Chapter 9
Investments in Human Capital: Education and Training

Summary

The purpose of Chapter 8 was to provide a framework for thinking about the role that working conditions and employee benefits play in an individual’s choice of occupation and employer. But supplying labor involves more than just showing up at a particular employer. What quality of labor will an individual supply? What level of education and training will an individual bring to the labor market? These are the kinds of questions taken up in Chapter 9.

Activities designed to enhance the value of the labor supplied by an individual are considered investments in human capital. Specific examples discussed in Modern Labor Economics include education and training, migration to locations where labor market opportunities are better, and job search. Each of these activities can be classified as an investment because they involve initial costs that the individual then hopes to recover over time. The term human capital is used to emphasize the similarity between these activities and a firm’s investment in new plant and equipment (physical capital). Individual education and training investments are discussed in this chapter, while migration and job search decisions are analyzed in Chapter 10. Job search issues are also taken up within the context of the unemployment discussion in Chapter 14.

Investments in physical or human capital will add to an individual’s wealth provided the present value of the benefits exceeds the present value of the costs. These investments should continue as long as the marginal benefit of an additional unit of capital exceeds the marginal cost. In the case of education and training investments, the costs include direct expenses for tuition and books, forgone earnings during the time devoted to education, and psychic losses due to the difficulty, stress, and anxiety of schooling. The prospective benefits include higher future earnings, access to more interesting, challenging, or pleasant jobs, the satisfaction that comes with being a more educated person, and the psychic benefits that come from some of the more pleasant aspects of student life.

The benefits and costs of investment in human capital will not occur at the same time, and thus any benefits occurring in the future must be converted to a present value basis before a comparison can be made. After all, a dollar of benefits received today is worth more than a dollar received next year, since dollars received today can be invested. Also, benefits received in the future may not be as valuable as benefits today because there is no guarantee the person will live long enough to enjoy the future benefits.

Letting \( r \) be the rate at which the yearly benefits of education \((B_1, B_2, \ldots)\) are discounted, and assuming the costs of education \((C)\) all occur in the initial year (year 0), the present value method suggests that an educational investment should be undertaken provided

\[
\frac{B_1}{1+r} + \frac{B_2}{(1+r)^2} + \cdots + \frac{B_T}{(1+r)^T} > C.
\]
The subscripts refer to different years along an interval 1 to \( T \) with 1 being the first year after the initial year and \( T \) the last. When the benefit values and the discount rate are constant, the entire present value of the benefit stream (\( PV_B \)) can be found using the formula

\[
PV_B = B \frac{1}{r} \left( 1 - \frac{1}{(1+r)^T} \right).
\]

This formula is called the **annuity formula** and applies for any value of \( T \). Note that if \( T \) is very large, the formula reduces to \( PV_B = B/r \).

An alternative, but equivalent, approach to evaluating educational investments is the **internal rate of return method**. Under this method, one solves for the discount rate that will just set the present value of the benefits equal to the present value of the costs. If this rate exceeds the discount rate required by the individual (usually the going interest rate on alternative investments), then the investment is considered to be worthwhile.

Both the present value and internal rate of return methods predict that educational investments (e.g., a college education) are more likely (holding all else constant) the lower the values of \( r \) and \( C \), and the higher the values of \( B \) and \( T \). A lower value of \( r \) is a way of saying the person is less present-oriented and more future-oriented, while higher values of \( T \) are associated with younger persons. Changes in the value of \( B \) and \( C \) can typically explain a large part of the change in college enrollments over time. In general, this model predicts that present-oriented people are less likely to go to college than future-oriented people, that most college students will be young (because they receive the benefits from a college education for more years), that college attendance will fall as costs rise, and that college attendance will increase if the gap between earnings of college graduates and high school graduates increases. An additional aspect of cost is the cost of credit, which may vary widely for different potential students; programs that make borrowing easier or cheaper are also likely to increase college enrollments.

Although higher levels of benefits create a greater incentive to make educational investments, the level of \( B \) is largely determined by the extent to which educational investments enable a person to earn higher wages. The level of wages associated with any educational investment, however, is determined in part by how many people make the investment—in other words, the supply of educated workers. It is the supply of educated workers, together with the demand for such workers, that determines the wage workers receive, and ultimately the benefits associated with making the investment. When more people attend college, the supply of college-educated workers eventually rises, which (all other things equal) causes the wage to decline, and thus the benefits received may be lower than expected.

After using the basic human capital investment model to discuss investment in a college education, the discussion in the text turns to the relationship between education, earnings, and on-the-job training. The focal point of the discussion is the **age-earnings profiles** of men and women as of 1997. These profiles, presented in graphical form, show the relationship that exists on average between age and earnings for workers with various levels of education.

The age-earnings profiles constructed for men and women display four tendencies. The first tendency is for the average earnings of full-time workers to rise with the level of education. The second tendency is for earnings to rise rapidly with age, then flatten out, and eventually fall. Graphically, this leads to age-earnings profiles that are concave. The third tendency is for higher levels of education to be associated with steeper age-earnings profiles. This steepening leads to the education-related differences in earnings becoming more pronounced as a person ages. Graphically, this shows up as a *fanning out* of the age-earnings profiles. While, the previous three tendencies related to the age-earnings profiles of both men and women, the fourth tendency relates to a comparison of the profiles between men and women. Such a comparison reveals that the profiles for women display less concavity and are less steep than the profiles for men.
How does the human capital investment framework account for these four tendencies? The first tendency, the positive relationship between earnings and education, must occur because without it, there would be little incentive to invest in education.

The second tendency, the concavity of the age-earnings profiles, is attributed to formal or informal on-the-job training. General on-the-job training can be viewed much like any other educational investment. Workers typically pay for such training in the form of lower wages. In return, the workers receive training that they hope will pay off in the form of higher wages and better jobs in the future. This combination of lower wages early on, and higher wages later, forms the initial steep segment of the concave age-earnings profile. However, like any other investment, the chance of fully recovering educational costs decreases as a person ages, holding all else constant. Thus, job training (whether sought by the worker or initiated by the firm) can be expected to decline as the worker ages, with older workers receiving so little training that their skills begin to deteriorate. The leveling off of training opportunities and the resulting deterioration of older worker skills is thought to explain the leveling off, and eventual decline, of the age-earnings profile.

The third tendency, the tendency for more educated workers to display a steeper age-earnings profile, is also thought to be related to on-the-job training. The basic principle is that investments such as job training are more likely the lower the expected costs. Holding all else constant, workers who have completed higher levels of education typically have displayed the ability to learn more quickly. This in turn shortens the training period and lowers the psychic costs of the investment, and so lowers the total cost of the investment. Thus, the higher the level of formal education, the more likely it is that workers will seek out or be offered job training. The tendency of better educated workers to invest more in job training means that their age-earnings profiles will rise more quickly than for less educated workers, thus leading to a fanning out of the age-earnings profiles.

When comparing the age-earnings profiles of men and women, it is clear that the fourth tendency is for women’s profiles to be less concave and to fan out less as education rises. This tendency is again thought to be connected to job training opportunities. Because of the role women have traditionally played in child rearing and household production, historically it has been expected that, on average, women will work fewer years for pay. Also, within a given occupation, women have averaged fewer hours of work per week than men. Because of the shorter expected work life of women, the human capital investment model predicts that the benefits to the average women of investing in on-the-job training will be less. Thus, historically women have had less of an incentive to seek out, and firms have had less incentive to offer them job training opportunities at the level received by males. To the extent that job training accounts for the concavity and fanning out of the age-earnings profiles, the model predicts that these effects should be less pronounced for women. However, as the traditional role of women has changed, and their work lives have become less interrupted, the model also predicts that the profiles should start to more closely resemble the patterns displayed by men. This prediction is supported by a comparison of the age-earnings profiles for women in 1999 with those from 1977.

According to the human capital investment framework, longer expected careers for women should also lead to an increased incentive to undertake formal educational investments. Comparisons of college and university graduates by field of study verify a dramatic increase in the percentage of women receiving bachelor’s and master’s degrees. Also, women have dramatically increased their representation in highly technical fields where it is widely perceived that continuous experience is important.

The presentation of the age-earnings profiles for men and women clearly revealed that higher levels of education tend to be associated with higher earnings. But what is the rate of return on educational investments? Is additional education a good investment? Studies of the monetary costs and benefits of educational investments have typically revealed a real internal rate of return in the range of 5% to 15%, suggesting that education is at least as good an investment over time as stocks, bonds, or real estate. Internal rate of return studies of education are difficult to interpret, however, because of several conflicting biases which affect the data. Most of these biases are connected to the problem of omitted variables (see Appendix 1A).
However, estimates of the rate of return to schooling may be biased in three ways. First, they may be overestimated, because it is not possible to separate the contribution of ability to earnings. This “ability bias” suggests that more-able workers are likely to obtain more schooling (because both the direct and implicit costs of schooling may be less), but these more-able workers would be likely to receive a higher-than-average wage even if they did not obtain more schooling.

Secondly, the rate of return to education may be underestimated for a number of reasons. Some benefits of education are not reflected in productivity but rather in such things as a greater appreciation of life and thus cannot be measured. Typical studies also tend to measure money earnings rather than total compensation, and benefits tend to rise as a percentage of total compensation as earnings rise. Finally, some of the benefits of education are nonmonetary, such as having a more interesting or pleasant job, another return that cannot be quantified.

Thirdly, a subtle and sometimes important source of bias in labor economics is selection bias (also known as the selectivity problem). Selection bias occurs when the samples being compared differ in some systematic, but typically unobservable way. For example, someone who ends up as a college graduate is in that group because they chose (selected) to be there. They did this presumably because they did not find the alternatives available to them without a college degree very appealing, perhaps because they had little aptitude for jobs not requiring a degree. Hence, measuring the returns to education by comparing the actual average earnings of different groups will tend to understate the return to those who made the investment (and overstate the return possible for those that did not) due to this “ability bias.”

Despite the difficulty in interpreting estimates of the rate of return on educational investments, empirical studies are basically supportive of the notion that additional education is a reasonable investment from an individual perspective. Similarly, empirical studies of the labor market experiences of adult women indicate that government training programs generate enough of an earnings increase for the participants to justify government expenditures. But just because additional education may be a reasonable investment from an individual perspective, it does not follow that additional education is a reasonable investment from the perspective of society as a whole. This uncertainty is associated with the view that education serves primarily as a signaling device in the labor market. For example, if education does nothing to enhance individual skills, but rather simply helps firms to identify which individuals have the highest skills to begin with, then fostering higher levels of education may be unnecessary from a social standpoint.

**Example**

Consider Figure 9-1 which shows the present value of lifetime earnings (PVE) that firms are willing to offer to workers who have attained different levels of education (E). 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 $1,600,000 (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 $800,000 (PVE₁).

![Figure 9-1](image-url)
Suppose that the total cost of various levels of education is given by the equations

\[ C_A = 225,000(E - 12) \quad \text{and} \quad C_B = 50,000(E - 12), \]

where the subscripts \( A \) and \( B \) refer to two types of workers. Type \( A \) workers are low productivity workers while type \( B \) workers are high productivity workers. These total cost schedules are shown as lines \( C_A \) and \( C_B \) in Figure 9-1.

Note that at 12 years of education the net benefit (i.e., the difference between the present value of lifetime earnings and the total cost of additional education) for type \( A \) workers is \( $800,000 \) (the difference between points \( a \) and \( b \)), whereas at 16 years of education the net benefit falls to \( $700,000 \) (the difference between points \( d \) and \( e \)). Consequently, the best choice for type \( A \) workers is 12 years of education. In contrast, the net benefit for type \( B \) workers is \( $800,000 \) at 12 years of education and \( $1,400,000 \) at 16 years of education (the difference between points \( c \) and \( e \)). Clearly, type \( B \) workers do better by attaining 16 years of education. Given the position of the cost curves in Figure 9-1, type \( A \) workers voluntarily choose not to attain a college degree, while type \( B \) workers do attain the degree. As a result, even if additional education does nothing to enhance worker productivity, a college degree serves a useful purpose in that it enables employers to accurately distinguish low-productivity workers from high-productivity workers.

Note that in order for a college degree to play an effective signaling role, the cost to the workers of acquiring the signal must be strongly and inversely related to the worker’s inherent ability. This is plausible if the psychic costs of education are included as part of the total cost of additional years of education. Individuals with low ability are likely to find additional years of education more challenging, stressful, and unpleasant than those with high ability.

Finally, note that from the perspective of society as a whole, raising the level of education that is necessary to obtain the higher income stream would result in increased costs for some workers but no increase in benefits for society. For example, if the threshold for the higher income stream were made 18 years of education instead of 16, high-productivity workers would attain the threshold amount while low-productivity workers would not. Type \( B \) workers would gain \( $1,200,000 \) by investing in 18 years of schooling versus a maximum of \( $800,000 \) if they did not. In contrast, type \( A \) workers would gain \( $800,000 \) at 12 years of schooling but only \( $250,000 \) at 18 years of schooling. Consequently, the higher educational threshold would impose additional costs on type \( B \) workers without changing the effectiveness of education as a signal.

Although evidence on whether schooling serves primarily as a signaling device or whether it actually enhances worker productivity is not conclusive at this point, it is important to note that from an individual perspective, the distinction is unimportant since in either case employers will be willing to offer higher earnings to those who complete higher levels of education. From society’s point of view, however, the signaling hypothesis is important because it suggests that devoting more resources to education is not necessarily a good investment. Still, the fact that employers are willing to pay more for educated workers suggests that even if education is just a signal, it is an effective signal and one that is less costly to use than any other signal that is available to firms.

The appendices to Chapter 9 relate to the relationship between education and earnings. Appendix 9A builds on the notion that the level of wages associated with any educational investment is determined by the forces of supply and demand. When the investment in education involves a time commitment of several years, however, it is important to note that the forces of demand and supply may not work to determine the market clearing wage as smoothly or as rapidly as the demand and supply model presented in Chapter 2 suggested. The extensive time needed to train new workers for some occupations means that the quantity of labor supplied cannot adjust quickly to changes in the wage. These lags in the supply response in turn can lead to boom-and-bust cycles in which wages and employment opportunities fluctuate over a rather wide range when compared to other occupations that require less-extensive training.
These cycles can be depicted through an extension of the demand and supply model known as the **cobweb model**. Failure to realize that such cycles may be a normal part of the adjustment process in some labor markets may lead the government to try to smooth out the cycles through subsidizing the supply of workers at certain times. The cobweb model, however, suggests that such attempts may only make the cycles more pronounced.

**Example (Appendix 9A)**

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

\[
LD = 90 - 3W, \\
LS = 2W,
\]

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. These curves appear as lines \(D_1\) and \(S\) in Figure 9-2.

If the market is initially in equilibrium, the market-clearing wage occurs where the quantity of labor demanded equals the quantity of labor supplied.

\[
LD = LS \Rightarrow 90 - 3W = 2W \Rightarrow W^* = 18 \Rightarrow L^* = 36.
\]

The market-clearing wage \((W^*)\) and employment level \((L^*)\) associated with the initial demand and supply curves are indicated by point \(a\) in Figure 9-2.

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

\[
LD = 150 - 3W.
\]

The new demand schedule results in a parallel shift of the demand curve to line \(D_2\) in Figure 9-1. Given this new demand curve, the market-clearing wage should rise to \$30 and the new equilibrium employment level should be 60 (point \(f\)) since

\[
150 - 3W = 2W \Rightarrow W^* = 30 \Rightarrow L^* = 60.
\]

However, if no new quantity of labor could be immediately supplied because of lags in the training of new workers, the wage would rise to \$38 (point \(b\)) since

\[
150 - 3W = 36 \Rightarrow W^* = 38.
\]
With the number of trained workers fixed at 36 for the time being, it is as if the supply curve temporarily becomes line $S_1$. If workers shortsightedly based their training plans on this new wage, the quantity of workers that will be supplied when training is complete will equal 76 (point $c$) since

$$L_S = 2W = 2(38) \Rightarrow L_S = 76.$$  

Once training is complete and 76 trained workers exist, it will be as if the supply curve is now temporarily given by the line $S_2$, since once workers are trained they may be reluctant to leave that occupation. With the supply of workers fixed for the time being at 76, the market clearing wage now falls to $24.67 (point $d$) since

$$150 - 3W = 76 \Rightarrow W^* = 24.67.$$  

If workers again shortsightedly base their training plans on this new wage, the quantity of workers that will be supplied when training is complete will equal 49.33 (point $e$) since

$$L_S = 2W = 2(24.67) \Rightarrow L_S = 49.33.$$  

Note that instead of following a smooth path from the original wage and employment level of $18$ and $36$ (point $a$) to the new market-clearing wage and employment level of $30$ and $60$ (point $f$), the wage has cycled from $18$ to $38$ to $24.67$, and the employment level has cycled from $36$ to $76$ to $49.33$. Note that this spiraling effect that is occurring around the new market-clearing values (hence the name cobweb model) is bringing the market closer to a true equilibrium (where there is no tendency for change). The cycle gradually dampens out any time the magnitude of the slope of the demand curve (as it appears on the graph) is less than the slope of the supply curve. Note that in Figure 9-1, the demand curve slope has a magnitude of one-third while the supply curve has a slope of one-half. On the other hand, if the slope magnitudes were reversed so that demand was steeper than supply, the alternating shortages and surpluses would worsen over time and the market would cycle away from the new equilibrium value.

Can the government help to dampen the boom-and-bust cycles? In most cases, the answer is no. For example, suppose that when the first shortage of workers appeared in response to the demand shift and the wage was bid up to $38$, the government intervened and subsidized the training of workers in this occupation. The result would have been a shift in the supply curve $S$ to the right of its initial position. Consequently, more than 76 workers eventually would have been trained, and the market then would have overshot the new equilibrium employment level by an even wider margin, making the next downturn in the cycle even worse.

Note that in the above example, it was not only the lags in the supply of new workers that caused the boom-and-bust cycles, but also the myopic or shortsighted behavior of workers who based their decision to train for a certain occupation on the basis of the current wage, ignoring the effect their decisions may have on the future behavior of the wage. An alternative assumption is that people base their decision to train for a certain occupation on the basis of current wages and the past movement of wages. Such an extension would be called an adaptive expectations model and in general would lead to smaller cycles. On the other hand, if workers eventually understood exactly how the model worked and based their supply decisions on a perfect prediction of what the future wage would be, there would be no cycles, rather just an immediate movement to the new market-clearing wage. A model in which workers know the model and so can make perfect predictions about the future wage is called a rational expectations model. One constructive role government can play in labor markets where training takes time is to provide information to workers suggesting that the current wage is not a good indicator of the future wage. In so doing, this may help to foster rational expectations among workers in that market and speed the adjustment to the true market clearing values.

Appendix 9B adapts the hedonic theory of wages framework presented in Chapter 8 to explain the connection between higher levels of education and higher wage earnings. While it was emphasized in Chapter 9 that higher wages must accompany educational investments to induce workers to make the investments, this framework is valuable in emphasizing the role that employers play in actually creating such incentives. The matching of employers and employees in this model is identical to that presented in
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