Chapter 8 when workers had to contend with jobs offering different risks of fatal injury. The similarity in analyses suggests that the higher wages associated with education can also be viewed as a **compensating differential** workers receive for undertaking the costs of education.

### Review Questions

Choose the letter that represents the **BEST** response.

**The Benefits and Costs of an Educational Investment**

1. Which of the following benefits is typically considered to be part of an individual’s return on his or her educational investment?
   a. higher wages
   b. increased likelihood of on-the-job training
   c. increased satisfaction from participation in nonmarket activities
   d. all of the above

2. Which of the following costs is typically considered to be associated with an individual’s educational investment?
   a. expenditures for tuition and books
   b. earnings forgone while in school
   c. the effort expended attending class and studying
   d. all of the above

3. Benefits that are received in the future must be discounted (put on a present value basis) before they can be compared with benefits that accrue today because
   a. inflation erodes the purchasing power of dollars received in the future.
   b. dollars received today can be invested.
   c. the future is uncertain, people prefer to consume benefits earlier.
   d. both b and c.

4. Assuming the discount rate is 6%, what is the present value of $1,000 received 10 years from now?
   a. $558.39
   b. $564.47
   c. $625
   d. $943.40

5. Suppose that a college education will raise the average earnings of a typical individual by $10,000, relative to those of a high school graduate, over each of the next 40 years. If the interest rate is 6%, what is the present value of the monetary benefits to a college education?
   a. $150,462.97
   b. $166,666.67
   c. $377,358.49
   d. $424,000
6. Consider a training program that will result in a worker receiving a one-time bonus of $2,500 two years from now. The cost of the training program is $2,000. What is the internal rate of return on this investment?
   a. 4.9%
   b. 11.8%
   c. 21.4%
   d. 25%

7. Holding all else constant, which of the following factors would tend to make educational investments more attractive?
   a. An increase in the discount rate (r)
   b. An increase in the wage earned by high school graduates
   c. An increase in the age at which people retire
   d. A decrease in the scores earned by high school students on tests like the Scholastic Aptitude Test (SAT)

8. According to data presented in the text, college enrollment rates for women rose during the 1970s even though the average earnings of college graduates fell relative to high school graduates during this period. These facts do not contradict the human capital theory of investment because
   a. the discount rate used by women was rising.
   b. as women have worked more outside the home, the time period over which the investment can be recovered has lengthened.
   c. the cost of college was falling.
   d. all of the above.

**Signaling in the Labor Market**

In answering Questions 9–12 please refer to Figure 9-3, which shows the present value of lifetime earnings (PVE) firms are willing to offer to workers who have attained different levels of education. Those workers who have completed 16 years or more of education (4 or more years after high school) will be offered a wage leading to a present value of lifetime income of $2,000,000 (PVE2), while those completing less than 16 years of education will be offered a wage leading to a present value of lifetime income equal to $1,000,000 (PVE1). Lines CA and CB show the total cost of different levels of education for two types of workers. Type A workers are low-productivity workers while type B workers are high-productivity workers.
9. The optimal level of education for a type A worker is
   a. 12 years.
   b. 14.5 years.
   c. 16 years.
   d. 20 years.

10. The optimal level of education for a type B worker is
    a. 12 years.
    b. 14.5 years.
    c. 16 years.
    d. 20 years.

11. Based on the levels of education chosen by each group of workers, one can conclude that
    a. 16 years of education is not an effective signal since no worker has an incentive to attain that level of education.
    b. 16 years of education is not an effective signal since all workers have an incentive to attain that level of education.
    c. making 16 years of education the qualification for the higher paying job will effectively distinguish high-productivity workers from low-productivity workers.
    d. there is no way that educational attainment can effectively distinguish high-productivity workers from low-productivity workers.

12. From society’s point of view, the optimal level of education to distinguish high-productivity workers from low-productivity workers would be
    a. slightly more than 12 years.
    b. slightly more than 14.5 years.
    c. 16 years.
    d. when education only has signaling value, there is no optimal level from society’s point of view.

**Education, Earnings, and Post-Schooling Investments**

13. Age-earnings profiles, especially those for men, tend to be very steep early on and then flatten out. According to the human capital investment framework, this occurs because
    a. on-the-job training investments have a higher payoff for younger workers.
    b. on-the-job training investments that lead to the acquisition of general skill will be paid for by workers in the form of lower wages.
    c. on-the-job training investments lead to new skills and subsequently higher wages.
    d. all of the above.

14. Age-earnings profiles for college-educated individuals, especially men, tend to be steeper than the age-earnings profiles for individuals that only complete high school. According to the human capital investment framework, this difference occurs because
    a. the steepening is necessary as an incentive for individuals to invest in a college education.
    b. college graduates have shown that they can learn more easily than high school graduates, and so are more likely to also seek out (or be offered) on-the-job training.
    c. college graduates acquire more general skills that tend not to diminish over time.
    d. both a and b.
15. Age-earnings profiles computed for women as of 1999, while lower and less steep than the comparable profiles for men, are clearly steeper than those computed for women as of 1977. According to the human capital investment framework, this change is attributable to
   a. changes in women’s labor force participation that have led to longer worklives for women.
   b. increased acquisition by women of on-the-job training.
   c. increased willingness of women to pursue post-graduate education.
   d. both a and b.

Is Education a Good Investment?

16. Education is a good investment for an individual if
   a. workers with higher levels of education tend to earn higher wages.
   b. given the individual’s discount rate, the present value of the benefits of the investment are greater than or equal to the present value of the costs of the investment.
   c. the internal rate of return associated with the investment is positive.
   d. all of the above.

17. Rate of return estimates for educational investments will be biased upward if
   a. the psychic benefits associated with educational investments are included in the measure of benefits.
   b. the sample contains people with different inherent abilities.
   c. differences in ability are not accounted for.
   d. firms use educational investments as a way to screen for high-productivity applicants.

18. Failure to account for the comparative advantage people have in different occupations (the selectivity problem) when estimating the rate of return on educational investments will result in
   a. a small upward bias in the rate of return.
   b. a downward bias in the rate of return attained by those who actually made the investment.
   c. an upward bias in the rate of return that is possible for those who did not make the investment.
   d. both b and c.

19. From society’s point of view, encouraging investments in the expansion or upgrading of education may waste scarce resources if
   a. educational activities do not enhance productivity, rather they only serve to signal those individuals who are inherently more productive.
   b. education enhances productivity, but the marginal rate of return to society on educational investments is no greater than the marginal rate of return on other forms of investment (such as investment in physical capital).
   c. the internal rate of return on educational investments just equals the market interest rate.
   d. all of the above.
A Cobweb Model of Labor Market Adjustment (Appendix 9A)

In answering Questions 20–24, please refer to Figure 9-4, which depicts the demand \((D)\) and supply \((S)\) curves for highly trained workers in a particular occupation. Assume the demand curve has shifted out from \(D_1\) to \(D_2\) and that there is a significant lag in the quantity of labor that can be supplied because of the time needed to train new workers. Also suppose individuals myopically base their decision to train for this occupation on the current wage.

![Figure 9-4](image)

20. Assuming the market was initially in equilibrium, what is the size of the shortage created by the shift in demand from \(D_1\) to \(D_2\)?
   a. The distance from point \(a\) to point \(b\) (22.5 workers)
   b. The distance from point \(c\) to point \(d\) (10 workers)
   c. The distance from point \(c\) to point \(e\) (6 workers)
   d. The distance from point \(f\) to point \(g\) (15 workers)

21. If there can be no immediate change in the quantity of labor supplied because of a lag in the training of new workers, what effect will the demand shift have on the market-clearing wage?
   a. The wage will rise from point \(c\) to point \(e\) ($4 increase).
   b. The wage will rise from point \(c\) to point \(f\) ($10 increase).
   c. The wage will remain unchanged.
   d. The wage will fall from point \(c\) to point \(b\) ($5 decrease).

22. If workers myopically base their training plans on the current wage, the demand shift will eventually result in a surplus of workers equal to
   a. the distance between point \(a\) and point \(b\) (22.5 workers).
   b. the distance between point \(c\) and point \(d\) (10 workers).
   c. the distance between point \(b\) and point \(e\) (9 workers).
   d. the distance between point \(f\) and point \(g\) (15 workers).

23. Assuming trained workers choose to stay in their chosen occupation, the surplus of workers that results from the myopic response to the initial wage change will cause
   a. the wage to fall from point \(g\) to point \(b\) ($15 decrease).
   b. the wage to fall from point \(g\) to point \(e\) ($6 decrease).
   c. the wage to fall from point \(e\) to point \(b\) ($9 decrease).
   d. the wage to increase from point \(e\) to point \(g\) ($6 increase).
24. In this example, the market moves farther and farther from the true equilibrium wage and employment level as the process continues. This result occurs because
   a. the magnitude of the slope of the demand curve is greater than the slope of the supply curve.
   b. workers are assumed not to have rational expectations.
   c. workers are adapting their expectations to the boom and bust cycles.
   d. both a and b.

A Hedonic Model of Earnings and Educational Level (Appendix 9B)

In answering Questions 25–27, please refer to Figure 9-5. The curves $A_2$ and $B_2$ refer to indifference curves between the wage and the level of non-compulsory schooling for two individuals, while the curves $Y$ and $Z$ refer to zero-profit isoprofit curves for two firms.

![Figure 9-5](image)

25. In Figure 9-5 the indifference curves between the wage and the level of education are drawn upward sloping. This is consistent with the statement that
   a. individuals prefer more education and more wages.
   b. more education is costly, and so the only way to keep worker utility constant is for the wage to rise.
   c. more educated workers are more productive, and so they can demand higher wages.
   d. more education signals higher productivity workers, who in turn must be paid more.

26. In Figure 9-5, the isoprofit curves between the wage and education are drawn upward sloping because
   a. more education may signal higher-productivity workers, and higher-productivity workers must be paid more.
   b. education causes workers to be more productive, and more-productive workers must be paid more.
   c. highly educated workers demand more in wages so that they can recover their educational costs.
   d. either a or b.
27. Figure 9-5 shows that those workers obtaining 4 additional years of education will be paid $8, while those obtaining 8 additional years of education will be paid approximately $12.25. This outcome is the result of a matching process where
   a. those workers finding additional years of education most difficult are matched with those firms willing to pay the most for additional years of education.
   b. those workers who are less averse to additional years of education are matched with firms where education adds greatly to productivity.
   c. workers are mobile enough to have various employment opportunities.
   d. both b and c.

### Problems

**The Benefits and Costs of Educational Investments:**

**The Present Value Method**

28. Consider an individual who currently earns $20,000 as an unskilled laborer. Suppose that by taking courses full time at a community college for one year, the person can qualify for a more skilled job paying $23,000 that is guaranteed to last for 10 years (after which the person would retire). Assume the cost of tuition and books at the community college for one year is $2,000 and that the current interest rate is 6%. Is this a good investment?

**The Benefits and Costs of an Educational Investment:**

**The Internal Rate of Return Method**

29. Consider a worker who is offered a salary bonus of $2,000 for each of the next two years if he or she enrolls in a job training program this year. The total cost to the worker, including any forgone earnings, is $3,500.

*29a. What is the internal rate of return on this investment?*

29b. Would this be a good investment for someone with a discount rate of 6%?

29c. What is the highest discount rate a person could have and still find this investment attractive? Is it possible for a person to have a higher discount rate than the market interest rate?

29d. Why are older workers less likely to seek out, or be offered, on-the-job training opportunities? How does this affect the shape of the typical age-earnings profile?

**The Relationship Between Expected Inflation and the Discounting of Future Benefits from Education**

30. In evaluating educational investments in which costs are incurred in the current year (year 0), but benefits accrue over future years (years 1 through \( T \)) it important that the future benefits be discounted. Dollars accessible today are more valuable since they can be consumed today with certainty or invested at some rate of interest. Therefore, dollars received in the future must first be discounted if they are to be fairly compared with current dollars. However, dollars received in the future may also be less valuable than dollars today if inflation occurs, raising the general level of prices and reducing the purchasing power of future dollars.
In Chapter 2, adjustments for inflation were discussed in the context of converting nominal wages to real wages. To adjust nominal values to real values, one simply divides the nominal dollar values by the price index and then multiplies the result by 100. The result is a measure that can be compared to dollar values in the base year of the price index.

When inflation is anticipated, it is also important to note that anyone loaning (investing) money will typically require that a premium for expected inflation be built into the interest rate payable on the investment so as to assure a certain real rate of return after accounting for inflation. The nominal (market) interest rate is converted to the real interest rate by the formula

\[ i = \frac{r - p}{1 + p}, \]

where \( i \) is the real interest rate, \( r \) is the market interest rate (expressed as a fraction) and \( p \) is the expected rate of inflation (also expressed as a fraction). When expected inflation is small, the above formula is often approximated by the simple formula \( i = r - p \).

Table 9-1 lists the costs and benefits associated with an educational investment. The price indices presented in the table reflect the expectation that in each of the two years after the investment is made, inflation will be 4%. The market interest rate throughout the period is assumed to be constant at 6% per year.

<table>
<thead>
<tr>
<th>Year</th>
<th>Price Index</th>
<th>Costs</th>
<th>Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 0</td>
<td>100</td>
<td>$10,000</td>
<td>$0</td>
</tr>
<tr>
<td>Year 1</td>
<td>104</td>
<td>$ 0</td>
<td>$6,000</td>
</tr>
<tr>
<td>Year 2</td>
<td>108.16</td>
<td>$ 0</td>
<td>$6,000</td>
</tr>
</tbody>
</table>

30a. Using the market interest rate as the discount rate, convert the nominal values of the costs and benefits to present values. Does the present value of the benefits exceed the present value of the costs? If so, by how much?

30b. Compute the real rate of interest expected in each year to five decimal places.

30c. Using the expected price indices, convert the nominal values of the costs and benefits to real values.

30d Using the real interest rate as the discount rate, convert the real values of the costs and benefits to present values. Does the present value of the benefits exceed the present value of the costs? If so, by how much?

30e. Compare your answers to 30a and 30d. Is it necessary to convert all nominal values to real values in order to accurately assess the costs and benefits of educational investments?
Measuring the Rate of Return to Educational Investments

31. According to studies cited in the text, estimates of the individual rate of return on educational investments range (in real terms) from 5% to 15%.

31a. If you knew that these studies suffered from selection bias, would you be more inclined to believe the upper or lower range of these estimates?

31b. What similarities do you see between the notions of selection bias and ability bias?

Signaling and the Labor Market

32. Consider Figure 9-6 which shows the present value of lifetime earnings (PVE) firms are willing to offer to workers who have attained different levels of education. Those workers who have completed 16 years or more of education (4 or more years after high school) will be offered a wage leading to a present value of lifetime income of $2,000,000 (PVE₂), while those completing less than 16 years of education will be offered a wage leading to a present value of lifetime income equal to $1,000,000 (PVE₁). Lines 𝐶_𝐴 and 𝐶_𝐵 show the total cost of different levels of education for two types of workers. Type A workers are low-productivity workers while type B workers are high-productivity workers.

![Figure 9-6](image)

32a. What is the net benefit (i.e., the difference between the PVE and the cost of education) a type A person would derive from attaining 16 years of education? What would be the net benefit for A from 12 years of education? What is the optimal level of education for a type A person?

32b. What is the net benefit a type B person would derive from attaining 16 years of education? What would be the net benefit for B from 12 years of education? What is the optimal level of education for a type B person?

32c. Is 16 years of education an effective way to distinguish low-productivity workers from high-productivity workers?
32d. Suppose firms lowered the cutoff for the higher wage job to 14 years of education. What level of education would type A workers attain? What level of education would type B workers attain? Would the level of education be an effective signal of worker productivity?

32e. Suppose firms raised the cutoff for the higher wage job to 18 years of education. What level of education would type A workers attain? What level of education would type B workers attain? Would the level of education be an effective signal of worker productivity?

The Cobweb Model (Appendix 9A)

33. Consider a labor market where the demand and supply curves for highly trained workers are given by the equations

\[ L_D = 10 - 0.5W, \]
\[ L_S = 0.5W, \]

where \( L \) represents the number of workers, \( W \) is the wage, and the subscripts \( D \) and \( S \) are used to distinguish between the quantity of labor demanded and the quantity of labor supplied.

33a. Find the initial market-clearing wage and employment level.

33b. Now suppose that the demand for labor in this particular occupation increases to

\[ L_D = 12 - 0.5W. \]

Find the new market-clearing wage and employment level.

33c. Suppose that because of lags in the training of new workers, no new quantity of labor could be immediately supplied in response to the demand shift. With the number of trained workers fixed for the time being at the original employment level, calculate what would initially happen to the wage.

33d. If workers shortsightedly based their training plans on the new wage (computed in Question 33c), find the quantity of workers that will be supplied when training is complete.

33e. Once training is complete and the newly trained workers are in the labor market, calculate what will happen to the equilibrium wage. Assume that once workers are trained, they will be extremely reluctant to leave that occupation.

33f. If workers again shortsightedly base their training plans on this new wage, find the quantity of workers that will be supplied when training is complete.

33g. Is this market moving closer to the market clearing values associated with the new demand curve?

33h. Will this market eventually converge on the wage and employment values associated with the new demand curve? How can you tell?
A Hedonic Model of Earnings and Educational Level (Appendix 9B)

34. In Figure 9-7, the curves labeled $A$ and $B$ refer to indifference curves between the wage and the level of non-compulsory schooling attained for two individuals, while the curves $Y$ and $Z$ refer to zero profit iso-profit curves for two firms. Suppose that initially persons A and B have both attained 4 years of additional schooling beyond the compulsory level (point $a$).

![Figure 9-7](image)

34a. What would be the monetary benefit to person B of investing in an additional 4 years of education?

34b. What is the minimum wage increase person B would accept in return for undertaking the additional years of education?

34c. Would the additional years of education be a good investment for person B? What about for person A?

Applications

Increases in the Cost of Education

35. According to data presented in Table 9.1 of Modern Labor Economics, the college enrollment rates of high school graduates rose most rapidly during the period 1980 to 1985. During that period, enrollment rates for men rose 11.9% while the rates for women rose 5.1%. On the other hand, according to data published in The Wall Street Journal (August 17, 1988, p. 31), the average annual cost of tuition and fees at public four-year colleges and universities rose from $706 to $1,242, a 76% increase. For four-year private colleges and universities, average tuition and fees rose 65% from $3,279 to $5,418. These increases far exceeded the 31% increase in the Consumer Price Index that took place over this time. How is it possible that college enrollment rates could be rising at the same time college costs were rising so substantially in real terms?

Changing Patterns in Graduate Business School Enrollments

36. According to data presented in Table 9.3 of the text, the percentage of women among those graduating with master’s degrees in business rose dramatically from 3.9% in 1971 to 37% in 1995. In the fall of 1992, however, The Wall Street Journal reported on what appeared to be a change in that trend. According to an article in the September 25, 1992 issue (p. B1), women as a percentage of entering Master of Business Administration (M.B.A.) classes had fallen substantially at many top schools after peaking in the 1980s.