wage (price of workers). We also assume that all workers are equal in terms of ability, motivation, and productivity.

The Demand for Labor
Demand for labor is a derived demand, as the demand for labor is based on demand for labor’s product. If a product gains popularity, the firm hires more workers; if consumer incomes fall, firms lay off workers. Due to this derived demand, the demand for labor depends on the productivity of the workers and the market value of the product. Highly productive resources and products with greater value increase the demand for resources.

Productivity is measured by the marginal product, the increase in total product resulting from hiring one more worker. According to the Law of Diminishing Returns, as more workers are hired to work with a fixed amount of other resources, output increases but at a diminishing rate. As each new worker is hired, he adds less and less to total product as specialization wears off and the workers begin to overwhelm the available capital.

But the demand for labor goes one step further, relying on the marginal revenue product for labor—the change in total revenue resulting from hiring one more worker. Marginal revenue product is the firm’s demand for labor. The market demand curve for labor in an industry is the sum of all of the individual firms’ demand curves.

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<tr>
<th>Marginal Revenue Product</th>
<th>Change in Total Revenue</th>
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<td>Change in the Number of Workers</td>
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Profit-Maximizing Labor Hiring
To determine how many workers to hire, the firm also needs to know the marginal resource cost, or the cost of hiring one more unit of labor.
The firm maximizes profit at the quantity of workers where the marginal revenue product from hiring the next worker equals the marginal resource cost of hiring the next worker. If the firm will earn more revenue from hiring the next worker than it will cost to hire that worker, the firm should hire the worker. But if the marginal resource cost is higher than the revenue the worker would bring to the firm, the firm should not hire that worker.

**The MRP = MRC Rule:** Firms **ALWAYS** maximize profit by hiring the number of workers where MRP = MRC.

**Taking the EEK! Out of Economics**
By this point, you should recognize important parallels between the perfectly competitive product market and the perfectly competitive resource market. They are very similar, with most principles transferring between the two markets. The primary difference between them is that the perfectly competitive product market is where consumers are buying finished products from firms, and the perfectly competitive resource market is where firms are buying resources from households in order to create those products.

<table>
<thead>
<tr>
<th>Units of Resource</th>
<th>Total Product (Output)</th>
<th>Marginal Product (MP)</th>
<th>Marginal Product (MP)</th>
<th>Total Revenue, (2) x (4)</th>
<th>Marginal Revenue Product (MRP)</th>
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**The demand for labor: pure competition in the sale of the product**

In this table, we can see the total product of all of the workers together, the marginal product (the increase in output from hiring one more worker), the total revenue (the total product times the product price), and the marginal revenue product (the increase in total revenue from hiring one more worker). Remember, the firm wants to hire workers where the marginal revenue product is greater than or equal to the marginal cost of the worker. So if the prevailing wage in the industry is $10, the firm would hire three workers. If the wage is $6, the firm will hire five workers. Just like the product market, in the labor market, the quantity of workers demanded increases as the price (wage) falls. What if the wage is $7? No MRP exactly matches. If the firm hires three workers, the MRC (wage) is less than the MRP (the income to the firm for hiring that worker), so the firm wants that worker. But with the fourth worker, MRC > MRP, so the firm should not hire that worker.
**Bear in Mind**

Given the total product and product price, you must be able to calculate the marginal product, total revenue, and marginal revenue product in a table. Given the wage, you will also be expected to calculate the number of workers the firm should hire to maximize profit. Questions requiring this specific skill have appeared consistently in both multiple-choice and free-response questions on the AP microeconomics exam.

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**Profit-Maximizing Hiring in an Imperfectly Competitive Product Market**

<table>
<thead>
<tr>
<th>Units of Resource (Output)</th>
<th>Total Product (Output)</th>
<th>Marginal Product (MP)</th>
<th>Product Price</th>
<th>Total Revenue, ( (2) \times (4) )</th>
<th>Marginal Revenue, ( (5) \times (4) )</th>
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<td>4.40</td>
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<td>28</td>
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**The demand for labor: pure competition in the sale of the product**

Labor hiring in an imperfectly competitive product market is very similar, though you'll notice one major difference in the table. In the perfectly competitive product market, the product price remains the same, regardless of how many products are sold, because the firm is a price-taker. In imperfectly competitive product markets (monopolistic competition, oligopoly, or monopoly), price-making firms must lower the price of all of their products in order to sell more. As a result, the price falls, causing the marginal revenue product to fall even more steeply. Therefore, the MRP curve for the firm selling in an imperfectly competitive product market falls for two reasons: diminishing returns and the need to lower prices in order to sell more products. As a result, the labor demand curve for a firm selling in an imperfectly competitive product market is less elastic than the labor demand for a firm selling in a perfectly competitive product market. This can be seen in the firm's decision to restrict output to sell products at a higher price; if the firm produces fewer products, it demands fewer workers to produce those products.

The imperfectly competitive firm also hires where the MRC = MRP. In this example, if the prevailing wage in the industry is $10, the firm would hire two workers. At a wage of $6, the firm would hire three workers. Notice that this imperfectly competitive firm hires fewer workers than the perfectly competitive firm in the previous example.

**Determinants of Demand for Resources**

The demand for labor relies on a number of factors. First, with derived demand, an increase in demand for the product increases demand for the labor to produce it, so labor demand shifts to the right. The reverse is true when product demand falls. Second, if labor becomes more productive, the demand for labor will increase. When workers can produce more products at a lower cost per unit, the firm has an incentive to increase production in order to gain additional profit. Productivity can be increased through a greater availability of other necessary resources, advances in technology, and increased health, education, and skills of the labor force. High
productivity of the workforce helps to explain why American workers' wages are higher than those in many other nations.

Changes in the price of substitute and complementary resources also affect the demand for labor. Substitute capital takes the place of a worker, such as a fast food restaurant machine that automatically dispenses drinks based on the computerized order. If the cost of the machine falls, the firm can produce at a lower cost, leading the firm to increase the quantity of machines and reduce its demand for workers. Complementary resources, on the other hand, are capital goods that are used together with labor. One ultrasound technician is necessary for each piece of ultrasound equipment. If the price of capital used as a complementary resource falls, the firm buys more capital and the demand for labor will actually rise, as the firm needs more workers to use the additional equipment.

**Elasticity of Resource Demand**

Elasticity of resource demand refers to the sensitivity of firms to changes in the price of resources; when the price of a resource falls, do firms respond? If the percentage change in the number of workers hired is greater than the percentage change in wage, demand for labor is elastic. If the percentage change in the number of workers hired is less than the percentage change in wage, demand for labor is inelastic. If the percentage change in the number of workers equals the percentage change in wage, labor demand is unit elastic.

One factor affecting resource elasticity is how easily one resource can be substituted for another. It may be relatively easy to find a machine to install headlights on an assembly line, but it is much more difficult to find a machine to provide the services of a physical therapist or financial analyst. A second factor affecting resource elasticity is the elasticity of product demand. The more elastic the demand for the product, the more elastic the demand for labor. If customers significantly reduce the quantity demanded for the product, the firm needs fewer workers to produce those products. Finally, the ratio of the resource cost to the total cost of production affects resource elasticity. If the cost of labor is a large proportion of the cost of production, the demand for labor is more elastic.

**Bear in Mind**

To determine effects of wages on labor hiring, most questions on the AP microeconomics exam assume labor is the only factor of production, in order to simplify the analysis.

**The Least-Cost Rule**

The least-cost rule illustrates when a firm is minimizing its costs at a specific output. When the last dollar spent on labor and the last dollar spent on capital both result in the same marginal product, the firm has reached least-cost production.

<table>
<thead>
<tr>
<th>Marginal Product of Labor</th>
<th>Marginal Product of Capital</th>
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<table>
<thead>
<tr>
<th>Price of Labor</th>
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If the last worker hired has a marginal product of six at a price of $1, and the last unit of capital hired has a marginal product of four at a price of $1, the marginal products are not equal. The firm would be better off buying less capital and hiring more workers, because it gains more production for the same cost (which is the same as saying the firm produces the same amount at a lower total cost). The firm will continue to choose among labor or capital, shifting between
resources to buy more of the resources that provide a higher marginal product and fewer of the resources that provide a lower marginal product until the marginal products are equal. Then the firm is producing at least cost.

**The Profit-Maximizing Rule**

While it is important for the firm to minimize costs, doing so will not necessarily maximize profit. As we know, the firm maximizes profit where MC = MR in the product market, and where MRC = MRP in the factor market. In order to maximize profit for the firm in all variable resources, we need to extend the MRC = MRP formula to all resources.

<table>
<thead>
<tr>
<th>MRP for Labor</th>
<th>MRP for Capital</th>
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<tr>
<td>Price of Labor</td>
<td>Price of Capital</td>
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The least-cost rule told us which combination of resources—labor or capital—reduced costs. The profit-maximizing rule tells us how many of each resource to buy to maximize profit. We should hire labor until the marginal revenue product equals the price (wage, or marginal resource cost). The numerator and denominator of the fraction should be equal. In the same way, the firm should continue to buy capital as long as the marginal revenue product (additional income the firm earns from products produced by the capital) equals the cost of buying the capital. The profit-maximizing rule includes the least-cost rule within the formula, so the firm maximizing profit is achieving least-cost production. A firm achieving least-cost production, though, may not be maximizing profit. If a firm sells its products for $1 apiece, and the MP for the last unit of labor is nine at a price of $3, and the MP for the last unit of capital is twelve at a price of $4, the firm has achieved least-cost production because both labor and capital produce a marginal product of three units per dollar of cost. However, the firm is not maximizing profit, because the marginal revenue product for each resource is higher than the price of the resource. The firm should continue to hire labor and capital until the MRP of each falls to the price of each.

**Multiple-Choice Questions**

1. Which of the following situations illustrates the concept of derived demand?
   (A) If the price of orange juice increases, the demand for apple juice increases.
   (B) If demand for shoes increases, the demand for shoelaces increases.
   (C) If the price of cars increases, the demand for gas decreases.
   (D) If demand for taxi rides increases, the demand for taxi drivers increases.
   (E) If the supply of hot dogs increases, the demand for hot dog buns increases.

2. Each worker hired adds less to total output than the worker before, according to the
   (A) Law of Demand.
   (B) Law of Diminishing Returns.
   (C) Law of Diminishing Marginal Utility.
   (D) Least-Cost Rule.
   (E) Principle of Derived Demand.

3. Marginal revenue product measures the additional
   (A) output produced from hiring one more worker.
   (B) income to the firm from producing one more product.
   (C) cost to the firm for producing one more product.
   (D) wage required to hire one more worker.
   (E) income to the firm from hiring one more worker.
4. In order to maximize profit, the firm should hire the number of workers where the
(A) marginal cost equals the marginal revenue.
(B) marginal revenue product equals the marginal cost.
(C) wage equals the product price.
(D) marginal resource cost equals the marginal revenue product.
(E) marginal revenue equals the marginal resource cost.

Questions 5–6 refer to the table below, which shows the daily total product of a firm operating in perfectly competitive product and labor markets.

<table>
<thead>
<tr>
<th>Number of Workers</th>
<th>Total Product</th>
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<td>1</td>
<td>25</td>
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<td>2</td>
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<td>70</td>
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5. What is the marginal product of the third worker?
(A) 15 products
(B) 60 products
(C) 35 products
(D) 20 products
(E) 30 products

6. If the firm sells its products for $10 each, and the wage the firm must pay workers is $100 per day, how many workers should the firm hire to maximize profit?
(A) 1 worker
(B) 2 workers
(C) 3 workers
(D) 4 workers
(E) 5 workers

7. A firm selling products in a monopoly product market finds its marginal revenue product falling much more quickly than a firm selling in a perfectly competitive product market, because in addition to diminishing returns,
(A) the government is required to regulate the price of the product.
(B) the firm becomes inefficient by trying to sell too many units of output.
(C) the firm must lower the price of all products in order to sell more units.
(D) consumers prefer not to buy from monopolies, so demand falls.
(E) workers tend to earn higher wages in monopoly product firms.

8. The demand for labor at Tyrone’s auto repair shop would increase if
(A) the cost of complementary capital significantly fell.
(B) the cost of substitute capital significantly fell.
(C) wages of auto repair workers significantly increased.
(D) mild weather resulted in fewer car crashes this winter.
(E) workers at the auto repair shop became less productive.
9. When the wage increases 5 percent, the quantity of workers hired falls 1 percent, indicating that labor demand is
(A) perfectly inelastic.
(B) relatively inelastic.
(C) unitary elastic.
(D) relatively elastic.
(E) perfectly elastic.

10. Mary’s Noodles is a profit-maximizing firm that specializes in preparing frozen chicken and noodle dinners for sale at local grocery stores. Mary’s staff has always prepared the noodles by hand, but recently, a noodle-making machine has been developed which would allow the company to replace some of its staff with the machine. The marginal product of the last worker hired is two pounds of noodles per hour, at a wage of $8. The marginal product of the noodle-making machine is eight pounds of noodles per hour, at a cost of $40. Which of the following statements is true?
(A) Mary’s Noodles would be better off using labor rather than the machine, because the marginal product per dollar is lower for labor than for the machine.
(B) Mary’s Noodles would be better off using the machine rather than labor, because the marginal product of the machine is four times as high as the marginal product of the last worker hired.
(C) Mary’s Noodles has achieved least-cost production.
(D) Mary’s Noodles maximizes its profit if it buys the machine.
(E) Mary’s Noodles cannot achieve a profit given these production costs.

11. According to the profit-maximizing rule for hiring resources, the firm should hire labor and capital until the marginal revenue product for each equals the
(A) market price of the product.
(B) quantity of labor and capital hired.
(C) price ceiling for the product.
(D) profit per unit for each.
(E) marginal resource cost of each.

Free-Response Question
Assume a firm can hire all of the workers it wants at a wage of $60 per day, and the firm can sell all of its products at a price of $10. The firm’s production schedule is below.

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<thead>
<tr>
<th>Number of Workers</th>
<th>Total Product</th>
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(a) What kind of market structure does this firm sell its product in? Explain.
(b) What kind of market structure does this firm hire its workers in? Explain.
(c) Calculate the marginal revenue product of the fourth worker.
(d) How many workers should this firm hire to maximize its profit? Explain.
(e) If the wage fell to $55 per day, how many workers should this firm hire to maximize its profit? Explain.

Multiple-Choice Explanations
1. (D) Derived demand is the concept that if the demand for a product increases, the demand for workers to make that product will increase, as well.
2. (B) In diminishing returns, each additional worker adds to production, but specialization has worn off, and additional workers begin to overwhelm the fixed capital.
3. (E) The marginal revenue product is the marginal product added by one more worker multiplied by the price those additional products can be sold for in the product market.
4. (D) The firm maximizes profit where the additional cost to hire one more worker equals the revenue brought into the firm as a result of hiring that worker.
5. (A) Marginal product is the increase in total product as a result of hiring one more worker. The third worker increased production from 45 to 60 units, an increase of 15 products.
6. (D) The marginal product of the fourth worker is 10 units, which can each be sold for $10, so that worker’s marginal revenue product is $100. If the wage is $100, the firm’s profit-maximizing output of MRC = MRP is achieved with the fourth worker.
7. (C) Imperfectly competitive firms must lower their prices in order to sell more products, so the marginal revenue to the firm falls much more quickly than it does for perfectly competitive firms.
8. (A) Complementary capital is a resource that must be used in a fixed amount with a worker (in this case, a paint sprayer and a worker). If the price of the complementary capital falls, the marginal resource cost for the worker and capital together is lower, so that now the marginal revenue product is higher than or equal to that marginal resource cost, and the firm will hire the additional worker.
9. (B) When a change in wage causes a relatively smaller percentage change in the quantity of workers hired, demand is relatively inelastic. The firm is not very responsive to the change in wage.
10. (A) Least-cost production occurs where the marginal product per dollar of labor equals the marginal product per dollar of capital. In this case, the MP/$ of labor is 0.25 pounds of noodles, and the MP/$ of capital is 0.20 pounds of noodles. Because Mary’s Noodles gets a greater marginal product for the cost from labor, the company should continue to use labor rather than the machine.
11. (E) The firm maximizes profit when both the labor and capital are hired until the marginal revenue product generated by hiring the next unit equals the marginal resource cost of hiring that unit.

Free-Response Explanation
9 points (2 + 2 + 1 + 2 + 2)
(a) 2 points:
• 1 point is earned for stating that the firm sells its product in a perfectly competitive market.
• 1 point is earned for explaining that the firm does not have to lower its price to sell more units, a characteristic that only occurs in perfectly competitive markets.
(b) 2 points:
• 1 point is earned for stating that the firm hires its workers in a perfectly competitive labor market.
• 1 point is earned for explaining that the firm hires all of its labor for the same wage and does not have to raise its wage to attract more workers.

(c) 1 point:
• 1 point is earned for stating that the marginal revenue product of the fourth worker is $70 (the marginal product of 7 units—the increase from 27 to 34—multiplied by the $10 product price).

(d) 2 points:
• 1 point is earned for stating that this firm should hire five workers.
• 1 point is earned for stating that the fifth worker’s MRP = MRC.

(e) 2 points:
• 1 point is earned for stating that the firm still should hire five workers at the lower wage.
• 1 point is earned for explaining that the marginal revenue product of the sixth worker is only $50, so the wage would have to fall to $50 before the firm would hire the sixth worker.