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Chapter

Labor Markets

Meng Sun

Abstract

What is the labor market? Like the goods and services markets, a labor market consists of the supply and demand sides. In the labor market, while workers supply labor, firms demand labor. This chapter studies the backward-bending nature of the labor supply curve and the downward-sloping nature of the labor demand curve. We also analyze the labor market equilibrium in a perfectly competitive labor market. Several policies such as immigration and minimum wage will be introduced to illustrate how government policies affect the labor market equilibrium.

Keywords: labor market, labor demand, labor supply, labor market equilibrium, policies

1. Introduction

Just like the goods and services markets, the labor market has supply and demand. Although the labor market works similar to the goods and services markets, the stories behind the demand and supply are different. In the labor market, workers supply labor, the valuable services they contribute to producing goods and services because they need money for food, rent, and other activities. On the other hand, firms who hire labor are the demanders for labor. Without workers, firms could not produce goods and services and earn profits. For this reason, the "product" in the labor market is labor, and the "price" of the labor is the wage rate.

Modern labor markets are complex. Companies from all over the world hire many different occupations such as engineers, business analysts, construction workers, designers. Today, over 3 billion people are either working or looking for jobs in the labor market, and each of these people has different skills and experiences. How do companies decide which employee to hire and at what wage rate? How do the workers decide which company they want to work for? To answer these questions, we follow the economist's approach: simplify the problem by using a model.

In this chapter, we will construct the competitive labor market model. We will discuss the backward-bending nature of the labor supply curve and the downward-sloping nature of the labor demand curve. We then will look at how workers and firms interact in the labor market to determine how many workers to hire and at what wage rate? Immigration and minimum wage policies will be introduced, and we will discuss how these policies affect the labor market equilibrium.

2. Key assumptions of the competitive labor market model

Competitive labor markets are similar to competitive goods and services markets. **Table 1** compares the assumptions in competitive labor markets and

Goods and services markets	Labor markets
Large number of sellers and buyers	Large number of workers and firms
Sellers produce homogenous product	Workers are homogenous
Sellers and buyers have perfect information	Workers and firms have perfect information

Table 1.
The key assumptions in competitive labor markets and competitive goods and services market.

competitive goods and services markets. There are four key assumptions we need to make in order to simplify our analysis:

1. **Workers are homogenous.** It means the workers in a competitive labor market are identical and equally productive. Therefore, firms have no preference toward one worker over another.

2. **Workers and firms share complete and accurate information in the labor market.** Every worker has the same information on wage, and every firm knows how productive a worker is. This assumption is a natural extension of the homogenous-workers assumption, which also implies no negotiation between firms and workers.

3. **There are many workers and firms in the labor market.** This assumption implies that no worker or firm has the market power to affect the wage. In other words, the wage is determined by the labor demand and supply, and everyone in the market is a "price (wage) -taker."

Notice that those simplifying assumptions of the competitive labor market model are not (entirely) realistic. For example, in reality, workers have different training, level of skills, and experiences. Therefore, they are not homogenous, especially in terms of productivity. The information in the labor market is also not likely to be perfect. It is challenging for firms to evaluate a work's productivity during the interview. Moreover, workers are also not likely to know the wage a firm is willing to offer. Nevertheless, the model provides a good description of how the labor market work. It can help us to focus on and understand the essential labor market mechanism.

3. The supply of labor

3.1 Work and leisure

An individual needs to decide how to allocate time between market and nonmarket activities.

Market activity: activities that include financial transactions and done with intention of earning money or profit [1]:

- Work (for pay)

Nonmarket activity: activities that do not include any financial transactions and done without any intention of earning money or profit [1]:

- Leisure

- Household production (raising children, cooking, home repair, growing vegetables, etc.)

- Investing in "human capital" (i.e., acquiring skills/knowledge that increase future earning capacity)

For the sake of simplicity, we divide an individual's activities into: *work and leisure*. Note that *leisure* here includes all activities that are not *work*.

3.2 Utility function

Assume that an individual can allocate his/her time between two activities: *work and leisure*. Assume that the total time the individual can allocate a day is T. Let I denote the hours of leisure the individual spends. The individual's hours of work are $T - I$. Choosing to work $T - I$ hours at a given wage is equivalent to consuming I hours of leisure. Therefore, we can model either the individual's leisure demand or the individual's labor supply. We will model the individual's leisure demand here.

Assume there are two categories of goods that an individual can consume: *leisure and consumption goods*. We can describe the individual's preferences by an utility function

$$U = U(C, I) \tag{1}$$

where C is the quantity of the consumption goods. The utility function measures the individual's satisfaction or happiness at any quantities of the consumption goods and the individual's leisure hours. In addition, we assume that buying more consumption goods or having more leisure hours both increase the individual's utility. **Figure 1** shows a typical indifference curve.

3.3 Indifference curves

Suppose that an individual consumes $100 worth of consumption goods and 2 hours of leisure a day (point A in **Figure 1**). Combining the $100 worth of consumption and 2 hours of leisure give the individual 60 units of happiness. If the individual only consumes $60 worth of consumption goods and 5 hours of leisure (point B in **Figure 1**), the individual receives the same level of happiness.

Suppose that the individual is still consuming $100 worth of consumer goods. At the same time, he/she spends 5 hours on leisure instead of 2 hours (point C in **Figure 1**). Combining the $100 worth of consumption and 5 hours of leisure give the individual 90 units of happiness. The indifference curves are the graphical representation of the utility function.[1]

3.4 The budget constraint

An individual's income consist of two parts: earned income and unearned income. **Earned income** is the money you make in exchange for the work you do. For most people, almost all the money they make is earned income. Any money earned in professional wages or fees—including tips—counts as earned income. Reimbursements from your employer for travel expenses, including meals, accommodations,

[1] Indifference curves have five important properties: 1. indifference curves are strictly downward sloping; 2. indifference curves are convex to the origin; 3. indifference curves never cross; 4. higher indifference curves mean higher levels of utility; 5. indifference curves are continuous, with no gaps.

Figure 1.
Consumption-leisure indifference curves.

and transportation, also count as earned income. Unearned income involves the money you make without having performed a professional service. **Unearned income** includes money-making sources that involve interest, dividends, and capital gains. Additional forms of unearned income include retirement account distributions, annuities, unemployment compensation, social security benefits, and gambling winnings. Other forms of income, such as money from an estate, trust, or partnership, may also be considered unearned income [2].

Let K denote an individual's unearned income. Let L be the number of hours the individual works and w be the hourly wage rate. C is the quantity of the consumption goods. The individual's budget constraint can be written as

$$C = wL + K \tag{2}$$

Eq. (2) means the expenditures on the consumption goods equals to the sum of earned income and unearned income.

Since the total time the individual can allocate a day is T and the individual can only allocate his/her time between two activities: *work (L) and leisure (I)*, we have $T = L + I$. Thus, $L = T - I$. We can then rewrite the budget constraint as

$$C = w(T - I) + K \tag{3}$$

Rearrange Eq. (3)

$$C = (wT + K) - wI \tag{4}$$

Figure 2 shows the consumption-leisure budget line. If the individual chooses to spend all of his/her time on leisure, the individual's expenditure on the consumption goods is K, which is his/her unearned income (point D in **Figure 2**). If the individual chooses to spend all of his/her time on work, the individual's expenditure on the consumption goods is $wT + K$, which is the sum of his/her earned income and unearned income (point E in **Figure 2**). Moreover, the slope of the consumption-leisure budget line is $-w$.

Figure 2.
Consumption-leisure budget line.

3.5 Worker's optimal choice

The budget line shows the combinations of the consumption goods and the hours of leisure that the individual can afford. Notice that the individual can choose any combination of the consumption goods and leisure hours on the budget line or in the area below the budget line. We want to determine which combination within the budget gives the individual the highest level of utility. **Figure 3** illustrates the solution to this problem.

Combinations that lie on indifference curves above the budget line, such as point E, are not in the budget set. Even though the individual prefers point E to point A or B, he/she cannot afford the combination of the consumption goods and the hours of leisure at point E.

Although the individual can afford any combination inside the budget line, such as point B, he/she can always find a better affordable combination such as point D. Thus, the individual will not choose any combination of the consumption goods and leisure hours in the area below the budget line.

Points A and C lie on the budget line as point D. However, the indifference curve that passes through point D is higher than the indifference curve that pass through points A and C. Therefore, the combination of the consumption goods and leisure hours at point D gives the individual higher level of utility (higher indifference curves mean higher levels of utility). In fact, the point where an indifference curve is tangent to the budget line is the affordable combination of the consumption goods and leisure hours that gives the individual the highest level of utility.

3.6 Substitution and income effects

Figure 3 demonstrates the optimal combination of the consumption goods and leisure hours an individual will choose given the hourly wage rage at w. What happens if the wage rate increases? Would the individual choose more work and less leisure because he/she can earn more per hour? Or would the individual choose less

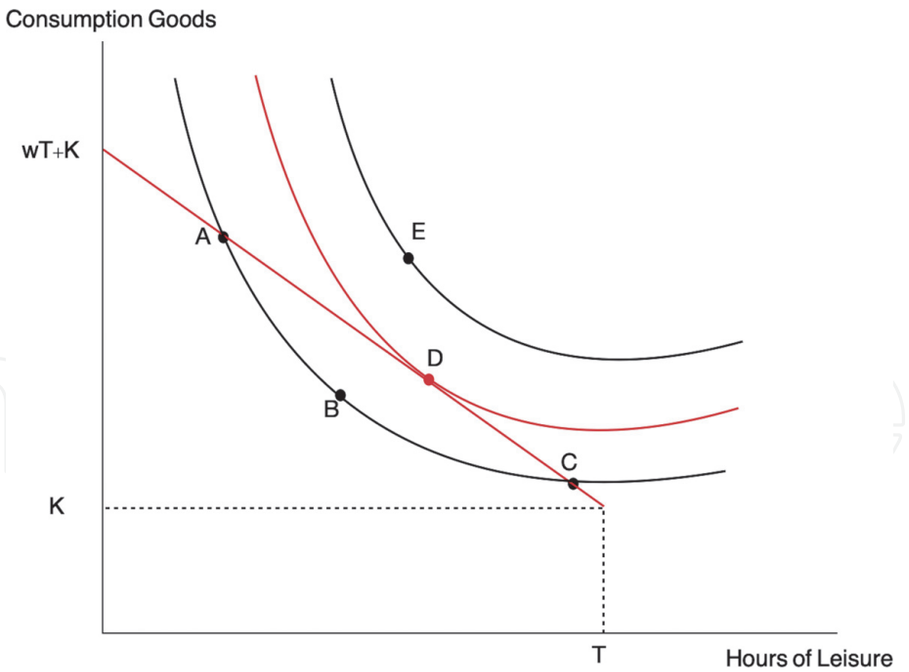

Figure 3.
Worker's optimal choice of the combination of the consumption goods and leisure hours.

work and more leisure because he/she has a higher income to maintain the same standard of living by working less?

- **Substitution effect:** When an individual earns a higher wage rate, the opportunity cost of leisure increases. In other words, leisure is more expensive and the quantity demanded for leisure decreases.

- **Income effect:** When an individual earns a higher wage rate, the income of the individual increases. Since leisure is a normal good, the demand for leisure increases.

Both the substitution and income effects are present for all individuals. When the substitution effect dominates the income effect, a higher wage reduces leisure hours and, therefore, increases work hours. On the other hand, when the income effect dominates the substitution effect, higher wage increases the hours of leisure and, therefore, decreases work hours.

- If substitution effect $>$ income effect: wage $\uparrow \Rightarrow$ hours of leisure $\downarrow \Rightarrow$ hours of work $\uparrow$ (**Figure 4 (a)**).

- If substitution effect $<$ income effect: wage $\uparrow \Rightarrow$ hours of leisure $\uparrow \Rightarrow$ hours of work $\downarrow$ (**Figure 4 (b)**).

3.7 Individual labor supply curve

Figure 5 shows a typical individual labor supply curve. When the hourly wage rate is w_1, the individual is willing to work L_1 hours and spends $T - L_1$ on leisure activities. When the hourly wage rate rises from w_1 to w_2, the individual increases his/her hours of work from L_1 to L_2. The substitution effect dominates the income effect, and the individual is substituting leisure with work. When the hourly wage rate rises from w_2 to w_3, the individual reduces his/her hours of work from L_2 to L_3.

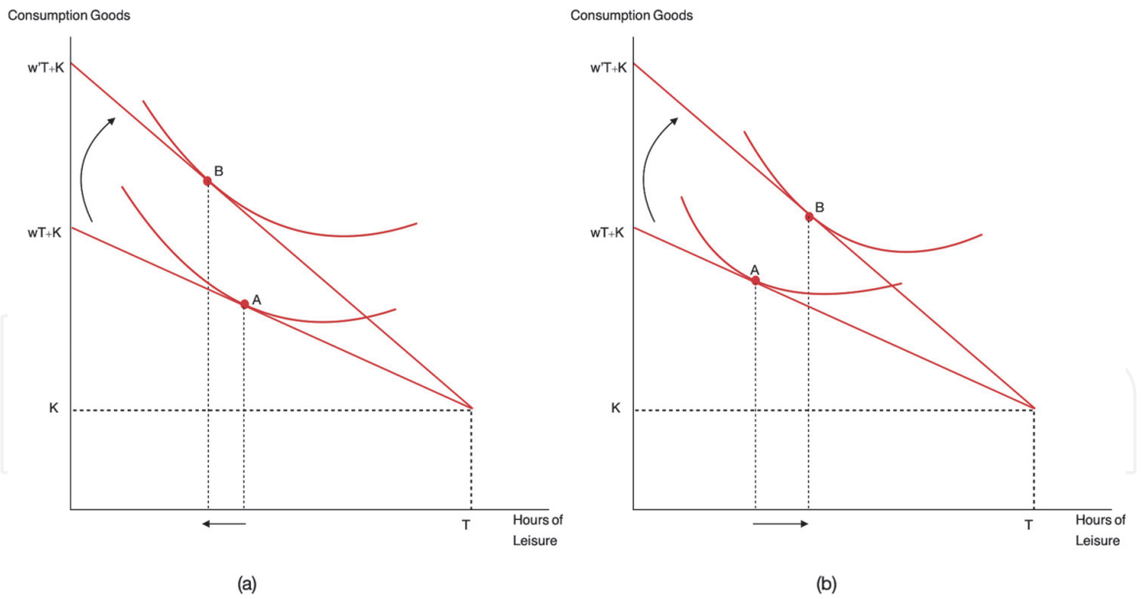

Figure 4.
Substitution and income effects. (a) the substitution effect dominates the income effect, (b) the income effect dominates the substitution effect.

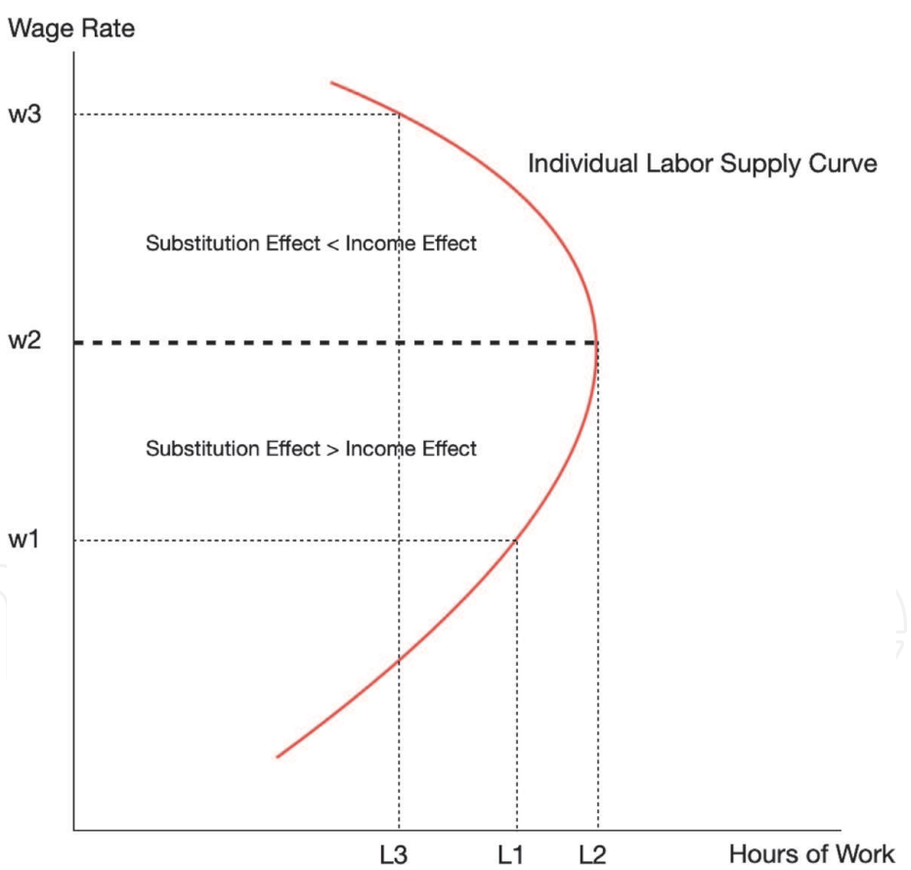

Figure 5.
Individual labor supply curve.

The income effect dominates the substitution effect, and the individual is "buying" more leisure hours.

The substitution effect of a higher wage encourages the individual to work more, while the income effect encourages the individual to work less. Therefore, the individual labor supply curve is *backward-bending*.

Wage rate	Individual 1 (hours of work)	Individual 2 (hours of work)	Individual 3 (hours of work)	Market (hours of work)
$6	5	5	5	15
$12	8	9	9	26
$15	10	7	11	28

Table 2.
Individual and market labor supply.

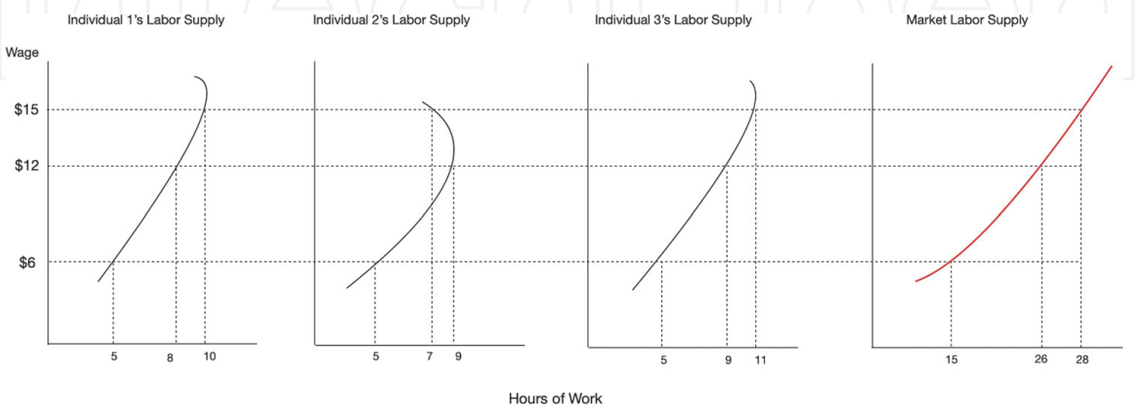

Figure 6.
From the individual labor supply curves to the market labor supply curve.

3.8 Market labor supply curve

The individual labor supply can tell us how many hours an individual is willing to work given different wages. We can add together all the labor supply curves of the individuals to obtain the market labor supply curve.

Table 2 shows the hours of work three different individuals are willing to supply under different wage rates. When the hourly wage rate is $6, all three individuals are willing to work for 5 hours. Thus, the market's supply of work hours is $5 + 5 + 5 = 15$ hours. When the hourly wage rate is $12, all three individuals increase their work hours. The market's supply of work hours is $8 + 9 + 9 = 26$ hours. When the hourly wage rate increases to $15, individuals 1 and 3 increase their work hours, while individual 2 reduces work hours because his income effect dominates the substitution effect. The market's supply of work hours is $10 + 7 + 11 = 28$. The market's supply of work hours is still increasing even individual 2 reduces his work hours.

Figure 6 shows the individual labor supply curves of individuals 1, 2, and 3. We get the market labor supply curve by horizontally adding up all the individual labor supply curves at any wage rate. Although an individual?s labor supply curve is backward-bending, the market labor supply curves usually are upward sloping, as shown in **Figure 6**. Just like the goods and services markets, higher wages mean a higher quantity supplied of labor.

4. The demand of labor

In this section, we will focus on the behavior of the firms. Firms demand labor to use it as an input to produce output. For example, the demand for App developers is

linked to the need to develop new smartphone software. Therefore, unlike goods and services, the demand for labor is a "derived demand."[2]

4.1 Short run vs. long run

We first need to distinguish between the "short-run" and "long-run." However, how short is short, and how long is long? In the study of economics, the short run and the long run do not refer to a specific period, such as 3 months versus 3 years. Instead, they depend on the number of variable and/or fixed inputs that affect the production output [4].

- **The short run** is a period of time in which the quantity of at least one input is fixed and the quantities of the other inputs can be varied [5].

- **The long run** is a period of time in which the quantities of all inputs can be varied [5].

Here, we assume that capital is fixed, while labor is variable. Extra shifts, overtime, and hiring can be relatively easily arranged when more labor is needed. However, it will not be able to employ more capital in the same time frame as capital acquisition takes time.

4.2 Short-run labor demand curve

Imagine a firm in the short run. The capital inputs are fixed. The firm needs to decide how many workers to hire. Hiring an additional worker increases the firm's output and therefore revenue. The output the additional worker contributes is the **marginal product of labor**, MP_L.[3] The revenue by selling the output contributed by the additional worker is the **marginal revenue product of labor**, MRP_L. We assume that the final goods and services markets are perfectly competitive, and the market price of the firm's product is P. Thus,

$$MRP_L = MP_L \times P \tag{5}$$

While hiring the additional worker raises the revenue, the firm has to pay the wage to the worker. The cost of hiring one additional worker is the **marginal wage cost**, MWC. We assume that the labor market is perfectly competitive, and the wage rate is w. Thus,

$$MWC = w \tag{6}$$

If $MRP_L > MWC$, the firm wants to hire more workers because the benefit from hiring an additional worker is greater than the cost. On the other hand, if $MRP_L < MWC$, the firm does not want to hire because the cost from hiring an additional worker is greater than the benefit the firm can receive. The firm has the optimal amount of labor when

$$MRP_L = MWC \tag{7}$$

[2] Derived demand is the demand for intermediate goods that is derived from the demand for the final goods [3].

[3] A firm's production exhibits diminishing marginal product of labor.

or

$$MP_L \times P = w \tag{8}$$

Table 3 assumes that the firm can sell its output at \$50 in a competitive market. When the firm hires the first worker, the worker produces 10 units of output, resulting in a marginal product of labor of 10 units. The marginal revenue product of labor is, therefore, $MPL \times P = \$500$. If the market-determined wage rate is $w = \$500$, the firm will hire one worker.

Assume that the market-determined wage rate is $w = \$300$. The gain from hiring the second worker is \$450, while the cost is \$300. Therefore, the firm will hire a second worker. Similarly, the gain from hiring the third worker is \$400, while the cost is \$300. Therefore, the firm will hire a third worker. In fact, the firm will continue hiring until the gain equals the cost. It results in hiring five workers at $w = \$300$.

By plotting the number of labor (column (1)) on the horizontal axis and wage (column (5)) on the vertical axis, we have a downward sloping short-run labor demand curve (**Figure 7**).

4.3 Long-run labor demand curve

In long run, both labor and capital are variable. Suppose wage increases. How would a firm respond to the increase in wage?

- **Substitution effect:** An increase in wage increases the cost of labor. Since labor is now more expensive relative to capital and assuming that labor and capital are substitutes in production, the firm will use less labor and more capital to produce any output level.

- **Scale effect:** Again, an increase in wage increases the cost of labor, which increases the cost of production. Since a competitive firm sells its product at a market-determined price, a higher production cost reduces its output level. Therefore, the firm will use less labor and capital.

Number of labor	Quantity of output	MP_L	Price of output	$MRP_L = w$
0	0	—	\$50	—
1	10	10	\$50	\$500
2	19	9	\$50	\$450
3	27	8	\$50	\$400
4	34	7	\$50	\$350
5	40	6	\$50	\$300
6	45	5	\$50	\$250
7	49	4	\$50	\$200
8	52	3	\$50	\$150
9	54	2	\$50	\$100
10	55	1	\$50	\$50

Table 3.
Firm's short-run hiring decision.

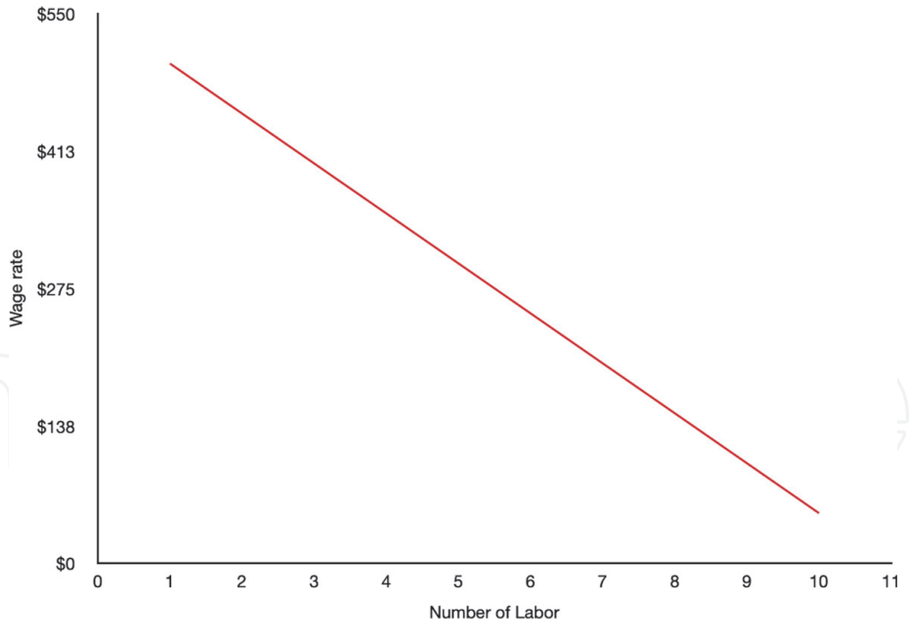

Figure 7.
Short-run labor demand curve.

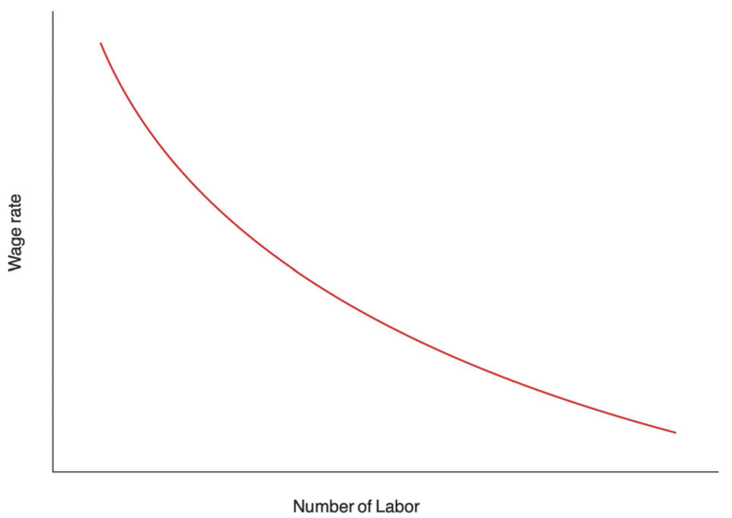

Figure 8.
Long-run labor demand curve.

When wage increases, both the substitution effect and scale effect cause the demand for labor to decrease. Thus, wage and demand for labor are negatively related in the long run, which means the long-run labor demand curve is also downward sloping (**Figure 8**).

5. Competitive labor market equilibrium

One of the most important implications of the perfectly competitive assumptions is that buyers and sellers are price takers. In other words, all the firms (buyers of labor) and workers (sellers of labor) in a perfectly competitive labor market accept the market price (wage) as given. No firm and worker has any influence over the market wage.

However, if all the firms and workers cannot influence the wage, who sets the wage? In fact, in a perfectly competitive market, the demand and supply of labor

together determine the market wage and the trading quantity of labor (employment).

When a competitive labor market is in equilibrium, the quantity supplied for labor equals the quantity demanded for labor at the market wage. **Figure 9** combines the supply and demand for labor in a perfectly competitive labor market. In **Figure 9**, the competitive labor market equilibrium is where the labor supply and demand curves cross. The equilibrium wage is $20 per hour, and the equilibrium employment level is 300 workers.

If the wage rate is above $20, as shown in **Figure 10 (a)**, the quantity supplied for labor is greater than the quantity demanded. The excess supply is known as a surplus. It means some of the workers cannot find a job. In order to find a job, those workers would accept a lower wage rate. As wage falls, the quantity demanded for labor rises and the quantity supplied falls until the market reaches equilibrium at point E.

If the wage rate is below $20, as shown in **Figure 10 (b)**, the quantity demanded for labor is greater than the quantity supplied. The excess demand is known as a shortage. It means some of the firms cannot find workers. In order to find workers,

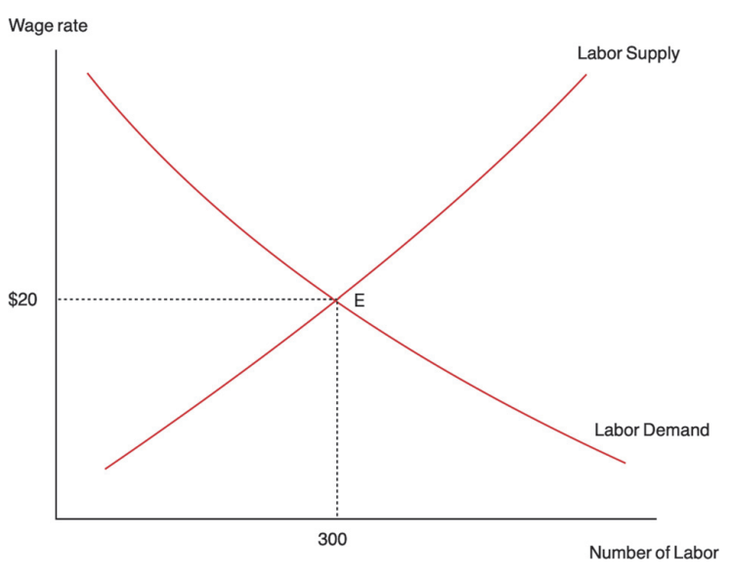

Figure 9.
Competitive labor market equilibrium.

Figure 10.
Why the intersection of the labor supply and demand is the equilibrium. (a) the quantity supplied for labor is greater than the quantity demanded (b) the quantity supplied for labor is less than the quantity demanded.

those firms would offer a higher wage rate. As wage rises, the quantity demanded for labor falls and the quantity supplied rises until the market reaches equilibrium at point E.

Notice that both the supply and the demand together bring the wage back to $20 per hour. When the wage is at $20 per hour, no worker has an incentive to accept a lower wage, and no firm has an incentive to offer a higher wage. Therefore, the equilibrium wage is $20 per hour.

6. Policy application: Immigration

Immigrant workers can either be substitutes for native-born workers or complements to them. When immigrant workers are perfect substitutes for native-born workers, they have the same skills and compete for the same jobs. Thus, an influx of immigrant workers increases the labor supply, shifting the labor supply curve to the right.

The impact of immigration on the labor market when immigrant workers are substitutes for native-born workers is illustrated in **Figure 11 (a)**. As the immigrants enter the labor market, the labor supply curve shifts to the right, increasing the total employment from 300 to 320. In addition, the hourly wage rate decreases from $20 to $18. Because many immigrants are low-skilled workers, economic studies have found that an influx of immigrants depresses wages for low-skilled native-born workers in the short run. And, because many immigrants are also high-skilled, a similar substitution effect occurs for some high-skilled workers [6]. Since native workers are less likely to accept the lower wage, the employment of native workers decreases.

However, when workers are complementary, an influx of immigrant workers can increase the productivity of the native workers. Thus, an increase in immigrant labor can raise the demand for native workers.

The impact of immigration on the labor market when immigrant workers are complements for native-born workers is illustrated in **Figure 11 (b)**. As the immigrants enter the labor market, the labor demand curve for native workers shifts to the right, increasing the total employment of native workers from 300 to 330. In addition, the hourly wage rate of native workers also increases from $20 to $23.

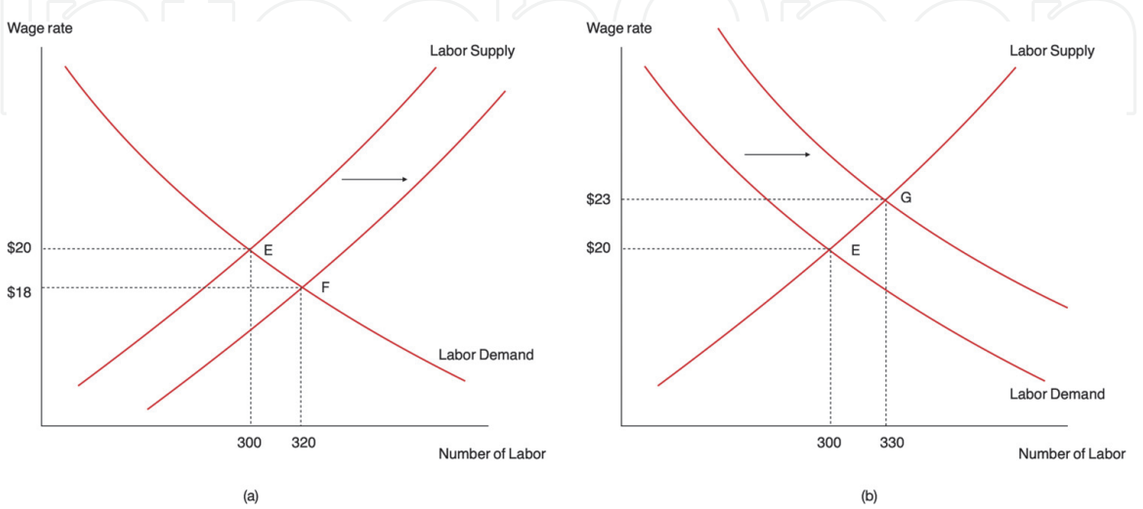

Figure 11.
The impacts of immigration on labor market. (a) the impact of immigration on the labor market when immigrant workers are substitutes for native-born workers, (b) the impact of immigration on the labor market when immigrant workers are complements for native-born workers.

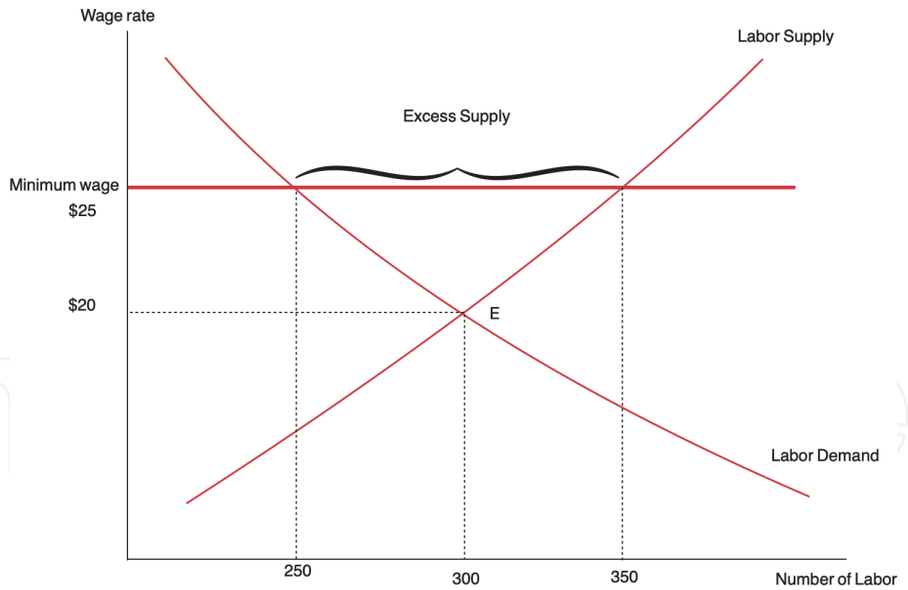

Figure 12.
The impacts of minimum wage on labor market.

7. Policy application: Minimum wage

Minimum wage is a government-mandated lowest wage rate an employer can pay an employee. If the minimum wage is below the market equilibrium wage, it is not binding and will not impact the market equilibrium. When the minimum wage is above the market equilibrium wage, the hourly wage rate cannot legally fall below the minimum wage rate.

Figure 12 shows the economic impact of the minimum wage. Before the minimum wage, the equilibrium wage rate is $20 per hour, and the total employment is 300. When the government implements the minimum wage, the lowest wage rate the firms can offer is $25 per hour. The workers are willing to supply 350 hours at the mandated minimum wage the firms only demand 250 hours. That is, there is an excess supply of labor in the labor market.

8. Conclusion

In this chapter, we have studied the labor market. Just like the goods and services markets, the labor market consists of supply and demand. We saw that the backward-bending nature of the labor supply curve arises from people's decisions between work and leisure. We also learned that the downward-sloping nature of the labor demand curve arises from the fixed amount of capital. The interaction of labor supply with demand determines the market equilibrium wage and total employment. Using this perfectly competitive labor market model, we examined the impacts of immigration and minimum wage on the labor market. Although the labor market, in reality, can be very complicated, the simplified model can assist us in understanding the core of the labor market.

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