Key Concepts

Real GDP and Employment

A production possibility frontier between real GDP and leisure shows that GDP can be increased if time spent at leisure is decreased, that is, if employment increases. The production function shows the relationship between real GDP and the quantity of labor employed when all other influences in production remain the same. A production function is illustrated in Figure 7.1.

- When employment increases, there is a movement along the production function, as illustrated by the movement from point $a$ to point $b$ along $PF_0$.

An increase in labor productivity, real GDP per hour of work, shifts the production function upward, as illustrated by the shift from $PF_0$ to $PF_1$. Labor productivity increases with:

- increases in physical capital;
- increases in human capital, people’s skill and training obtained from education and on-the-job training via learning-by-doing;
- increase in technology.

In the United States, capital accumulation and technological change have shifted the production function upward.

Labor Market and Aggregate Supply

The demand for labor and the supply of labor depend on the real wage rate, the quantity of goods and services an hour of labor earns. The money wage rate is the number of dollars an hour of labor earns.

- The real wage rate equals the money wage rate divided by the price level.

The demand for labor is the relationship between the real wage rate and the quantity of labor firms demand, where the quantity of labor demanded is the number of labor hours hired by all the firms in the economy. As the real wage rate increases, the quantity of labor demanded decreases.

- The marginal product of labor is the additional real GDP produced by an additional hour of labor. The law of diminishing returns points out that as the quantity of labor increases, other things the same, the marginal product diminishes.

- Because the marginal product of labor diminishes as employment increases, firms will hire additional workers only if the real wage rate falls. Thus the labor demand curve, $LD$, slopes downward, as illustrated in Figure 7.2 (on the next page).

- The demand for labor increases when the marginal product of labor increases.
The supply of labor is the relationship between the quantity of labor supplied and the real wage rate when all other influences on work plans remain the same.

- The labor supply curve, $LS$, slopes upward, as illustrated in Figure 7.2, because higher real wage rates increase the amount of goods and services that can be purchased for an hour's work.

In Figure 7.2 the equilibrium real wage rate is $35 per hour and equilibrium employment is 200 billion hours.

- The equilibrium quantity of employment from the labor market and the production function determine potential GDP. The long-run aggregate supply curve, $LAS$, is the relationship between the quantity of real GDP supplied and the price level when real GDP equals potential GDP. The $LAS$ curve is vertical at potential GDP.

- In the short run, the labor market can depart from full employment. The short-run aggregate supply curve, $SAS$, is the relationship between the quantity of real GDP supplied and the price level when the money wage rate and potential GDP remain constant. The $SAS$ curve is upward sloping.

- If the price level rises and the money wage does not change, the real wage falls. Firms hire more workers, real GDP increases and the economy moves along the $SAS$ curve. A shortage of labor results so that the money wage rate rises. Eventually the real wage rate returns to its equilibrium and GDP again equals potential GDP.

### Changes in Potential GDP

Real GDP increases if the economy recovers from a recession or it potential GDP increases. Potential GDP increases if the population increases or if labor productivity increases.

- An increase in population increases the supply of labor so that the labor supply curve shifts rightward. The production function does not shift. Employment increases and the economy moves along its (unchanged) production function to a higher level of potential GDP.

- An increase in labor productivity (because of an increase in physical capital, human capital, or technology) shifts the production function upward and increases the demand for labor. Employment increases because of the increase in demand for labor. Potential GDP increases because employment increases and because the production function has shifted upward.

In the United States, over the last twenty years, the population increased, thereby increasing the supply of labor. The demand for labor increased because the capital stock increased and because technology advanced. Both these last two factors increased productivity and thus shifted the production function upward. So potential GDP has increased because equilibrium employment has increased and because the production function has shifted upward.

### Unemployment at Full Employment

Two factors help explain why unemployment is always present even at full employment (when the unemployment rate equals the natural rate of unemployment):

- **Job search** — the activity of looking for an acceptable vacant job. The length of time spent searching, and hence the natural rate of unemployment, increases when more young people enter the labor market; when unemployment compensation payments become more generous; and when structural change in the economy increases.

- **Job rationing** — paying workers an above-equilibrium wage rate and then rationing jobs by some method. Jobs can be rationed because of efficiency wages (paying a higher wage rate to increase productivity) or because of a minimum wage law (which sets the lowest legal wage a firm can pay) that prevents some workers from finding jobs.
Helpful Hints

1. FROM THE LABOR MARKET TO POTENTIAL GDP:
The production function stands between the labor market and the aggregate output market. The equilibrium level of employment is determined in the labor market and then the production function indicates how much output results from that level of employment.

The labor market functions like the “typical” supply and demand markets you studied in Chapter 3. Everything you learned there about how to use the supply and demand model applies to the labor market in this chapter. In particular, the key difference between shifts in a curve versus movements along a curve continues to apply: Changes in the real wage rate create movements along the labor demand and labor supply curves while other relevant factors shift these curves.

2. PRODUCTION FUNCTION:
The production function graphically illustrates the relationship between the amount of labor employment and the level of real GDP.

In the next chapters you will meet a similar concept, the “productivity function”. The productivity function relates output per hour of work to capital per hour of work. Graphically, the productivity function appears similar to the production function. The productivity function is related to the production function but it is not the same. Thoroughly study the production function now so that you are not confused between the two when you study the productivity function.

Questions

True/False and Explain

Real GDP and Employment
1. If the production possibilities frontier does not shift, real GDP can be increased only if leisure is increased.
2. An increase in employment causes a movement along the production function.
3. Labor productivity increases when the amount of the nation’s human capital increases.
4. Learning-by-doing increases the nation’s physical capital.
5. In the United States, there have been movements along the U.S. production function but no shifts in the function.

Labor Market and Aggregate Supply
6. The demand for labor curve is downward sloping.
7. As more workers are employed, the marginal product of labor increases.
8. A rise in the real wage rate increases the quantity of labor supplied.
9. When employment equals the equilibrium quantity, the economy is on its LAS curve.

Changes in Potential GDP
10. An increase in the demand for labor raises the real wage rate.
11. An increase in the demand for labor increases potential GDP.
12. An increase in the nation’s physical capital stock decreases the demand for labor.
13. An increase in labor productivity shifts the production function downward and decreases the quantity of employment.
14. Since 1980 in the United States, the supply of labor has increased more than the demand for labor.

Unemployment at Full Employment
15. When the unemployment rate equals the natural rate, there is no job search.
16. An increase in unemployment compensation will decrease job search.
17. Efficiency wages can be a cause of unemployment.

Multiple Choice

Real GDP and Employment
1. The production possibilities frontier between real GDP and leisure
   a. shifts inward when the capital stock increases because unemployment rises.
   b. shows that increasing leisure will decrease real GDP.
   c. shifts if employment increases.
   d. All of the above answers are correct.
2. Which of the following shifts the nation’s production function upward?
   a. An increase in employment.
   b. A decrease in employment.
   c. An increase in human capital.
   d. A decrease in human capital.

3. A movement along the production function with no shift in the production function is created by
   a. changes in the amount of physical capital.
   b. changes in the amount of human capital.
   c. advances in technology.
   d. changes in employment.

4. Between 1980 and 2001, the U.S. production function shifted ____ and the quantity of labor hours ____.
   a. upward; increased
   b. upward; decreased
   c. downward; increased
   d. downward; decreased

5. The money wage rate is $10 per hour and the price level is 100. If the price level rises to 200 and the money wage rate does not change, what happens to the real wage rate?
   a. The real wage rate doubles.
   b. The real wage rate rises, but does not double.
   c. The real wage rate does not change.
   d. The real wage rate falls.

6. Five workers produce total output of $200; six workers produce total output of $222. The marginal product of the sixth worker equals
   a. $40.
   b. $37.
   c. $22.
   d. None of the above answers is correct.

7. The demand curve for labor is downward sloping because the
   a. marginal product of labor diminishes as more workers are employed.
   b. supply curve of labor is upward sloping.
   c. demand curve shifts when capital increases.
   d. None of the above answers are correct because the demand curve for labor is upward sloping.

8. As the real wage rate increases, the quantity of labor supplied increases
   a. only because people already working increase the quantity of labor they supply.
   b. only because the higher wage rate increases labor force participation.
   c. because people already working increase the quantity of labor they supply and because the higher wage rate increases labor force participation.
   d. None of the above answers is correct because an increase in the real wage rate decreases the quantity of labor supplied.

9. A rise in the real wage rate
   a. shifts the labor demand curve rightward.
   b. shifts the labor demand curve leftward.
   c. shifts the labor supply curve leftward.
   d. does not shift the labor demand or labor supply curve.

10. If the economy is at full employment, the
    a. entire population is employed.
    b. entire labor force is employed.
    c. long-run aggregate supply curve is upward sloping.
    d. the quantity of labor supplied equals the quantity of labor demanded.

11. At potential GDP,
    a. the labor market is in equilibrium, with the quantity of labor demanded equal to the quantity supplied.
    b. there is no necessary relationship between the quantity of labor demanded and the quantity supplied.
    c. the real wage has adjusted so that it equals the money wage.
    d. the real wage rate must be rising because otherwise people will not work.

12. An increase in population shifts the
    a. labor demand curve rightward.
    b. labor demand curve leftward.
    c. labor supply curve rightward.
    d. labor supply curve leftward.
13. An increase in productivity from new technology shifts the production function ____ and shifts the demand for labor curve ____.
   a. upward; rightward
   b. upward; leftward
   c. downward; rightward
   d. downward; leftward

14. An increase in the demand for labor ____ the real wage and ____ the quantity of employment.
   a. raises; increases
   b. raises; decreases
   c. lowers; increases
   d. lowers; decreases

15. Which of the following will NOT increase labor productivity?
   a. An increase in physical capital.
   b. An increase in human capital.
   c. An increase in employment.
   d. An advance in technology.

16. In the United States, from 1981 to 2001, the demand for labor has
   a. increased more than the supply of labor has increased.
   b. increased less than the supply of labor increased.
   c. increased while the supply of labor has decreased.
   d. decreased while the supply of labor has increased.

17. The demand for labor and the supply of labor are both increasing over time, but the demand for labor is increasing at a faster rate. Over time, therefore, you would expect to see the real wage rate ____ and employment ____.
   a. rise; increase
   b. rise; decrease
   c. fall; increase
   d. fall; decrease

19. Which of the following is a reason that jobs might be rationed?
   a. Efficiency wages
   b. Equilibrium real wage rate.
   c. The vertical LAS curve.
   d. An increase in the demand for labor

20. An efficiency wage refers to
   a. workers being paid wages below the equilibrium wage rate in order to increase the economy’s efficiency.
   b. wages being set to generate the efficient level of unemployment.
   c. workers being paid wages above the equilibrium wage rate in order to increase their productivity.
   d. None of the above.

21. Suppose that the real wage rate is above the equilibrium real wage rate. Then the quantity demanded of labor ____ the quantity supplied of labor and there ____ unemployment.
   a. is more than; is
   b. is more than; is not
   c. is less than; is not
   d. is less than; is

Unemployment at Full Employment

18. An increase in unemployment compensation payments will
   a. decrease the extent of search unemployment.
   b. lead to more job rationing.
   c. decrease the extent of demographic change.
   d. increase the length of time a worker searches for a job.

19. Which of the following is a reason that jobs might be rationed?
   a. Efficiency wages
   b. Equilibrium real wage rate.
   c. The vertical LAS curve.
   d. An increase in the demand for labor

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   c. workers being paid wages above the equilibrium wage rate in order to increase their productivity.
   d. None of the above.

21. Suppose that the real wage rate is above the equilibrium real wage rate. Then the quantity demanded of labor ____ the quantity supplied of labor and there ____ unemployment.
   a. is more than; is
   b. is more than; is not
   c. is less than; is not
   d. is less than; is

Short Answer Problems

1. What is the connection between the production possibilities frontier showing the relationship between leisure and real GDP and the production function showing the relationship between employment and real GDP?

2. a. What does diminishing returns mean?
   b. Moving along a production function, why does the marginal product of labor diminish as employment increases?

3. Why is the marginal product of labor curve the same as the labor demand curve? What does this equality imply for the slope of the labor demand curve?

4. a. What is the real wage rate? How does it differ from the money rate? How is the real wage rate constructed?
   b. Why does the supply of labor depend on the real wage rate rather than the money wage rate?
5. In Figure 7.3 what is the equilibrium real wage rate? Illustrate a real wage rate at which jobs are rationed. Indicate the amount of unemployment.

6. What can account for job rationing?

7. Suppose that new technology shifts the production function upward and increases labor productivity. Using Figures 7.4 and 7.5, show what happens in both. Does the equilibrium quantity of employment rise or fall? Does real GDP increase or decrease?

You’re the Teacher

1. “Look, I really studied this chapter, but why bother? I mean, I thought we were going to be learning about stuff like money, and recessions, and stuff like that. I know that unemployment is important, but why do we bother to study unemployment at full employment?” It is undoubtedly good that your friend has been studying this chapter, but it undoubtedly would be better if your friend understood why this chapter is important. Can you help your friend grasp this key point?
Answers

True/False Answers

Real GDP and Employment
1. F Increasing leisure decreases employment and hence decreases real GDP.
2. T An increase in employment causes a movement along the production function to a higher level of real GDP.
3. T When productivity increases, the nation’s production function shifts upward.
4. F Learning-by-doing increases human capital, not physical capital.
5. F The U.S. production function has shifted upward because of increases in capital and advances in technology.

Labor Market and Aggregate Supply
6. T The demand for labor curve is downward sloping because the marginal product of labor diminishes as more workers are employed.
7. F As more workers are employed, the marginal product diminishes.
8. T If the real wage rate rises, more workers enter the labor force and workers already in the labor force supply more hours of work.
9. T Equilibrium employment is full employment, which means the economy is at potential GDP on its LAS curve.

Changes in Potential GDP
10. T An increase in the demand for labor raises both the real wage rate and employment.
11. T Because an increase in the demand for labor increases employment, it also increases potential GDP.
12. F An increase in capital raises the marginal product of labor, which increases the demand for labor.
13. F An increase in productivity shifts the production function upward and increases the quantity of employment.
14. F The demand for labor has increased by more than the supply of labor and, as a result, the real wage has risen.

Unemployment at Full Employment
15. F Job search always exists.
16. F An increase in unemployment compensation creates more job search and hence increases unemployment.
17. T When wages are set above the equilibrium level, unemployment results.

Multiple Choice Answers

Real GDP and Employment
1. b If leisure increases, people are spending less time at work. As a result, real GDP decreases.
2. c Changes in employment, answers (a) and (b), create movements along the production function. An increase in human capital shifts the production function upward.
3. d As the previous answer pointed out, changes in employment create a movement along the production function. Changes in other relevant factors shift the production function.
4. a The production function shifted upward because of increases in productivity.

Labor Market and Aggregate Supply
5. d The real wage rate equals the money wage rate divided by the price level so when the price level rises and the money wage rate does not change, the real wage rate falls.
6. c The marginal product of labor equals the change in output divided by the change in employment, or, in this case, \( \frac{222 - 200}{6 - 5} = 22 \).
7. a The demand for labor curve is the same as the marginal product of labor curve.
8. c For both reasons given in the answer, the supply of labor curve is upward sloping, indicating that an increase in the real wage rate increases the quantity of labor supplied.
9. d A change in the real wage rate creates a movement along the labor demand and labor supply curves but does not shift either curve.
10. d When the labor market is in equilibrium, the economy is at full employment.
11. a When the labor market is in equilibrium — the quantity of labor supplied equals the quantity of labor demanded — the economy is producing its potential GDP.
Changes in Potential GDP

12. c With more people, the supply of labor increases.

13. a The increase in productivity increases the marginal product of labor, which shifts the demand for labor curve rightward.

14. a As Figure 7.6 illustrates, the increase in the demand for labor is reflected in the rightward shift in the demand curve from \( LD_0 \) to \( LD_1 \). The wage rate rises from $10 an hour to $15 and the level of employment increases from 100 billion hours to 150 billion. This answer demonstrates how an increase in productivity and the resulting increase in the demand for labor (the last question) results in a higher real wage rate.

![Figure 7.6](image)

**Multiple Choice Question 14**

15. c By itself, an increase in employment will create a movement along the production function to a lower level of productivity.

16. a Because the demand for labor has increased more than the supply of labor, the real wage rate has risen.

17. a The situation outlined in the question is what occurred in the United States, so in the United States employment and the real wage rate have increased.

Unemployment at Full Employment

18. d Unemployment compensation payments reduce the cost of being unemployed, so an increase in these payments makes unemployed workers more willing to search for longer periods of time to find better jobs.

19. a Efficiency wages and the minimum wage both can lead to job rationing.

20. c Answer (c) is the definition of an efficiency wage.

21. d With the real wage rate above the equilibrium wage rate, there are workers who cannot find jobs and these workers are unemployed.

**Answers to Short Answer Problems**

1. The production possibilities frontier and the production function are basically opposite sides of the same coin.

   The production possibilities frontier shows that if leisure is decreased — so that employment is increased — then real GDP increases. Because of increasing opportunity cost, the production possibilities frontier also shows that as more additional time is spent in employment, the additional GDP that results diminishes.

   The production function shows similar results. The production function demonstrates that if employment increases, real GDP increases. Because of diminishing returns, the production function also shows that as employment increases, the additional GDP that results diminishes.

2. a. Diminishing returns means that as the quantity of labor increases, the additional GDP that results diminishes. In other words, the 1,000,001st hour of labor by itself creates less additional GDP than does the 1,000,000th hour of labor.

   b. Moving along a production function, the marginal product of labor diminishes because along the production function the amount of the capital stock and technology are constant. Thus additional labor must work with the same number of factories, assembly lines, and so forth. In this situation, an added worker might not create much additional output because the assembly lines, machine tools, and so forth are already efficiently stocked with enough workers.

3. The marginal product of labor is the same as the labor demand curve because firms want to earn the maximum possible profit. When a firm is considering hiring another worker, the firm looks at two factors: How much it costs to hire the worker and
how much the worker adds to the firm’s output. If the worker adds more to the firm’s output than it costs to hire the worker, the firm will employ the worker. (Conversely, if it costs more to hire the worker than the worker adds to output, the firm will not hire the worker.)

The cost of hiring another worker is the real wage rate. And, the amount of output that the worker produces is the marginal product of labor. If the marginal product exceeds the real wage rate, the firm hires the worker because it is profitable. As the firm hires more and more workers, the marginal product of labor diminishes. But, as long as the marginal product exceeds the real wage rate, the firm hires the workers because by so doing the firm raises its profit. Eventually the firm hires enough workers so that the marginal product of an additional worker just equals the real wage. The firm will hire this worker but will hire no more workers because for all additional workers the marginal product of labor would be less than the real wage rate. So the quantity of workers that the firm hires is determined by the marginal product of labor curve, so that the quantity hired is given by the marginal product of labor curve. But the quantity of workers the firm hires is the same as the quantity it demands, so therefore the marginal product of labor curve is the same as the labor demand curve.

4. a. The real wage rate shows the quantity of goods and services that can be purchased with an hour’s labor. The money wage rate is the quantity of money received for an hour’s labor. The real wage rate is defined as the money wage rate divided by the price level.

b. The supply of labor depends on the real wage rate because workers are interested in what they can buy in exchange for their work. The money wage rate just shows the number of dollar bills that the worker will receive for an hour’s labor. But the worker is concerned with what can be purchased with these dollar bills, which is what the real wage rate indicates.

5. In Figure 7.7 the equilibrium wage rate is $15 an hour. Any wage rate higher than the equilibrium wage rate creates some job rationing. For instance, at the wage rate of $20 an hour, the demand for labor is only 100 billion hours of labor, yet at this wage rate 200 billion hours of labor are supplied. At this wage rate unemployment is 100 billion hours of labor.

More generally, at any wage rate, the extent of unemployment equals the difference between the quantity of labor supplied and the quantity demanded.

6. Two factors can account for job rationing: efficiency wages and the minimum wage.

Efficiency wages occur when firms pay above-equilibrium wage rates to increase their workers’ productivity. Firms might pay a wage rate that exceeds the equilibrium wage rate knowing that, although the higher wage rate increases their costs, this effect is more than offset by the higher productivity of the workers receiving the higher wage rate. Finally, the minimum wage might be at a level that is above the equilibrium wage rate. In this case the quantity of labor demanded is less than that supplied, and jobs are rationed because not everyone who wants to work at the going (minimum) wage rate can find employment.

7. Start with the production function, illustrated in Figure 7.8 (on the next page). The upward shift and increase in productivity are illustrated. (Your diagram does not need to look exactly like what is illustrated, but the production function must shift upward and become steeper.)

The key feature of this change is that labor productivity increased, so the change increases the demand for labor. Hence in Figure 7.9, the demand for
labor curve has shifted rightward, from $LD_0$ to $LD_1$. (Your figure does not need to look exactly like Figure 7.9, as long as the labor demand curve has shifted rightward.) As a result, the equilibrium quantity of employment increases, to 300 billion hours, and the equilibrium real wage rate rises, to $21 per hour in the figure.

GDP changes for two reasons: First, the production function has shifted upward, so even if employment did not change, GDP would increase. But, employment does increase. Thus as Figure 7.8 demonstrates, GDP increases from $7 trillion to $12 trillion as the economy moves from point $a$ on production function $PF_0$ to point $b$ on production function $PF_1$.

You’re the Teacher

1. “Well the things you mentioned, money, recessions, and so on are important and when I flip through the book I see that we’ll get to them a little later in the class. But they are not the only really important macroeconomic topics. I mean, one of the really important topics is economic growth, how rapidly our economy grows. And it’s this topic that this chapter is concerned about.

“Look, here’s how I see it. We want to know how fast our economy can grow and what we can do to make sure that it grows at the best speed possible, right? Well, economic growth basically depends on two things: the resources our nation has and the technology we can use. Well, one of the most important resources is labor and this chapter is focusing on that. This chapter helped me understand what factors change the equilibrium amount of labor, like the productivity growth. I mean, productivity has to be important because it not only increases the demand for labor and so increases the amount of labor that will be employed, but it also increases our real wages.

“And look, I’ve been talking with our teacher again and our teacher said that this chapter and the next two concentrate on economic growth. This chapter talks about one resource, labor. The next covers another resource, capital. And the one after that puts all this together with a discussion of technology. So, this chapter is part of an important group.

“So, don’t get upset because we aren’t talking about money or recessions or other stuff yet. Be patient; we’ll get there. But in the meantime let’s settle back and learn all about economic growth!”
Chapter Quiz

1. A nation’s production function shifts upward if
   a. employment increases.
   b. employment decreases.
   c. human capital increases.
   d. physical capital decreases.

2. Diminishing marginal product of labor means that
   a. the supply of labor curve is upward sloping so that a higher real wage increases the quantity of labor supplied.
   b. as more labor is employed, GDP decreases.
   c. the demand for labor curve is upward sloping.
   d. as more labor is employed, the additional amount of GDP produced diminishes.

3. If the money wage rate rises and the price level does not change, the real wage rate
   a. increase.
   b. do not change.
   c. decrease.
   d. probably change, but without knowledge of the labor demand and labor supply, it is impossible to tell the direction.

4. When the economy producing more than potential GDP,
   a. the labor market is in equilibrium.
   b. the real wage rate is below the equilibrium real wage rate.
   c. the real wage rate is above the equilibrium real wage rate.
   d. None of the above answers are correct.

5. If the demand for labor increases, the equilibrium quantity of employment ___ and potential GDP ___.
   a. increases; increases
   b. increases; decreases
   c. decreases; increases
   d. decreases; decreases

6. In the United States, from 1981 to 2001, which of the following accurately describes what occurred?
   a. Employment increased because population growth increased the labor supply and technological change increased the demand for labor.
   b. Employment decreased because population growth lead to increased amounts of unemployment and technological change decreased the demand for labor.
   c. Employment grew because population growth increased the supply of labor but the real wage fell because technological change decreased the demand for labor.
   d. None of the above answers are correct.

7. The demand for labor is ____ sloped; the supply of labor curve is ____ sloped.
   a. positively; positively
   b. positively; negatively
   c. negatively; positively
   d. negatively; negatively

8. If the supply of labor increases more than the demand for labor, then the real wage rate ____ and the level of employment ____.
   a. rises; increases
   b. rises; decreases
   c. falls; increases
   d. falls; decreases

9. Job search occurs
   a. only when the supply of labor increases.
   b. only when the quantity of labor demanded exceeds the quantity of labor supplied.
   c. only when the quantity of labor supplied exceeds the quantity of labor demanded.
   d. at all times.

10. Job search increases if
   a. the minimum wage falls.
   b. efficiency wages are lowered.
   c. unemployment compensation payments increase.
   d. the demand for labor increases.

The answers for this Chapter Quiz are on page 309