9

Investments in Human Capital: Education and Training

Chapters 6, 7, and 8-on the decision to work and job choice-emphasized the effects of *current* wages, employee benefits, and psychic income on worker decisions. Many labor supply choices, however, require a substantial initial *investment* on the part of the worker. Recall that investments, by definition, entail an initial cost that one hopes to recoup over some period of time. Thus, for many labor supply decisions, *current* wages and working conditions are not the only deciding factors. Modeling these decisions requires developing a framework that incorporates investment behavior and a *lifetime* perspective. '

Workers undertake three major kinds of labor market investments: education and training, migration, and search for new jobs. All three investments involve an initial cost, and all three are made in the hope and expectation that the investment will pay off well into the future. To emphasize the essential similarity of these investments to other kinds of investments, economists refer to them as investments in *human capital,* a term that conceptualizes workers as embodying a set of skills, that can be "rented out" to employers. The knowledge and skills a worker has which come from education and training, including the learning that experience yields-generate a certain *stock* of productive capital. However, the *value* of this amount of productive capital is derived from how much these skills can earn in the labor market. Job search and migration are activities that increase the value of one's human capital by increasing the price (wage) received for a given stock of skills.

Society's total wealth should therefore be thought of as a combination of both human and nonhuman capital. Human capital includes accumulated investments in such activities as education, job training, and migration, whereas nonhuman capital includes society's stock of natural,. resources, buildings, and machinery. Total wealth in the United States was around $421,000 per person in 1990, 59 percent of which ($248,000 per person) was in the form of human capital.[1] Estimates of human capital per person in Canada, Germany, and Japan were $155,000, $315,000, and $458,000, respectively. Thus, investments in human capital are an enormously important component of the overall wealth in any society, averaging 64 percent of per capita wealth worldwide (see Example 9.1 for a further indication of the relative importance of human capital).

Investment in the knowledge and skills of a particular worker can be thought of as having taken place in three stages. First, in early childhood, the acquisition of human capital was largely determined by the decisions of others. Parental resources and guidance, plus one's cultural environment and early schooling experiences, help to influence basic language and mathematical skills, attitudes

[1] 'Peter Passel, "The Wealth of Nations: A "Greener" Approach Turns List Upside Down," *New York Times,* September 19, 1995, Cl, C12.

toward learning, and one's general health and life expectancy (which themselves affect the ability to work). Second, teenagers and young adults go through a stage in which their acquisition of knowledge and skills is as full-time students in a high school, college, or vocational training program. Finally, after entering the labor market, workers' additions to their human capital generally take place on a part-time basis, through on-the-job training, night school, or participation in relatively short formal training programs.

In this chapter we analyze the choices made by teenagers and adults about investing in their own *education and training* over a lifetime; in Chapter 10 we analyze their investments in *job search* and *migration.* In both chapters we focus on the latter two stages above, when people are old enough to make considered choices about occupations and the related human capital investments. This focus arises from our central concern with *labor market* behavior, but the influence of early childhood (or "Premarket") experiences on later human capital decisions and economic outcomes is worthy of at least brief comment.

One of the challenges of any behavioral theory is to explain why people faced with what appears to be the same environment make different choices. In Chapter 6, for example, we saw that an important factor in decisions about the hours of work an individual supplies to the market is his or her preferences regarding income and leisure. Similarly, the compensating wage differentials for job injury risk in Chapter 8 were generated by workers' varying degrees of aversion to the risk of injury. We will see in this chapter that individuals' decisions about investing in human capital are affected by the ease and speed with which they learn, their aspirations and expectations about the future, and their access to financial resources.

Parental wealth and educational attainment are thought to play an important role in developing children's basic cognitive skills and their attitudes toward learning and work.[2] Neighborhoods, and even preschool experiences, can also be hypothesized to affect one's aspirations and learning skills.[3] Thus, as we begin our analysis of the human capital choices made by workers, it is important to keep in mind that these "market" decisions about human capital are being made by workers who differ in their attitudes toward, and abilities for, learning. These "premarket" differences are, at least in part, influenced by the decisions, values, and resources of others during each worker's childhood.[4]

---

[2] For seminal work in this vein, see Gary S. Becker and Nigel Tomes, "An Equilibrium Theory *of* the Distribution *of* income and Intergenerational Mobility," *Journal of Political Economy 87,* no. *6* (December *1979):1153-1189,* and Gary S. Becker and Nigel Tomes, "Human Capital and the Rise and Fall *of* Families," *Journal of Labor Economics 4,* no. *3,* pt. *2* (July *1986): S I -S39.* For a recent empirical article, see Mark R. Rosenzweig and Kenneth I.Wolpin, "Are There Increasing Returns to the Intergenerational Production *of* Human Capital?" *Journal of Human Resources 29,* no. *2* (Spring *1994): 670-693.*

[3] For recent empirical studies on these topics, see George J. Borjas, "Ethnicity, Neighborhoods, and Human-Capital Externalities," *American Economic Review 85,* no. *3* (June *1995): 365-390,* and Janet Currie and Duncan Thomas, "Does Head Start Make a Difference?" *American Economic Review 85,* no. *3* (June *1995): 3411-364.*

[4] A recent book that considers the role of genetic factors in determining cognitive abilities is Richard J. Herrnstein and Charles Murray, *The Bell Curve: Intelligence and Class Structure in American Life* (New York: Free Press, 1994). For a critical review of this book by two prominent economists, see Arthur S.

EXAMPLE 9.1

Hiroshima, Hamburg, and Human Capital

An insight into the relative magnitudes and importance of physical and human capital is obtained by noting some interesting facts concerning severely war-damaged cities. The atomic attack on Hiroshima destroyed 70 percent of its buildings and killed about 30 percent of the population. Survivors fled the city in the aftermath of the bombing, but people began returning within 24 hours; within three months two thirds of city's surviving population had returned. Because the air-burst bomb left the city's underground utility networks intact, power was restored to surviving areas one day after the bombing. Through railway service began again in two days, and telephone service was restarted in a week. The U.S. Strategic Bombing Survey estimated that plants responsible for three-quarters of the city's industrial production (many of these were located on the outskirts of the city and were undamaged) could have begun normal operations within 30 days.

In Hamburg, Germany, a city of around 1.5 million in the summer of 1943, Allied bombing raids over a ten-day period in July and August destroyed about half of the buildings in the city and killed about 3 percent of the city's population. Although there was considerable damage to the water supply system, electricity and gas service were adequate within a few days after the last attack, and within four days the telegraph system was again operating. The central bank was reopened and business had begun to function normally after one week, and postal service was resumed within 12 days of the attack. The Strategic Bombing Survey reported that within five months Hamburg had recovered up to 80 percent of its former productivity.

The speed and success of recovery from these disasters has prompted one economist to offer the following two observations:

(1) the fraction of the community's real wealth represented by visible material capital is small relative to the fraction represented by the accumulated knowledge and talents of the population, and (2) there are enormous reserves of energy and effort in the population not drawn upon in ordinary times but which can be utilized under special circumstances such as those prevailing in the aftermath of disaster.

SOURCE: Jack Hirshleifer, Economic Behavior in Adversity (Chicago: University of Chicago Press, 1987), 12-14,78-79.

Goldberger and Charles F. Manski, "Review Article: 'The Bell Curve by Herrnstein and Murray," J*ournal of Economic Literature 33,* no. 2 (June 1995): 762-776.

Human Capital Investments: The Basic Model

As with any other investment, an investment in human capital entails costs that are borne in the near term with the expectation that benefits will accrue in the future. Generally speaking, the *costs* of adding to one's human capital can be divided into three categories:

1. *Out-of-pocket* or *direct* expenses include tuition costs and expenditures on books and other supplies.
2. *Forgone earnings* are another source of cost, because during the investment period it is usually impossible to work, at least not full-time.
3. *Psychic losses* are a third kind of cost incurred, because learning is often difficult and tedious.

In the case of educational and training investments by workers, the expected *returns* are in the form of higher future earnings, increased job satisfaction over one's lifetime, and a greater appreciation of nonmarket activities and interests. Calculating the benefits of an investment over time requires the progressive discounting of benefits lying further into the future (see Chapter 5). Benefits that are received in the future are worth less to us now than an equal amount of benefits received today for two reasons. First, if people plan to consume their benefits, they prefer to consume earlier. (One is relatively sure of being able to enjoy such consumption now, for example, but the uncertainties of life make future enjoyment problematic.) Second, if people plan to invest the monetary benefits rather than use them for consumption, they can earn interest on the investment and enlarge their funds in the future. Thus, no matter how people intend to use their benefits, they will discount future receipts to some extent.

Para una descripción más detallada respecto del cálculo del Valor Presente, ver últimas páginas anexadas a este texto.

As Chapter 5 explained, the present value of a stream of yearly benefits (B_1, B_2 ...) over time (T) can be calculated as follows:

$$\text{Present Value} = \frac{B_1}{1+r} + \frac{B_2}{(1+r)} + \frac{B_3}{(1+r)^3} + \ldots\ldots\ldots + \frac{B_r}{(1+r)^T} \qquad (9.1)$$

where the interest rate (or discount rate) is *r*. As long as *r is* positive, benefits into the future will be progressively discounted. For example, if *r = 0.06,* benefits payable in *30* years would receive a weight that is only 17 percent of the weight placed on benefits payable immediately (1.06" = 5.74; 1/5.74 = 0.17). The smaller r is, the greater the weight placed on future benefits; for example, if *r = 0.02,* a benefit payable in 30 years would receive a weight that is 55 percent of the weight given to an immediate benefit.

Our model of human capital investment assumes that people are utility maximizers and take a lifetime perspedive when making choices about education and training. They are therefore assumed to compare the near-term investment costs (C) with the present value of expected future benefits when making a decision,

say, about additional schooling. Investment in additional schooling is attractive if the present value of future benefits exceeds costs:

$$\frac{B_1}{1+r} + \frac{B_2}{(1+r)} + \frac{B_3}{(1+r)^3} + \ldots\ldots\ldots + \frac{B_r}{(1+r)^T} > C \qquad (9.2)$$

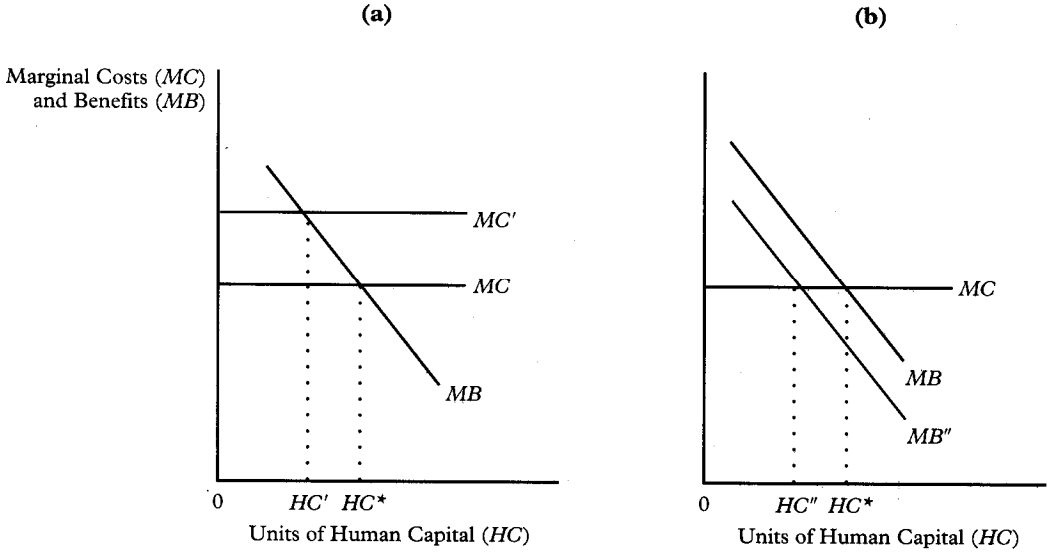
Utility maximization, of course, requires that people continue to make additional human capital investments as long as condition *(9.2) is* met, and that they stop only when the benefits of additional investment are equal to or less than the additional costs.

There are two ways one can measure whether the criterion in *(9.2) is* met. Using the *present-value method,* one can specify a value for the discount rate, *r,* and then determine how the present value of benefits compares to costs. Alternatively, one can adopt the *internal rate of return method,* which asks, "How large could the discount rate be and still render the investment profitable?" Clearly, if the benefits are so large that even a very high discount rate would render investment profitable, then the project is worthwhile. In practice, one calculates this internal rate of return by setting the present value of benefits equal to costs and solving for *r.* The internal rate of return is then compared to the rate of return on other investments. If the internal rate of return exceeds the alternative rates of return, the investment project is considered profitable.

Some basic implications of the model embedded in expression *(9.2)* are illustrated graphically in Figure *9.1* a, which depicts human capital decisions in terms of marginal costs and marginal benefits (focus for now on the black lines in the figure). The marginal costs, *MC,* of each additional unit of human capital (the tuition, supplies, forgone earnings, and psychic costs of an additional year of schooling, say) are assumed to be constant. The present value of the marginal benefits, *MB, is* shown as declining, because each added year of schooling means fewer years over which benefits can be "collected." The utility-maximizing amount of human capital (HC*) for any individual is shown as that amount for which *MC = MB.*

Earlier, we noted that as people arrive at the point in their lives when human capital decisions must be made, they do so with different resources, learning abilities, and expectations about the future. Those who find learning to be especially arduous, for example, will implicitly attach a higher marginal psychic cost to acquiring human capital. As shown by the blue line, *MC',* in Figure *9.1* a, individuals, with higher marginal costs will acquire lower levels of human capital (compare HC' with HC*). Similarly, those who expect smaller future benefits from additional human capital investments (the blue line, *MB",* in Figure 9.1b) will acquire less human capital.

FIGURE 9.1
The Optimum Acquisition of Human Capital



This straightforward theory yields some interesting insights about the behavior and earnings of workers. Many of these insights can be discovered by analyzing the decision confronting young adults about whether to invest full-time in educational or training programs after leaving high school. We illustrate how our theory can be used by looking in some detail at the decision to attend college full-time; however, analyzing the demand for full-time vocational training programs would utilize the same principles and generate the same insights.

The Demand for a College Education

The demand for a college education, as measured by the percentage of graduating high school seniors who enroll in college, is surprisingly variable.[5] For males, enrollment rates went from 55.2 percent in 1970, down to 46.7 percent in 1980, and back up to 59.7 percent by 1993. The comparable enrollment rates for women started lower, at 48.5 percent in 1970, and rose continuously throughout this period to a high of 65.4 percent by 1993; however, while the yearly increase in enrollment rates averaged 0.3 percentage points in the 1970s, it averaged 1.0 points in the 1980s and early 1990s. Why have enrollment rates followed these patterns?

[5] Strictly speaking, enrollments equal demand only if all students who want to invest in a college education are able to do so. The barriers of failing to meet admissions criteria or failing to have the necessary financial resources may prevent some from investing, so the *level* of enrollments may understate the level of demand. Unless the importance of these barriers changes significantly over time, however, the *direction* of enrollment changes-which is our major interest-should reflect the direction of changes in demand.

WEIGHING THE COSTS AND BENEFITS OF COLLEGE

Clearly, people attend college when they believe they will be better off by so doing. For some, at least part of the benefits may be short-term-they like the courses or the lifestyle of a student-and to this extent college is at least partially a *consumption* good. The consumption benefits of college, however, are unlikely to change much over the course of a decade, so changes in college attendance rates over relatively short periods of time probably reflect changes in marginal costs or benefits associated with the *investment* aspects of college attendance.

Earlier we noted that the costs of college attendance are both monetary and psychic. The monetary costs alone (that is, the direct costs of tuition and books plus forgone earnings) are in the range of $17,000 to $32,000 per year.[6] The investment related benefits of a college education are associated with increased future earnings and any nonmonetary rewards from having access to occupations requiring a college education. Because only the monetary benefits are measurable, our analysis of the marginal benefits of college focuses on them.

A person considering college has, in some broad sense, a choice between two streams of earnings over his or her lifetime. Stream A begins immediately but does not rise very high; it is the earnings stream of a high school graduate. Stream B (the college graduate) has a negative income for the first four years (owing to college tuition costs), followed by a period when the salary may be less than the high school graduate makes, but then it takes off and rises above stream A. Both streams are illustrated in Figure 9.2. (Why these streams are differentially *curved* will be discussed later in this chapter.) The streams shown in the figure are stylized so that we can emphasize some basic points. Actual earnings streams will be shown in Figures 9.3 and 9.4.

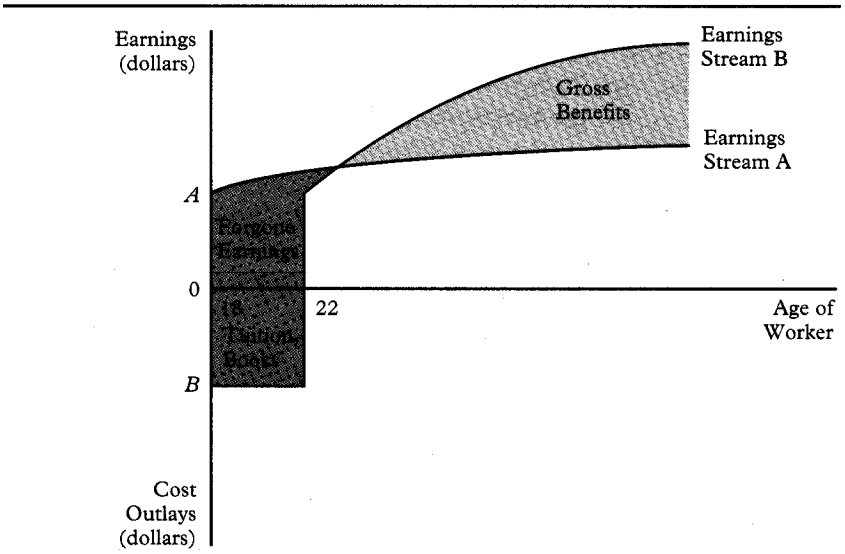
Obviously, the earnings of the college graduate would have to rise above those of the high school graduate to induce someone to invest in a college education (unless, of course, the consumption-related returns were large). The gross benefits, the difference in earnings between the two streams, must total much more than the costs because such returns are in the future and are therefore discounted. For example, suppose it costs $25,000 per year to obtain a four-year college education and the real interest rate (the nominal rate less the rate of inflation) is 2 percent. The after-tax returns-if they were the same each year must be $3,652 in constant-dollar terms (that is, after taking away the effects of inflation) each year for 40 years in order to justify the investment on purely monetary grounds. These returns must be $3,652 because $100,000 invested at a 2 percent interest rate can provide a payment (of interest and principal) totaling $3,652 a year for 40 years.[7]

---

[6] Cost estimates are from Charles T Clotfelter, Ronald G. Ehrenberg, Malcolm Getz, and John *Siegfried, Economic Challenges in Higher Education* (Chicago: University of Chicago Press, 1991), 72, expressed in 1995 dollars.

[7] This calculation is made using the annuity formula: $Y = X\,\frac{1-\left[1/(1+r)^n\right]}{r}$, where Y equals the total investment ($ 100,000), X = the yearly payment ($3,652), r the rate of interest (0.02), and n = the number of years (40). In this example, we treat the costs of a college education as being incurred all in one year rather than being spread out over four, a simplification that does not alter the magnitude of required returns much at all.

FIGURE 9.2
Alternative Earnings Streams



PREDICTIONS OF THE THEORY

In deciding whether to attend college, no doubt few students make the very precise calculations suggested in expression (9.2), Nevertheless, if they make less formal estimates that take into account the same factors, four predictions concerning the demand for college education can be made:

1. Present-oriented people are less likely to go to college than forward-looking people (other things equal).
2. Most college students will be young.
3. College attendance will decrease if the costs of college rise (other things equal).
4. College attendance will increase if the gap between the earnings of college graduates and high school graduates widens (again, other things equal).

PRESENT-ORIENTEDNESS Psychologists use the term *present-oriented* to describe people who do not weight future events or outcomes very heavily. While all people discount the future with respect to the present, those who discount it more than average-or, at the extreme, ignore, the future altogether-could be considered present-oriented. In terms of expressions (9.1) and (9.2), a present-oriented person is one who uses a very high discount rate (r).

Suppose one were to calculate investment returns using the *present-value method.* If *r is* large, the present value of benefits associated with college will be

lower than if the discount rate being used is smaller. Thus, a present-oriented person would impute smaller benefits to college attendance than one who is less present-oriented, and those who are present-oriented would be less likely to attend college. Using the *internal rate of return method* for evaluating the soundness of a college education, one would arrive at the same result. If a college education earns an 8 percent rate of return but the individuals in question are so presentoriented that they would insist on a 25 percent rate of return before investing, they would likewise decide not to attend.

The prediction that present-oriented people are less likely to attend college than forward-looking ones is difficult either to substantiate or to disprove. The rates of discount that people use in making investment decisions are rarely available, because such decisions are not made as formally as expression (9.2) implies. However, the model does suggest that people who have a high propensity to invest in education will also engage in other forward-looking behavior. Certain medical statistics tend to support this prediction.

In the United States there is a strong statistical correlation between education and health status.[8] People with more years of schooling have lower mortality rates, fewer symptoms of disease (such as high blood pressure, high cholesterol levels, abnormal X-rays), and a greater tendency to report themselves to be in good health. This effect of education on health is independent of income, which appears to have no effect of its own on health status except at the lowest poverty levels. Is this correlation between education and health a result of better use of medical resources by the well-educated? It appears not. Better-educated people undergoing surgery choose the same doctors, enter the hospital at the same stage of disease, and have the same length of stay as less-educated people of equal income.

What *may* cause this correlation is a more forward-looking attitude among those who have obtained more education. People with lower discount rates will be more likely to attend college, and they will also be more likely to adopt forward-looking habits of health. They may choose healthier diets, be more aware of health risks, and make more use of preventive medicine. This explanation for the correlation between education and health is not the only plausible one, but it receives some direct support from American data on cigarette smoking.[9] From 1966 to 1987, the proportion of male college graduates who smoked fell by 50 percent. During the same time period, the proportion of smokers among male high school dropouts was essentially unchanged. It is unlikely that the less-educated group was uninformed of the smoking dangers revealed during that period. It is more likely that they were less willing to give up a present source of pleasure for a distant benefit. Thus, we have at least some evidence that people who invest in education also engage in other forward-looking behavior,

---

[8] The analysis of the correlation between education and health status is taken from Victor Fuchs, "The Economics of Health in a Post-Industrial Society," *The Public Interest* (Summer 1979): 3-20.

[9] It could be, for example, that healthy people, iAith longer life spans, are more likely to invest in human capital because they expect to experience a longer payback period. Alternatively, one could argue that the higher incomes of college graduates later in life mean they have more to lose from illness than do non-college graduates. Data on smoking are from U.S. Department of Health and Human Services, Public Health Service, *Smoking Tobacco and Health,* DHHS publication no. (CDC)87-8397, October 1989,5.

AGE Given similar yearly benefits of going to college, young people have a larger present value of total benefits than older workers simply because they have a longer remaining work life ahead of them. In terms of expression (9.2), T for younger people is greater than for older ones. We would therefore expect younger people to have a greater propensity than older people to obtain a college education or engage in other forms of training activity. This prediction is parallel to the predictions in Chapter 5 about which workers employers will decide to invest in when they make decisions about hiring or specific training.

COSTS A third prediction of our model is that human capital investments are more likely when costs are lower. The major monetary costs of college attendance are forgone earnings and the direct costs of tuition, books, and fees. (Food and lodging are not always opportunity costs of going to college because some of these costs would have to be incurred in any event.) Thus, if forgone earnings or tuition costs rise, other things equal, we would expect a decrease in college enrollments. Similarly, if offers of financial aid to college applicants fall, other things equal, we would expect fewer enrollments. Are college enrollments responsive to cost?

Financial aid packages, including loans, rarely cover all the out-of-pocket expenses of college, and so the financial resources of students' families must be tapped for at least some of their costs. Given this fact, it is not surprising that, other things equal, students from relatively wealthy families are more likely to attend college. For example, 44 percent of high-ability students from low-income families enroll in four-year colleges, while the comparable figure for high-ability students from relatively wealthy backgrounds is 74 percent. Moreover, from 1974 to 1984, when financial aid to students from lower-income families rose more slowly than tuition and more slowly than financial aid to upper-income students, the proportion of college students from lower-income backgrounds fell.[10]

The costs of college attendance offer an additional reason why we observe older' people attending less often than younger people. As workers age, they acquire levels of experience and maturity that employers are willing to reward with higher wages. Because older workers thus command higher wages (on average), their opportunity costs of college attendance are higher than those for younger students. Older people are thus doubly discouraged from attending college: their forgone earnings are relatively high and the period over which they can capture benefits is comparatively short. Interestingly, however, college attendance by military veterans (who are older than the typical college student) has been quite responsive to the educational subsidies for which they are eligible.[11]

The subject of cost raises an interesting question: just who is most *responsive to* cost considerations? Economic theory postulates that, in any set of market transactions, some people are *at the* margin-meaning that they are close to the point of not transacting. Those closer to the margin, then, are the ones most likely to change their decisions in response to relatively small changes in the monetary costs of college. Who are those for whom the decision to attend is a "close call"?

---

[10] Charles Clotfelter, et al., *Economic Challenges in Higher Education, 43, 72, 103,* 105, and 110.

[11] See Joshua D. Angrist, "The Effect of Veterans Benefits on Education and Earnings," *Industrial and Labor Relations Review 46,* no. *4 (July 1993): 637-652.*

Our theoretical considerations have suggested several possibilities: those with lower cognitive achievement levels, lower levels of parental wealth, or higher personal discount rates (a greater degree of present-orientation). Interestingly, studies that have analyzed how the cost advantages of having a college in one's hometown affect an individual's enrollment decision find that these effects are largest for students who would otherwise be least likely to attend (that is, students with lower cognitive achievement and parents with lower levels of educational attainment themselves).[12]

EARNINGS DIFFERENTIALS The fourth prediction of human capital theory is that the demand for education is positively related to the increases in lifetime earnings that a college education allows. Strictly speaking, it is the benefits one *expects* to receive that are critical to this decision, and the expected benefits for any individual an? rather uncertain. Future earnings can never be perfectly foretold, and in addition, many students are uncertain about their later occupational choice.[13] As a first approximation, however, it is reasonable to conjecture that the *average returns* received by recent college graduates have an important influence on students' decisions. Thus, if the average earnings differential between recent college graduates and recent high school graduates of similar age were to narrow, we should expect to find that college enrollment rates subsequently decline. In contrast, if this differential were to widen, enrollment rates should increase.[14]

Dramatic changes in the average monetary returns to a college education over the past two decades are at least partially, if not largely, responsible for the changes in college enrollment rates noted earlier. It can be seen from the first and third columns of Table 9.1, for example, that the decline in male enrollment rates during the 1970s was correlated with declines in the college/high school earnings differential, while the higher enrollment -rates in the 1980s and early 1990s were associated with larger earnings differentials. (Interestingly, as discussed in Example 9.2, recent increases in the earnings differential between male college and high school graduates have not been created by a robust market for college graduates, but rather by a dramatic decline in the prospects of male high school graduates.)

---

[12] C. A. Anderson, M. J. Bowman, and B.Tinto, *W7iere Colleges Are and Who Attends* (New York: McGraw *Hill, 1972);* and David Card, "Using Geographic Variation in College Proximity to Estimate the Return to Schooling," in *Aspects of Labour Market Behavior: Essays in Honour of John Vanderkamp,* ed L. N. Christofides, E. K. Grant, and R. Swindinsky (Toronto: University of Toronto Press, *1995).*

[13] For studies that incorporate uncertainty into the formal model of choice, see Joseph G. Altonji, "The Demand for and Return to Education When Education Outcomes Are Uncertain,",7ournal of *Labor Economics 10* (January *1993): 48-83;* and Peter F. Orazern and J. Peter Mattila, "Human Capital, Uncertain Wage Distributions, and Occupational and Educational Choices," *International Economic Review 32* (February *1991): 103-122.* For a paper on the accuracy of students' knowledge about the salaries in various fields, see Julian R. Betts, "What Do Students Know About Wages? Survey Evidence on Mechanisms of Occupational Choice," working paper no. *93-45,* University of California-San Diego, Department of Economics, October *1993.*

[14] "Mary T Coleman, "Movements in the Earnings-Schooling Relationship, 1940-88," *Journal of Human Resources* 28, no. 3 (Summer 1993): 660-680, provides a careful documentation of the college/high school earnings differential since 1940.

TABLE 9.1
Changes in College Enrollments and the College High School Earnings Differential, by Gender, 1970-1993

Year	College Enrollment Rates of Graduates		Ratios of Mean Earnings of College to High School New High School Graduates, Ages 25-34, PriorYear[a]	
	Male	Female	Male	Female
1970	55.2%	48.5%	1.38	1.42
1975	52.6	49.0	1.16	1.29
1980	46.7	51.8	1.19	1.29
1985	58.6	56.9	1.27	1.35
1990	57.8	62.0	1.48	1.59
1993	59.7	65.4	1.54	1.53

[a]For year-round, full-time workers. Data for the first two years are for personal income, not earnings; however, in the years for which both income and earnings are available, the ratios are essentially equal.
SOURCES: U.S. Department of Education, *Digest of Education Statistics* 1994 (October 1994),Table 180; U.S. Bureau of the Census, *Money Income of Families and Persons in the United States,* Current Population Reports P-60, no. 66 (Table 4 1), no. 10 1 (Table 58), no. 129 (Table 53), no. 15 1 (Table 34), no. 174 (Table 29), no. 184 (Table 30).

The second and fourth columns of Table 9.1 document changes in enrollment rates and earnings differentials for women. Unlike enrollment rates for men, those for women rose throughout the two decades; however, it is notable that they rose much more slowly in the 1970s, when the college/high school earnings differential fell. Why did enrollment rates among women increase even when the earnings differential fell? Because women's labor force participation rates and their hours of work outside the home have increased over time, the period over which their human capital investment returns can be received has lengthened. It is quite plausible that, for women during the 1970s, increases in the expected number of years over which returns will be received more than offset declines in the returns expected for any given year-with the result that expected rates of return to a college education still grew.[15]

While changes in average earnings differentials are a useful indicator of relative labor market conditions, individuals must assess their own probabilities of success in specific fields or occupations. Recent studies have pointed to the importance of

[15] For evidence that women with "traditional" views of their economic roles receive lower rates of return on, and invest less in, human capital, see Francis Vella, "Gender Roles and Human Capital Investment: The Relationship Between Traditional Attitudes and Female Labour Market Performance," *Economica 6 1,* no. 242 (May 1994): 191-211. For an interesting analysis of historical trends in female college attendance, see Claudia Goldin, "Career and Family: College Women Look to the Past," working paper no. 5188, National Bureau of Economic Research, Cambridge, Mass., 1995.

friends, ethnic affiliation, and neighborhoods in the human capital decisions of individuals, even after controlling for the effects of parental income or education.[16] The educational and occupational choices of friends and acquaintances appear to have a significant effect on an individual's human capital decisions, perhaps be cause the presence of role models helps to reduce the uncertainty that inevitably surrounds estimates of future success in specific areas.

MARKET RESPONSES TO CHANGES IN COLLEGE ATTENDANCE

It is clear from Table 9.1 that the returns to college attendance have varied considerably over the past two decades, but the root causes of these changes are not immediately obvious. While we will inquire more deeply into these causes in Chapter 14, the student should be reminded at this point that, like other marke prices, the returns to college attendance are determined by the forces of both ernployer demand and employee supply. Thus, if more high school students decide to attend college when presented with higher returns to such an investment, market forces are put into play that will tend to lower these returns in the future., Increased numbers of college graduates put downward pressure on the wages observed in labor markets for these graduates, other things equal, while a smaller number of high school graduates will tend to raise wages in markets for less-educated workers.[17]

The fact that the *future* salaries commanded by college graduates are affected by the number of people who *currently* decide to attend may seem obvious, but it adds another element of uncertainty to an individual's estimation of the expected returns to a college investment. An individual may observe that the returns to college attendance have recently increased, but *others will* observe this increase as, well. If the improved returns cause a large rise in the percentage of high school graduates who attend college, the influx of workers four years from now into the labor markets for college graduates will put downward pressure on their wages at that time. Thus, current returns may be an unreliable estimate of future returns, (For an analysis of how the labor market might respond when workers behave as if the returns observed currently will persist into the future, see Appendix 9A.)

---

[16] George J. Borias, "Ethnic Capital and Intergenerational Mobility," *Quarterly Journal of Economics* 107 (February 1992): 123-150; Borjas, "Ethnicity, Neighborhoods, and Human Capital Externalities"; and James D. Montgomery, "Social Networks and Labor-Market Outcomes: Toward an Economic Analysis," *American Economic Review* 81 (December 1991): 1408-1418.

[17] One recent study estimated that, if the demand for college graduates remains steady, the increased supply of college graduates in response to the currently high returns to college would, by the year 2000, reduce the college/high school earnings differential by 25 percent. See Jacob Mincer, "Investment in US, Education and Training," working paper no. 4844, National Bureau of Economic Research, Cambridge, Mass., 1994.

EXAMPLE 9.2

Is the Market for College Graduates That Good, or Is the One for High School Graduates That Bad?

The rising returns to a college education evident in Table 9.1 may have seemed illusory to a college graduate who, in the early 1990s, was in the labor market. Compared to graduates in the late 1980s, college graduates in the early 1990s were increasingly likely to be unemployed, to start their careers in lower-paying sectors of the economy, and to be paid by the hour. How do these facts square with the claim that the returns to an investment in college were rising?

Human capital theory emphasizes that the monetary benefits of an educational investment are a function of the differential between one's expected earnings with and without the investment. Because it is the earnings differential that matters to a prospective student, one can observe an increase in the returns to college even in a market in which college graduates face the prospect of falling earnings; what is required is that the earnings of high school graduates be falling even faster!

In 1992, male college graduates between the ages of 25 and 29 earned an average of $32,225 per year if they worked full-time, whereas in 1985 they made an average of $35,032 if the Consumer Price Index is used to adjust for inflation. (As noted in Chapter 2, especially Table 2.2, the Consumer Price Index may

During this period, however, the average earnings of male high school graduates of similar age fell by 15 percent. Thus, however bad was the market for male college graduates, the market for male high school graduates was even worse, so that the wage differential between the two grew. Investing in a college education thus became more attractive, mainly as a way to escape the market's harsh treatment of male high school graduates during this period.

(The changing market conditions for women were not as adverse for either educational group. The real earnings of 25- to 29-year-old women who graduated from college and who worked full-time rose by I percent over this period, while comparable earnings for female high school graduates fell by 3 percent. We will analyze, in Chapter 14, why these earnings patterns developed for men and women of different educational groups.)

SOURCES: U.S. Bureau of the Census, Money Income of Households, Families, and Persons in the United States,
Current Population Reports P-60, no. 156 (Table 36) and no. 184 (Table 30); Paul Ryscavage, "Recent Data on job Prospects of College-Educated Youth:' *Monthly Labor* Review 116, no. 8 (August

overstate inflation to an unknown extent, but we use it here because it is readily available.) This 8 percent decline in real earnings reflect the labor market difficulties, noted above, that faced college graduates immediately after graduation in the early 1990s.

1993): 16-26. On this same subject, see John Tyler, Richard Murnane, and Frank Levy, "Are More College Graduates Really Taking High School jobs? *Monthly* Labor Review 118, no. 12 (December 1995): 18-28.

Education, Earnings, and Postschooling Investments in Human Capital

The preceding section used human capital theory to analyze the decision to undertake a formal educational program (college) on a full-time basis. We now turn to an analysis of workers' decisions to acquire training after they leave school and start working. Frequently, the human capital investments made after one has started to work arise from training received at the workplace. The presence of this type of training is difficult for the economist to directly observe; much of it is informal and not publicly recorded. We can, however, use human capital theory and certain patterns in workers' lifetime earnings to draw inferences about their demand for this type of training.

Figures 9.3 and 9.4 graph the 1992 earnings of men and women of various ages with different levels of education. An examination of these figures reveals four notable characteristics:

1. Average earnings of full-time workers rise with the level of education;
2. The most rapid increase in earnings occurs early in one's working life, thus giving a convex shape to the age/earnings profiles of both men and women;
3. Age/earnings profiles tend to fan out, so that education-related earnings differences later in workers' lives are greater than those early on;
4. The age/earnings profiles of men tend to be more convex and to fan out more than those for women.

In the sections that follow, we use human capital theory to help explain the above empirical regularities, with special attention given to the last three.

AVERAGE EARNINGS AND EDUCATIONAL LEVEL

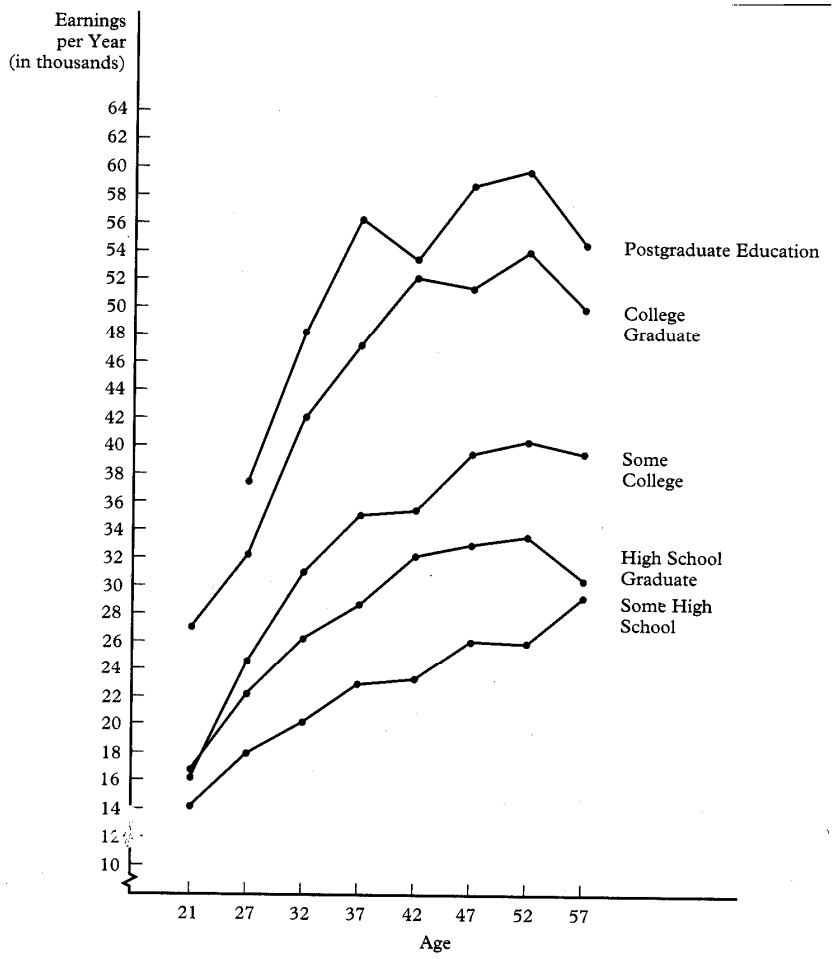
It is an implication of our *investment* model of educational choice that earnings rise with the level of education, for if they did not, the incentives for students to invest in more education would disappear. It is thus not too surprising to see in

Figures 9.3 and 9.4 that the average earnings of more-educated workers exceed those of less educated workers.

It is worthwhile to remember, however, that *earnings* are influenced by both wage rates and hours of work. Data on *wage rates* are probably most relevant when looking at the returns to an educational investment, because they indicate one's pay per unit of time at work. Wage data, however, are less widely available than earnings data. A crude, but readily available, way to control for working hours when using earnings data is to focus on full-time, year-round workers-which we do in Figures 9.3 and 9.4. More careful statistical analyses, however, which control for hours of work and factors other than education that can increase wage rates, come to the same conclusion suggested by Figures 9.3 and 9.4: namely, that more education is associated with higher pay. (A more rigorous theoretical analysis of the association between education and pay can be found in Appendix 9B, which presents the analysis in the context of hedonic wage theory.)

FIGURE 9.3

Money Earnings (Mean), for Full-Time Year-Round Male Workers, 1992



SOURCE: See footnote 18.

ON-THE-JOB TRAINING AND THE CONVEXITY OF AGE/EARNINGS PROFILES

The age/earnings profiles in Figures 9.3 and 9.4 typically rise steeply early on, then tend to flatten, and may eventually fall.[18] In fact, the early increases are so steep relative to those later on that a study of men's wage rates found that two-thirds of their *career* wage growth occurred in their first ten years of work![19] While in the next two chapters we will encounter other potential explanations for why earnings rise in this way with age, human capital theory explains the convexity of these profiles in terms of *on-the-job training.*[20]

Some on-the-job training is *learning by doing* (as one hammers nails month after month, one's skills naturally improve), but much of it takes place either in formal training programs run by employers or informally, in which case a trainee works under the close supervision of a more experienced worker. All forms of training are costly, in the sense that the productivity of learners is low, and all represent a conscious *choice* on the part of the employer to accept lower current productivity in exchange for higher output later. Both formal and informal training also involve the commitment of time by trainers or supervisors to the teaching process.[21]

Who bears the cost of on-the-job training? You will recall from Chapter 5 that the cost of *specific training,* training of use *only* to one's employer, is shared by the worker and the firm. The employee might be paid a wage greater than marginal product during the training period *(MPO),* but after training the employee's wage is below his or her post training marginal product *(MP,).* In the case of *general training,* in which employees acquire skills usable elsewhere, they alone pay the training costs.

How do employees pay the costs of general training provided by their employer? They work for a wage lower than they would get if they were not receiving training. Their wage is always equal to their *MP,* which is, of course, decreased during the training period when trainees require close supervision or time off the job to engage in classroom learning. Why do employees accept this lower wage? They accept it for the same reason that some decide to obtain formal

---

[18] The data reflected in Figures 9.3 and 9.4 do not "follow" specific individuals through time; rather, they match earnings with age and education in a given year. Thus, the generally declining profiles for men in their fifties could reflect reduced job opportunities for older men, changes in the composition of men still working full-time at age 57, or some factor that depressed the earnings of men born in the middle 1930s. Data in these figures are from U.S. Bureau of the Census, *Money Income of Households, Families and Persons in the United States,* Current Population Reports P-60, no. 184, Table 3 0.

[19] Kevin M. Murphy and Finis Welch, "Empirical Age-Earnings Profiles," *Journal of Labor Economics* 8 (April 1990): 202-229.

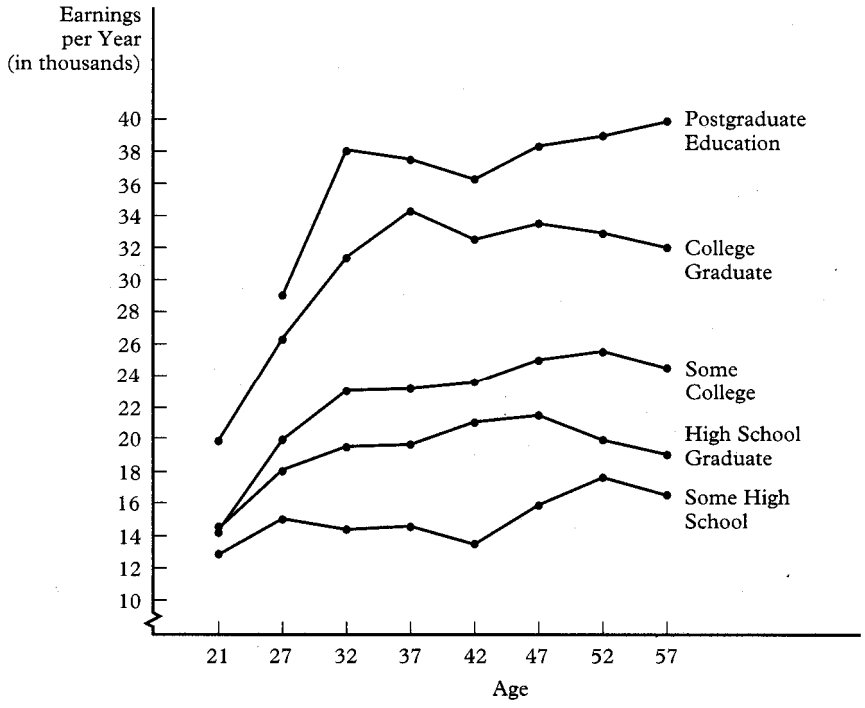
[20] For recent discussions of the relative importance of the human capital explanation for rising age/earnings profiles, see Ann P. Bartel, "Training, Wage Growth, and job Performance: Evidence from a Company Database," *_76urnal of Labor Economics* 13, no. 3 (July 1995): 401-425, and Charles Brown, "Empirical Evidence on Private Training," in *Research in Labor Economics, vol. 11,* ed. Lauri J. Bassi and David L. Crawford (Greenwich, Conn.: JAI Press, 1990), 97-114.

[21] It has been estimated that employers spend between $18 and $43 billion each year (1995 dollars) on *formal* training programs. The amount spent on informal training is unknown. See Stephen C. Mangum, "Evidence on Private Sector Training," in *Investing in People,* Background Papers, vol. 1, Commission on Workplace Quality and Labor Market Efficiency, U.S. Department of Labor (September 1989): 332-385.

schooling: in the expectation of improving the present value of their lifetime earnings. In other words, employees incur current investment costs (lower wages) to obtain increased earnings later.

Earlier, we argued that if people are going to invest in themselves they will tend to undertake most of the investment at younger ages. Human capital investments made at younger ages have a longer period over which to capture returns, and earnings that must be forgone during the period of training are lower when one is younger. Thus, other things equal, investments made earlier have higher rates of return.

FIGURE 9.4
Money Earnings (Mean), for Full Time, Year Round Female Workers, 1992



SOURCE: See footnote 18.

FIGURE 9.5
Investment in On-the-job Training over the Life Cycle

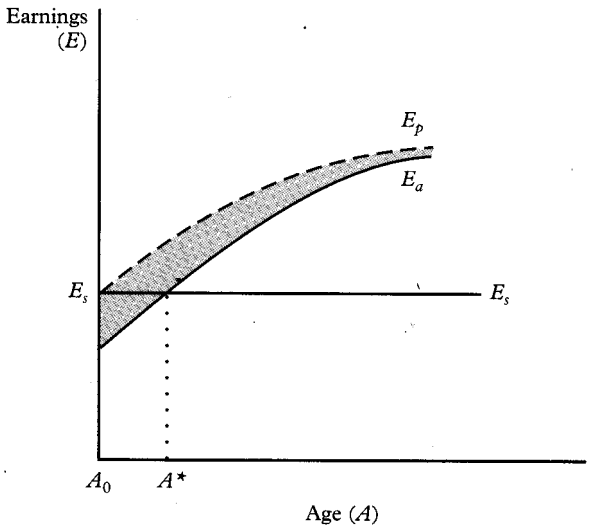


Figure 9.5 graphically depicts the life-cycle implications of human capital theory as it applies to on-the-job training. The individual depicted has completed full-time schooling, and with this schooling is able to earn *E,* at age A0. Without further training, if the knowledge and skills the worker possesses from his or her schooling do not depreciate over time, earnings would remain at *E,* over the life cycle. If the worker chooses to invest in on-the-job training, his or her future earnings potential can be enhanced, as shown by the (dashed) curve EP in the figure. Investment in on-the-job training, however, has the near-term consequence that actual earnings are below potential; thus, in terms of Figure 9.5, actual earnings *(E)* lie below EP as long as the worker is investing. In fact, the gap between EP and E, equals the worker's investment costs.

Figure 9.5 is drawn to reflect the theoretical implication, noted above, that human capital investments decline with age. With each succeeding year, actual earnings become closer to potential earnings; further, because workers become less willing to invest in human capital as they age, the yearly *increases* in potential earnings become smaller and smaller. Thus, curve EP takes on a convex shape, quickly rising above *E,* but flattening later in the life cycle.

Curve *Ea* also takes on a convex shape over the life cycle. Actual earnings start below *Ea,* and do not rise above it until after age A*. As human capital investments decline with age, however, *Ea* rises more quickly than EP, until at some point later in the life cycle actual and potential earnings are virtually identical. At this point, of course, the worker is no longer making on-the-job investments in human capital.[22]

[22] A* is sometimes called the "overtaking" age, and it is of great theoretical interest to economists. Because we cannot observe E_p- and can only observe E_a.- it is not possible to directly measure workers' investments in on-the-job training. Thus, we cannot directly test

Earnings differences across workers with different educational backgrounds tend to become more pronounced as they age. This phenomenon is also consistent with what human capital theory would predict.

Investments in human capital tend to be more likely when the expected earnings differentials are greater, when the initial investment costs are lower and when the investor has either a longer time to recoup the returns or a lower discount rate. Earlier, we argued that both younger people and those most willing to defer current consumption for future gains are more likely to invest in human capital. It should also be obvious that the same can be said of people who have the ability to learn more quickly. The ability to learn rapidly shortens the training period, and fast learners probably also experience lower psychic costs (lower levels of frustration) during training.

Thus, people who have the ability to learn quickly are those most likely to seek out, and be presented by employers with, training opportunities.[23] But who are these fast learners? They are most likely the people who, because of their abilities, were best able to reap benefits from formal schooling! Thus, human capital theory leads us to expect that workers who invested more in schooling will also invest more in postschooling job training.

The tendency of the better-educated workers to invest more in job training explains why their age/earnings profiles start low, rise quickly, and keep rising after the profiles of their less-educated counterparts have leveled off. Their earnings rise more quickly because they are investing more heavily in job training, and they rise

---

the theoretical implication that investments in on-the-job training decline with age. One indirect test of the theory is to see if age/earnings profiles are convex, but another lies with A*. If human capital theory provides a useful explanation for the shape of age/earnings profiles, then there should be some age (beyond A_O) at which differences in formal schooling do a better job of explaining differences in actual earnings than at either earlier or later ages. The age at which differences in formal schooling and differences in earnings are most closely related is A*-the age at which actual earnings equal E_s the potential earnings absent on-the-job training. Before A*, actual earnings are below E_s and reflect an unknown amount of on-the-job training; after A*, earnings are also "contaminated" by both the costs and returns to an unknown amount of on-the-job training. Landmark research on this topic estimated that, indeed, schooling has maximum correlation with earnings at about ten years after labor market entry; see Jacob Mincer, *Schooling, Experience, and Earnings* (New York: Columbia University Press for National Bureau of Economic Research, 1974), 57.

For other evidence consistent with the human capital model summarized in Figure 9.5, see David Neumark and Paul Taubman, "Why Do Wage Profiles Slope Upward? Tests of the General Human Capital Model," *Journal of Labor Economics* 13, no. 4 (October 1995): 736-76 1.

[23] For studies showing that on-the-job training is positively correlated with both educational level and ability, see Joseph G. Altonji and James R. Spletzer, "Worker Characteristics, job Characteristics, and the Receipt of On-the-job Training," *Industrial and Labor Relations Review* 45 (October 1991): 58-79; Jonathan R. Veum, "Training Among Young Adults: Who, What Kind, and For How Long?" *Monthly Labor Review* 116, no.8 (August 1993): 27-32; and Jill Constantine and David Neumark, "Training and the Growth mWage Inequality," working paper no. 4729, National Bureau of Economic Research, Cambridge, Mass., May 1994.

for a longer time for the same reason. In other words, people with the ability to learn quickly select the ultimately high-paying jobs where much learning is required and thus put their abilities to greatest advantage.

WOMEN AND THE ACQUISITION OF HUMAN CAPITAL

A comparison of Figures 9.3 and 9.4 discloses immediately that the earnings of women who work full-time year-round are lower than for men of equivalent age and education, and that women's earnings within each educational group rise less steeply with age. The purpose of this section is to analyze these differences in the context of human capital theory (a more complete analysis of male/female wage differentials is presented in Chapter 12).

As we have seen, human capital theory begins with an analysis of people's incentives to invest in education and training, and the expected monetary returns to such an investment are critical to their decisions. Anything that reduces these expected returns is hypothesized to reduce the incentives for workers (or their employers) to invest in human capital. -

A major difference in the incentives of men and women to make human capital investments has historically been in the, length of work life over which the costs of a human capital investment can be recouped. Chapters 6 and 7 clearly showed how rapidly working for pay has increased among women in recent decades, and this fact obviously should have made human capital investments more lucrative for women. Nevertheless, Table 9.2 shows that it is still the case that, on average, women can be expected to work (for pay) fewer years than men.. In addition, Table 9.2 indicates that within the occupations shown-all of which require the acquisition of skills-women average fewer hours of work per week than do men.

To the extent that there is a shorter expected work life for women than for men, it is caused primarily by the role women have historically played in child-rearing and household production. This traditional role, while undergoing significant change, has caused many women to drop out of the labor market for a period of time in their childbearing years. Thus, female workers often have not had the continuity of experience that their male counterparts accumulate. If this historical experience causes younger women who are making important human capital decisions to expect a discontinuity in their own labor force participation, they might understandably avoid occupations or fields of study in which one's skills depreciate during the period out of the labor market.[24] Moreover, historical experience could cause employers to avoid hiring women for jobs requiring much on-

[24] Jacob Mincer and Haim Ofek, "Interrupted Work Careers: Depreciation and Restoration of Human Capital," *Journal of Human Resources 17* (Winter 1982): 3-24, documented women's loss of earnings associated with withdrawal from the labor force. This study found that, upon reentry, women earn a lower real wage than when they withdrew. While wage growth is relatively rapid after reentry, the earnings of women who withdrew from the labor market never fully recover. Similar losses were suffered by men who involuntarily "withdrew" from their careers by being drafted into military service during the Vietnam War; see Joshua D. Angrist, "Lifetime Earnings and the Vietnam Era Draft Lottery: Evidence from Social Security Administrative Records," *American Economic Review* 80 (June 1990): 313-336. For a recent paper on skill depreciation rates, see Moon-Kak Kim and Solomon W. Polachek, "Panel Estimates of Male-Female Earnings Functions," *Journal of Human Resources* 29, no. 2 (Spring 1994): 406-428.

the-job training-a practice that itself will affect the returns women can expect from a human capital investment. Human capital theory, however, *also* predicts that recent changes in the labor force participation of women, especially married women of childbearing age, are causing dramatic changes in the acquisition of schooling and training by women. We turn now to a discussion of recent changes in these two areas.

TABLE 9.2
Average Work Life and Hours of Work, by Gender

Remaining Expected Years of Paid Work at Age 25':	**Male**	**Female**
High school graduates	34.1 (years)	25.4 (years)
Some college	35.4	27.8
College graduates	37.2	30.3
Average Weekly Hours of Paid Work for Those Working Full-Time in 1994:		
Executive, administrative, managerial workers	47.6 (hours)	43.1 (hours)
Professional specialty workers	45.9	41.6
Technicians and related support workers	43.4	40.4
Sales workers	47.5	42.1
Precision production, craft, and repair workers	43.2	41.5

[a] Data relate to nondisabled individuals in 1988.
SOURCES:Anthony M. Gamboa,"The NewWorklile Expectancy Tables for Disabled and Nonclisabled Persons by Sex and Level of Educational Attainment:'Vocational Econometrics, Louisville, Kentucky (199 1); U.S. Bureau of Labor Statistics, *Employment and Earnings 42* Oanuary 1995): Table *23.*

WOMEN AND JOB TRAINING There is little doubt that women receive less on-the-job training than men. A study of formal company training given to workers in their twenties found that, over the period 1986 to 1991, a lower percentage of women workers received such training and, of those who did, the hours of training were fewer. than those for men.[25] To the extent that the presence and patterns of on-the-job training cause age/earnings profiles to be convex, an explanation for the flatter age/earnings profiles of women may well be rooted in their lower levels of on-the-job training. This human capital "explanation" for the flatter age/earnings profiles among women does not directly address whether the lower levels of job training emanate from the employer or the employee side of the market, but both possibilities are theoretically plausible. If employers expect

[25] Veum, "Training AmongYoung Adults: Who, What Kind, and For How Long?"

women workers to have shorter work lives, they are less likely to provide training to them. Alternatively, if women themselves expect shorter work lives, they will be less inclined to seek out jobs requiring high levels of training to reach full productivity Finally, if women expect employers to bar them from occupations requiring substantial amounts of training or experience, their expected returns to investments in these occupations will be diminished, thus reducing their incentives for such investments.[26]

While human capital theory predicts that the "traditional" role of women in child-rearing will lead to reduced incentives for training investments, it also quite strongly suggests that as this role changes, the incentives for women to acquire training will change.[27] We should thus expect to observe a growing convexity in women's age/ earnings profiles over the past decades, and Figure 9.6 indicates this expectation is generally supported.

The darker lines in Figure 9.6 are the 1992 profiles for college and high school graduates that appeared in Figure 9.4. The lighter lines indicate the comparable profiles for 1977 (with earnings adjusted to 1992 dollars using the Consumer Price Index). A visual comparison reveals that the age/earnings profile for college-educated women has become much steeper for those in their twenties and early thirties. For example, in 1977 the earnings of a 32-year-old female college graduate were 26 percent greater than those of a 21-year-old college graduate, while in 1992 they were 59 percent greater. For women with high school educations, the profile for those in their twenties is only slightly steeper; 32-year-olds with high school educations earned 25 percent more than 21-year-olds in 1977 and 33 percent more in 1992. The faster earnings growth among younger women in 1992, as compared to 1977, suggests that their receipt of on-the-job training may have increased as their expected work lives have lengthened.

It is interesting to note that in a survey of workers who entered the labor force between 1979 and 1983, women did indeed experience lower average wage growth than did their male counterparts over their first four years of work (22.5 percent growth in four years for women, 27.6 percent for men). Different growth rates, however, were found, *only* among those who *changed employers;* men and women who stayed with the same employer had essentially the same rate of wage growth.[28] While some of the relatively slower wage growth for women who changed jobs was explained by their greater propensity to seek part-time work, most of this differential wage growth remained unexplained. An intriguing possibility raised by this study, however, is that recently hired women who stay with their employers may now be receiving the same levels of on-the-job training as their male colleagues.

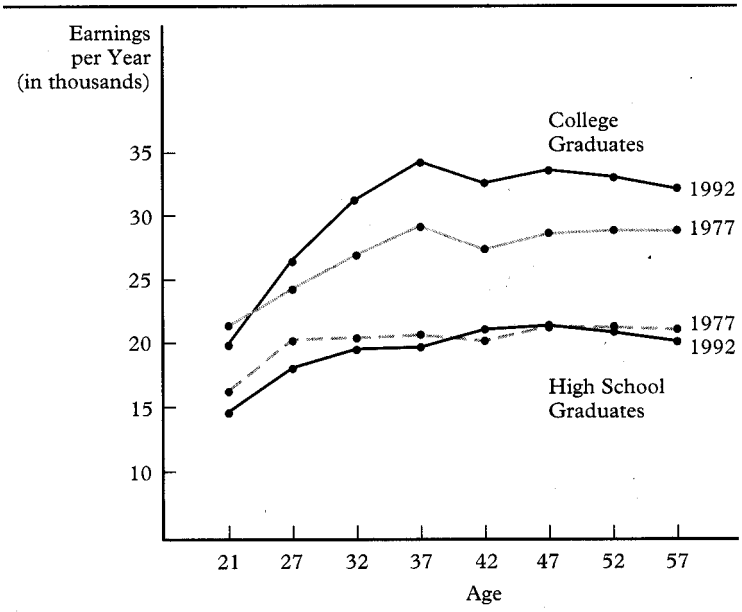
---

[26] Francine D. Blau and Marianne A. Ferber, "Career Plans and Expectations of Young Women and Men,",7ournal of *Human Resources 26* (Fall *1991): 581-607,* found that female college seniors, who expected starting salaries equal to those expected by men, expected much lower salaries later in their careers.

[27] See Elizabeth T Hill, "Labor Market Effects of Women's Post-School-Age Training," *Industrial and Labor Relations Review 49,* no. 1 (October *1995): 138-149.*

[28] Pamela J. Loprest, "Gender Differences in Wage Growth and job Mobility," *American Economic Review 82* (May *1992): 526-532.*

FIGURE 9.6
The Increased Convexity of Women's Age/Earnings Profiles



WOMEN AND FORMAL SCHOOLING As Table 9.1 suggested, there have been dramatic changes in the level of formal education received by women in recent years. Their fields of study have also changed markedly. These changes undoubtedly reflect the increased returns to human capital investments arising from women's increased attachment to the labor force and longer expected work lives. Table 9.3 outlines some of the magnitudes of these changes.

Women, who traditionally were less likely than men to graduate from college, now represent over half of both bachelor's and master's graduates. Increases have been especially great at the master's level, indicating that for many women, expected labor force attachment is now so great than an investment in postgraduate education is considered worthwhile. The most stunning changes, however, have occurred in the fields of study. Bachelor's business graduates, for example, are now almost 50 percent women; in 1971, women were only 9 percent of the total. A six fold increase can be seen among those receiving law and doctor of medicine degrees, and even greater percentage gains were recorded in the field of engineering and in business programs at the master's level.[29] (The traditionally

[29] For a study of how changes in college majors, for both women and men, have affected the rate of return to college in recent years, see Jeff Grogger and Eric Eide, "Changes in College Skills and the Rise in the College Wage Premium," *_7ournal of Human Resources 30,* no. *2* (Spring *1995): 280-3 10.* For a study of how college major, among other things, affects earnings, see Linda Datcher Loury and David Gorman, "College Selectivity and Earnings," *Journal of Labor Economics 13,* no. *2* (April *1995): 289-308.*

"female" fields of English, education, and health care have become slightly more heavily female, largely because college campuses themselves are more heavily female.)

TABLE 9.3
Percentages of Women Among College and University Graduates, by Degree and Field Of Study, 1971 and 1991

Percentage of	Bachelor's Degree		Master's Degree	
Women Among:	**1971**	**1991**	**1971**	**1991**
Total	43.4%	53.9%	40.1%	51.0%
Business majors	9.1	47.2 -	3.9	34.9
Computer science majors	13.6	29.3	10.3	29.6
Education majors	74.5	78.9	56.2	76.6
Engineering majors	0.8	13.9	1.1	14.1
English majors	66.7	67.8	61.0	66.8
Health professionals	77.1	83.6	55.9	79.0
First professional degreea			6.3	39.0

[a]Degrees in this category are largely doctor's degrees in law, medicine, and dentistry.

SOURCE: U.S. National Center for Education Statistics, *Digest* of *Education Statistics 1993* (1993),Tables 235, 269, 271-273, 275,278.

Although the data in Table 9.3 indicate a very rapid change in the human capital decisions among women, it is still true that women are "underrepresented" in certain fields: engineering, computer science, business at the master's degree level, and the professions of law and medicine. While interests that develop in the process of socialization may account for some of this under-representation, some women's expectations of a discontinuity in labor market experience may also be part of the explanation. The fields in which women are still underrepresented tend to be highly technical, and concerns about the depreciation of human capital during any expected period out of the labor force could reduce the incentives of women to invest heavily in these fields.

Is Education a Good Investment?

It is well established that workers with more education tend to earn higher wages. However, an individual deciding whether to go to college would naturally ask, "Will I increase my monetary and psychic income enough to justify the costs of

going to college?" Further, government policyrnakers trying to decide whether to improve educational programs or subsidize increased enrollments must ask, "Will the benefits of improved productivity outweigh the costs?"

It will be recalled from our discussion earlier in this chapter that there are two methods of assessing the returns to an investment. The *present-value method* involves choosing a discount rate and then summing the present value of expected future benefits so that the total returns can be compared to investment costs. If the present value of returns exceeds such costs, the investment can be considered worthwhile. Example 9.3 presents a situation in which calculating the present value of future investment returns is necessary.

The *internal rate of return method* calculates the discount rate that equates the present value of benefits with the investment cost. If the future returns from a particular investment decision are so large that the discount rate required to equate benefits and costs exceeds the rate of return an individual insists upon before investing, then the decision will be considered worthwhile. The next two subsections deal, respectively, with *individual* and *social* returns from educational investments, primarily using the rate-of-return method of analysis.

IS EDUCATION A GOOD INVESTMENT FOR INDIVIDUALS?

Individuals about to make an investment in a college education are typically committing themselves to costs of at least $17,000 per year. Is there evidence that this investment pays off for the typical student? Several studies have tried to answer this question by calculating the internal rates of return to educational investments. While the methods and data used vary, these studies normally estimate benefits by calculating earnings differentials at each age from age/ earnings profiles such, as those in Figures 9.3 and 9.4. *(Earnings* are usually used to measure benefits because higher wages and more stable jobs are both payoffs to more education). It should be stressed that all such studies have analyzed only the monetary, not the psychic, cost of and returns on educational investments.

The rates of return typically estimated for the United States generally fall in the range of 5-15 percent (after adjusting for inflation).[30] These finding are interesting because most other investments generate returns in the same range. Thus, it appears, at least at first glance, that an investment in education is about as good as an investment in stocks, bonds, or real estate. This conclusion must be qualified, however, by recognizing that there are systematic biases in the estimated rates of return to education. These biases, which are of unknown size, work in opposite directions.

[30] For a review of rate-of-return studies, see george Psacharopoulus, “Returns to Education: A Further International Update and Implications”, Journal of Human Resources 20, nº 4 (Fall 1985): 583-604; and David Card, “Earnings, Schooling, and Ability Revisited”, Research in Labor Economics, ed. Solomon Polachek, forthcoming.

EXAMPLE 9.3
Valuing a Human Asset: The Case of the Divorcing Doctor

State divorce laws typically provide for the assets acquired during marriage to be divided in some equitable fashion. Such laws in the state of New York recognize, among the assets to be divided, the asset value of human capital investments made by either spouse during the period of marriage. How these acquired human capital values are estimated can be illustrated by the following example.

Dr. Doe married his wife right after he had acquired a license to practice medicine as a general practitioner. Instead of opening a general (family) practice, however, Dr. Doe undertook specialized training to become a surgeon. During his training (residency) period, the income of Dr. Doe and his wife was much lower than it would have been had he been working as a general practitioner (thus both spouses were investing, albeit to different degrees, in Dr. Doe's human capital). Shortly after his residency was completed and he had acquired board certification as a general surgeon, Dr. Doe and his wife decided to divorce. She sued him for an equitable division of the asset value of his certification as a general surgeon. How can this asset value be estimated?

The asset value of Dr. Doe's certificate as a general surgeon is the present value of his estimated increase in lifetime earnings made possible by the investment undertaken during marriage. In the absence of a specific work history as a surgeon, the most reasonable estimate of his increase in yearly earnings is calculated by subtracting from what the typical general surgeon earns in a year the average earnings of general practitioners (which is an estimate of what Dr. Doe could have earned in the absence of his training as a surgeon). **In 1988,** the median earnings of general surgeons were $135,000, while the median earnings of general, practitioners **were $79,000,** implying a yearly earnings differential of **$56,000.* Assuming** a remaining worklife of 25 years and a real interest rate (which takes account of what inflation will do to the earnings differential) of 2 percent, the present value of the asset Dr. Doe "acquired" as the result of his surgical training comes to **$1,092,560.** (it would then be up to the court to divide this asset equitably between the two divorcing spouses.)

*The earnings data used are national medians for doctors with office practices in 1988. They were obtained with permission from Medical Economics magazine from "Earnings: Are You One of Those Losing Ground?" by Arthur Owens, Medical Economics **(September 4,1989):** 130.The formula used to calculate present value is the one given in footnote 7 of this chapter, where **X = $56,000,**
r = 0.02, and n = 25

THE UPWARD BIAS The typical estimates of the rate of return on further schooling may overstate the gain an individual student could obtain by investing in education because they are unable to separate the contribution that *ability* makes to higher earnings from the contribution made by *schooling.*[31] The problem is that *(a)* people who are smarter, harder-working, and more dynamic are likely to obtain more schooling, and *(b)* such people might be more productive, and hence earn higher-than-average wages, even if they did not complete more years of schooling than others. When measures of ability are not observed or accounted for, the studies attribute *all* the earnings differentials associated with college to college itself and none to ability, even though some of the added earnings college graduates typically receive may have been received by an equally able high school graduate who did not attend college.

Recent studies that attempt to control for "ability bias" in estimating rates of return to schooling have utilized several strategies. Some have estimated the separate effects of schooling and aptitude-test scores on earnings. Others have estimated how much the earnings of people are affected when a random event, not ability, affects their level of schooling.[32] Still others analyze differences among family members, who have the same family background, and even among identical twins, who share the same inherited characteristics.[33] These studies generally conclude that the problem of ability bias is small.

THE DOWNWARD BIAS There are three reasons to believe that conventionally estimated rates of return to educational investments may be downward-biased. First, some benefits of college attendance are not necessarily reflected in higher productivity, but rather in an increased ability to understand and

---

[31] Another source of upward bias has been pointed out by C. M. Lindsay, "Nieasuring Human Capital Returns," *Journal of Political Economy 79* (November/December *1971): 1195-1215.* Lindsay reasons that if human capital investments earn a normal rate of return, they do not change the wealth of those who invest; post investment returns, in other words, just make up for the costs of investment. Human capital investments, however, do raise wages, and hence the price of leisure. As the principles of labor supply in Chapters 6 and *7* suggested, an increased wage with unchanged wealth would cause hours of leisure consumed to fall. Thus, human capital investments cause an increased price, and reduced consumption, of the important consumer good we call "leisure." Some of the differential in earnings we observe between those with more human capital and those with less is offset by utility lost by the former group when leisure is reduced. To count the entire earnings differential as a return on the investment without correcting for lost leisure overstates the *real gains* (that is, those expressed in terms of *utility)* to human capital investments.

[32] See Card, "Earnings, Schooling, and Ability Revisited," for a summary of many of these studies; see also McKinley Blackburn and David Neumark, "Omitted-Ability Bias and the Increase in the Return to Schooling," *Journal of Labor Economics 11 (July 1993): 521-544.*

[33] Orley Ashenfelter and David J. Zimmerman, "Estimates of the Returns to Schooling from Sibling Data: Fathers, Sons, and Brothers," *Review of Economics and Statistics,* forthcoming; and Orley Ashenfelter and Alan Krueger, "Estimates of the Economic Returns to Schooling from a New Sample of Twins," *American Economic Review 84,* no. *5* (December *1994): 1157-1173.*

appreciate the behavioral, historical, and philosophical foundations of human existence. Second, most rate-of-return studies fail to include employee benefits; they measure money earnings, not total compensation. Because employee benefits as a percentage of total compensation tend to rise as money earnings rise, ignoring benefits tends to create a downward bias in the estimation of rates of return to education.

Third, some of the job-related rewards of college are captured in the form of psychic or nonmonetary benefits. Jobs in the executive or professional occupations are probably more interesting and pleasant than the more routine jobs typically available to people with less education. While executive and professional jobs do pay more than others, the total benefits of these jobs may be understated when only earnings differences are analyzed.[34]

SELECTION BIAS A third source of bias in the standard estimates of rates of return on education arises from what has become known in recent years as the *selectivity* problem. Briefly put, one who decides to go to college and become a manager, rather than terminate schooling with high school and become a mechanic, may do so in part because he or she has very little mechanical aptitude; thus, becoming a mechanic might yield this person *less* income than would be earned by others who chose to become mechanics rather than go to college. Likewise, those who go to college may have aptitudes that generate more income in managerial jobs than could have been earned in those jobs by terminal high school graduates if they had acquired the college education needed to qualify for the managerial jobs. The significance of the selectivity phenomenon described above is that conventionally calculated rates of return may *understate* the returns to a college education for those who decide to attend college and *overstate* the returns forgone by someone who decides not to go.

To understand the potential selectivity biases in the conventionally calculated returns to a college education, keep in mind that the returns to a college education are usually based on differences between the actual earnings of college and high school graduates. For people who graduated from college, the rate-of-return cal-

---

[34] "While not strictly an issue of downward bias, there is reason to believe that the conventionally measured rates of return to educational investments are below the rates of return that would be observed if some intervention (for example, the opening of a college in one's own hometown) were to cause people with lower educational attainment to increase their schooling. Human capital theory suggests that when deciding whether to make an investment, people compare their expected rate of return to their personal discount rate (that is, their "required" rate of return). Only if the expected rate of return exceeds the required return is the investment worth making. Suppose, now, that the yearly monetary costs and returns associated with the same educational investment do not vary much across individuals, but that personal discount rates vary considerably. Suppose too that each person continues to invest in education until the monetary rate of return equals (or is about to fall below) his or her personal discount rate. Under these conditions, those who had previously invested less did so because they had higher rates of discount, and a higher *required* rate of return implies a higher *observed* rate of r6turn. For more on this topic, see Card, "Earnings, Schooling, and Ability Revisited."

culation thus assumes that, in the absence of a college education, their earnings would have been equal to those of the average high school graduate. If, instead, their earnings would have been *less* than those of the high school graduate, the conventional calculation *understates* their gains from a college investment. Analogously, the conventionally calculated rate of return to a college education may *overstate* the returns that could have been received by those who decided against attending college, because they might have been unable to earn as much with a college education as do those who actually attended college.

Fortunately, the selectivity bias in estimated rates of return to schooling appears to be small.[35] Nevertheless, raising the selectivity issue does serve to remind us that the principle of comparative advantage is potentially important in making choices about schooling and occupations.

IS EDUCATION A GOOD SOCIAL INVESTMENT?

The issue of education as a social investment has been of heightened interest in the United States during the past decade especially because of three related developments. First, product markets have become more global, increasing the elasticity of both product and labor demand. As a result, American workers are now facing more competition from workers in other countries. Second, the growing availability of high-technology capital, especially the desktop computer, has created new products and production systems that require workers to have greater cognitive skills and to be adaptable, efficient learners. Indeed, a recent study has indicated that the returns to a worker's having greater quantitative skills especially the skills taught in the United States prior to high school-have risen in recent years.[36]

Third, American elementary and secondary school students score poorly relative to students elsewhere in language proficiency, scientific knowledge, and (especially) mathematical skills. For example, Table 9.4 displays the average scores on a mathematical proficiency test given on a comparable basis (that is, to all 13-year-olds) in six different countries. The American score lies below that in every other country shown. The combination of these three developments has caused concern about the productivity of America's future workforce, relative to workers elsewhere, and to a series of questions about our educational system: Are we devoting enough resources to educating our current and future workforce? Should the re sources we devote to education be reallocated in some way? Should we demand more of students in elementary and secondary schools?

---

[35] The discussion in this subsection is based on Robert J. Willis and Sherwin Rosen, "Education and Self-Selection," Yournal *of* Political Economy 87 (October 1979): S7-S36. Also see Kevin Hollenbeck, "Postsecondary Education as Triage: Returns to Academic and Technical Programs, "Economics *of Educa*tion *Review* 12, no. 3 (September 1993): 213-232.

[36] Richard J. Murnane, John B. Willett, and Frank Levy, "The Growing Importance of Cognitive Skills in Wage Determination," working paper no. 5076, National Bureau of Economic Research, Cambridge, Mass., 1995

TABLE 9.4
International Comparisons of Proficiency in Mathematics at Age 13, 1991

Country	Test Score
Canada	513
France	519
Spain	495
Switzerland	539
Taiwan	545
United States	494

SOURCE: National Center for Education Statistics, The *Condition ofEducation 1993* (NCES *93-290,* June *1993),* Table *15.2.*

As Table 9.5 indicates, the United States devotes at least as many resources to elementary and secondary education as do other developed countries. In terms of dollars per student, the United States ranks first among the six countries shown, and in terms of student/teacher ratios or the percentages of the population completing secondary school, it ranks in the middle. Moreover, the percentage of the population completing college is higher than in every comparison country~ and double that of the European countries shown. Thus, with almost 8 percent of its gross domestic product devoted to the direct costs of formal education (elementary, secondary, and college), and with forgone earnings (especially of college students) adding another 4 or 5 percent, the United States devotes a substantial fraction of its available resources to formal schooling.[37] Whether this huge social investment pays off, and whether its returns can be enhanced, are important questions. In beginning to answer them, we must try to understand how education and productivity are related.

The view that increased educational investments increase worker productivity is a natural outgrowth of the observation that such investments enhance the earnings of individuals who undertake them. However, this view that the educational investment is what *causes* productivity to rise is not the only possible interpretation for the positive relationship between earnings and schooling. Another interpretation is that the educational system provides society with a screening device that sorts people by their (predetermined) ability. As discussed below, this alternative view, in its extreme form, sees the educational system as a means of *finding out* who is productive, not of enhancing worker productivity.

[37] The forgone earnings of high school and college students have been estimated to equal 60 percent of the *direct* cost outlays at those schooling levels. See Theodore Schultz, The *Economic* Value *of Education* (New York: Columbia University Press, 1963).

TABLE 9.5
International Comparisons of Schooling, 1991

Country	Public Expenditures per Pupil Grades 1-12 (in U.S.$)	Pupils per Teacher, Elementary Schools	% of Those, Ages 25-44, Who Have Completed	
			Secondary School	University
Canada	$3,508	15.3	86.0%	17.5%
France	2,627	15.7	651.9	11.6
Germany	2,750	17.7	89.3	11.5
Japan	2,115	21.2	90.6	22.9
United Kingdom	2,492	19.7	79.2	11.7
United States	3,917	18.0	86.1	23.7

SOURCES: National Center for Education Statistics: The Condition *of* Education 1993 (NCES 93-290, June 1993),64, 140; Digest *of* Education Statistics 1993 (NCES 93-292, October 1993),Table 383.

THE SIGNALING MODEL[38] An employer seeking to hire workers is never completely sure of the actual productivity of any applicant, and in many cases the employer may remain unsure long after an employee is hired. What an employer *can* observe are certain indicators that firms believe to be correlated with productivity: age, experience, education, and other personal characteristics. Some indicators, such as age, are immutable. Others, like formal education, can be *acquired* by workers. Indicators that can be acquired by individuals can be called *signals;* our analysis here will focus on the signaling aspect of formal education.

Let us suppose that firms wanting to hire new employees for particular jobs know that there are two groups of applicants that exist in roughly equal proportions. One group has a productivity of 2, let us say, and the other has a productivity of 1. Further, suppose that these productivity levels are *immutable* (they cannot be changed by education or training) and that employers *cannot readily distinguish* which applicants are from which group. If they were unable to make such distinctions, firms would be forced to assume that all applicants are "average"; that is, they would have to assume that each had a productivity of 1.5 (and would offer them wages of up to 1.5).

While workers in this simple example would be receiving what they were worth on *average,* any firm that could devise a way to distinguish between the two groups (at little or no cost) could enhance its profits. When wages equal 1.5, workers with productivities equal to 1 are receiving more than they are worth. If these applicants could be discovered, and either rejected or placed into lower-paying jobs, the firm could obviously increase its profits. It turns out that using educational attainment as a hiring standard-even if education does not enhance productivity-is profitable for the employer if it so happens that the cost to

[38] This analysis is based on Michael Spence, "Job Market Signaling," Quarterly,7ournal of Economics 87 (August 1973): 205-221

workers of acquiring the required schooling is a signal of (that is, is related to) on-the-job productivity.

To illustrate the use of educational signaling, suppose that employers come to believe that applicants with at least e^* years of education beyond high school are the ones with productivity 2, and that those with less than e^* are in the lower-productivity group. With this belief, workers with less than e^* years would be rejected for any job paying a wage above 1, while those with at least e^* would find that competition among employers drives their wages up to 2. This simple hypothetical wage structure is illustrated in Figure 9.7. If additional schooling does not enhance productivity, can requiring the signal of e^* really distinguish between the two groups of applicants? The answer is yes if *the costs to the worker of acquiring the added schooling are negatively related to his or her on-the-job productivity.*

If workers with at least e^* years of education beyond high school can obtain a wage of 2, while those with less can earn a wage of only 1, all workers would want to acquire the signal of e^* if it were costless for them to do so; in this case, using educational attainment as a signaling device would fail, because workers in both groups would acquire the same signal. As we argued earlier, however, schooling costs are both large and different for different individuals. In particular, the *psychic* costs of education are probably inversely related to one's ability: those who learn easily can acquire the educational signal (of e^* in this case) more cheaply than others. If-and this is critical-those who have *lower* costs of acquiring education are *also* more productive on the job, then requiring educational signals can be useful for employers.

To understand the role of costs in signaling, refer to Figure 9.8, in which the reward structure from Figure 9.7 is expressed in terms of the present value of lifetime earnings (at a wage of 1 their discounted lifetime earnings sum to *PVEI,* while at a wage of 2 they sum to *PVE2)*- If we assume that each year of education costs C for those with less productivity, and C/2 for those with greater productivity, the fundamental influences on worker choices concerning education are easily seen.

FIGURE 9.7
The Benefits to Workers of Educational Signaling

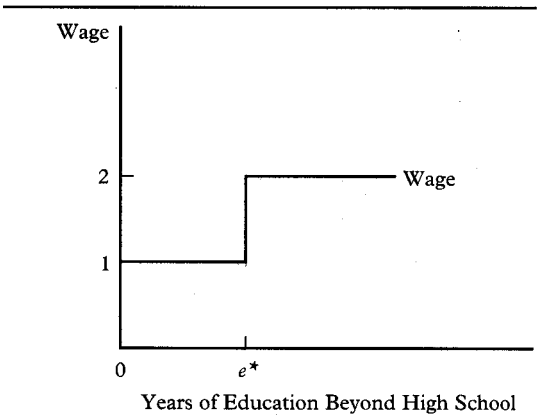
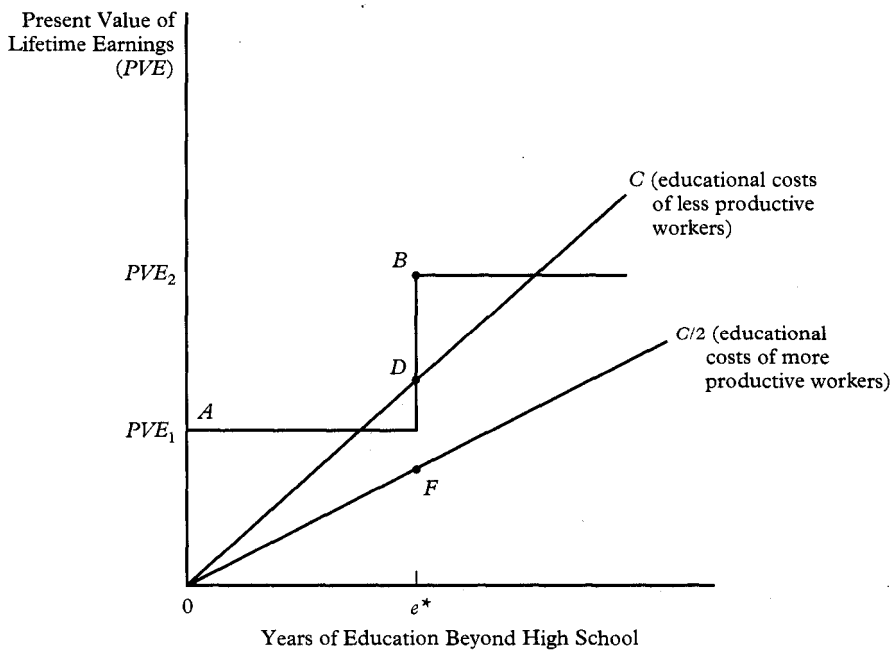


FIGURE 9.8
The Lifetime Benefits and Costs of Educational Signaling



Workers will choose the level of schooling at which the difference between their discounted lifetime earnings and their total educational costs is maximized. For those with yearly educational costs of C, the difference between lifetime earnings and total educational costs is maximized at zero years of education beyond high school. For these workers, the net benefit of e* years beyond high school (distance *BD)* is less than the net benefit of zero additional years (distance AO), and for them, the benefits of acquiring the signal of e* years is not worth the added costs. For those whose costs are C/2, it can be seen that the net benefits of investing in e* (distance *BF)* exceed the net benefits of other schooling choices. Therefore, only those with costs of C/2-the workers with productivities of 2-find it advantageous to acquire e* years of schooling.

Three points should be made about our simple example of signaling above. First, workers may not think of themselves as acquiring a signal if they attend school, even though in our example they are. All most workers will know is that by obtaining more education they can increase their wages, and their decision about how much education to acquire depends on the costs and returns to them.

Second, our simple example demonstrated how education could have signaling value even if it did not directly enhance worker productivity. It is necessary to stress, though, that for education to have signaling value in this case, on-the-job productivity and the costs of education must be *negatively related*. In our example, if the higher costs reflected along line C were associated with lower cognitive ability or a distaste for learning, then it is conceivable that in many jobs these costs

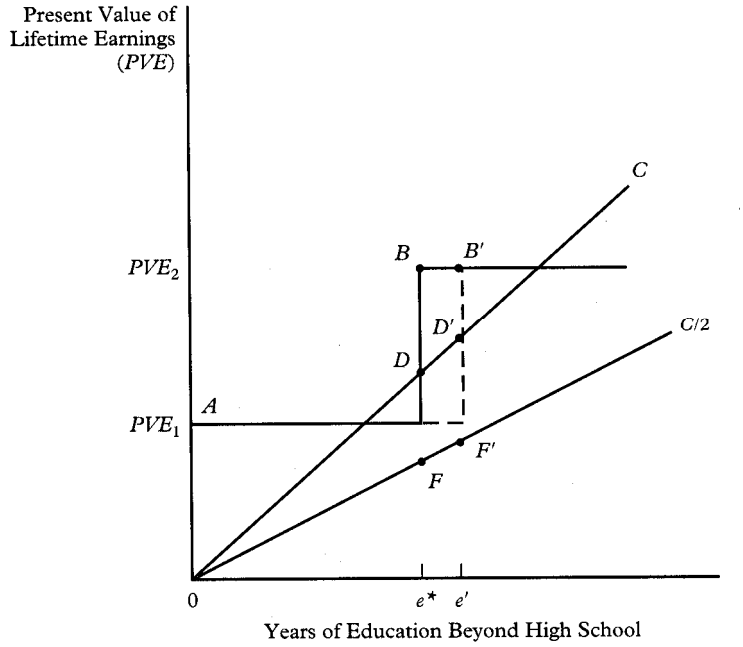
could be indicative of lower productivity. If, however, those with costs along C have higher costs only because of lower family wealth (and therefore smaller "contributions" from others toward their schooling costs), then they may be no less productive on the job than those along line C/2. In this latter case, signaling would fail in the sense that it would only indicate those with low family wealth, not lower productivity.

Third, even if educational signaling is a useful way to predict future productivity, there is an optimum signal beyond which society would not find it desirable to go. Suppose, for example, that employers now requiring *e** years for entry into jobs paying a wage of 2 were to raise their hiring standards to *e'* years, as shown in Figure 9.9. Those with educational costs along C would still find it in their best interests to remain at zero years of schooling beyond high school, and those with costs along C/2 would find it profitable to invest in the required signal of e'(because distance *B'F' is* greater than AO). Requiring more schooling of those who are selected for high-wage jobs, however, is more costly for those workers (and thus for society as a whole). While the new required signal would distinguish between the two groups of workers, it would do so at increased social cost. Put differently, using e* as the required signal would be just as effective as using e', yet would entail lower opportunity costs. Therefore, using e' cannot be socially optimal.[39]

Whether schooling is purely a signaling device or adds to productivity is not a particularly important question for individuals. Whatever role schools play, additional schooling does enhance one's lifetime income. Where the issue of signaling is important is at the social level. If the only purpose of schools is to provide signals, why encourage investments in the expansion or qualitative upgrading of schooling? If forty years ago being a high school graduate signaled above-average intelligence and work discipline, why incur the enormous costs of expanding college attendance only to find out that now these qualities are signaled by having a bachelor's degree'? The issue is of even more importance in less-developed countries, where mistakes in allocating extremely scarce capital resources could be disastrous (see Example 9.4).

[39] Some critics of the human capital view of education argue that escalation of educational standards has occurred for jobs in which work requirements have remained largely unchanged. These critics can be understood as saying that firms require *e'* when requiring *e** would be cheaper and work just as well. See, for example, Ivar Berg, *Education and Jobs: The Great Training Robbery* (New York: Praeger Publishers, 1970).

FIGURE 9.9
Requiring a Greater Signal May Have Costs Without Benefits



SIGNALING OR HUMAN CAPITAL? Direct evidence on the role schooling plays in society is difficult to obtain. Advocates of the signaling viewpoint, for example, might point to the higher rates of return for college *graduates* than for college *dropouts* as evidence that schooling is a signaling device.[40] They argue that what is learned in school is proportional to the time spent there and that an added bonus (rate of return) just for a diploma is proof of the signaling hypothesis. Advocates of the view that schooling enhances human capital could counter that one who graduates after four years probably has learned more than four times what the freshman dropout has learned. They argue that dropouts are more likely to be poorer students-the ones who overestimated their returns on schooling and quit when they discovered their mistake. Thus, their relatively low rate of return is associated not with their dropping out but with their *reason* for dropping out.

[40] Dropouts naturally have lower earnings than graduates, but because they have also invested less, it is not clear that their *rates of return* should be lower. For further discussion and evidence, see Andrew Weiss, "High School Graduation, Performance, and Wages," *Journal of Political Economy 96* (August *1988): 785-820;* and Jin Heurn Park, "Estimation of Sheepskin Effects and Returns to Schooling Using the Old and the New CPS Measures of Educational Attainment," working paper no. *338,* Industrial Relations Section, Princeton University, August *1994.* Thomas J. Kane and Cecilia Elena Rouse, "Comment on W Norton Grubb: 'The Varied Economic Returns to Postsecondary Education: New Evidence from the Class of *1972',",7ournal of Human Resources 30,* no. I (Winter *1995): 205-221,* calls into question the benefits of graduation independent of the number of *credits* taken.

EXAMPLE 9.4,

The Socially Optimal Level of Educational Investment

In additional to asking whether schooling is a good social investment, we could also ask,What is the socially optimal level of schooling? The general principle guiding our answer to this question is that society should increase or reduce its educational investments until the marginal rate of return (to society) equals the marginal rate of return on other forms of capital investment (investment in physical capital, for example).

The rationale for the above principle is that if society has some funds it wants to invest, it will desire to invest them in projects yielding the highest rates of return. If an investment in physical capital yields a 20 percent rate of return and the same funds invested in schooling yield (all things considered) only a 10 percent return, society will clearly prefer to invest in physical capital. As long as the two rates of return differ, society could be made better off by reducing its investments in low-yield projects and increasing them in those with higher rates of return.

The text has discussed many of the difficulties and biases inherent in estimating rates of return to schooling. However, the general principle of equating the rates of social return on all forms of investments is still a useful one to consider. It suggests, for example, that capital-poor countries should invest in additional schooling only if the returns are very high-higher, in all probability, than the rates of return required for optimality in mo re-cap ital- rich countries. Indeed, the rates of return to both secondary schooling and higher education appear to be generally higher in less-developed countries than in developed countries. One review estimated that the rate of return on secondary schooling investment was 10 percent for a developed country (on average), while for a less-developed country it was 13 to 15 percent. Comparable rates of return on investments in higher education were 8 percent and II percent, respectively.

SOURCE: George Psacharopoulos, "Returns to Investment in Education: A Global Update:' World Development 22, no. 9 (1994): 1325-1343.

To take another example, proponents of the human capital view of education could argue that the fact that earnings differentials between college and high school graduates grow with age supports their view. If schooling were just a signaling device, employers would rely on it initially, but as they accumulated direct information from experience with their employees, schooling would play a smaller role in determining earnings. Signaling advocates could counter that continued growth in earnings differentials and the continued association of schooling and earnings only illustrate that educational attainment is a successful signaling device.

As a final example, proponents of the signaling view of education point to the widespread placement of workers into jobs for which they are "overqualified." Put succinctly, if education is purely a signaling device and if levels of education are increasing over time, then as time goes on employers will be led to hire workers whose educational levels exceed the true requirements for their jobs. One study, however, found that workers who were educationally overqualified tended to be less experienced and to have received less job training than others; thus, their "extra" human capital from schooling appeared to be compensating for deficiencies in other forms of human capital.[41] Here again, the "human capital" and "signaling" views of education are difficult to distinguish with available data.[42]

SCHOOL QUALITY Given the difficulty of generating predictions of labor market outcomes that can directly distinguish the signaling from the human capital hypothesis, one is led to wonder if there are other ways to resolve the debate. A research strategy with some potential grows out of issues related to school quality.

As mentioned earlier, concerns have been raised about the cognitive achievement of American students.[43] If schooling performs primarily a signaling function, by helping to *discover* people's cognitive abilities, one would not necessarily look to the educational system to remedy the problem of low cognitive achievement. However, if schooling can enhance the kinds of skills that pay off in the labor market, then increased investment in the quality of the nation's schools could be warranted.

There is little doubt that workers of higher cognitive skill have higher earnings, even among those with equal levels of education.[44] Proponents of the signaling and human capital views of education can agree that people of higher ability are likely to be more productive; where they disagree is on whether better schools can

---

[41] Nachum Sicherman,"'Overeducation' in the Labor Market," *Journal of Labor Economics 9 (199 1): 101-122.*

[42] Attempts to distinguish between the two views of schooling continue, especially in the context of secondary schooling. For example, Joseph Altonji, "The Effects of High School Curriculum on Education and Labor Market Outcomes," *Journal of Human Resources 30,* no. *3* (Summer *1995):409-438,* finds evidence suggesting that *completing* high school, not what is learned in particular courses, is associated with higher wages among less-educated workers in the United States. This finding can be interpreted as support for the view that high school completion is valued by employers as a signal (of good work habits, presumably learned earlier) rather than for what is learned in various high school classes. For more on this, see Andrew Weiss, "Human Capital vs. Signaling Explanations of Wages," *Journal of Economic Perspectives 9,* no. *4* (Fall *1995): 133-154.* Somewhat different results are found in a study using data from the Netherlands; see Wim Groot and Hessel Oosterbeek, "Earnings Effects of Different Components of Schooling; Human Capital versus Screening," *Review of Economics and Statistics 76,* no. *2* (May *1994): 317-321.*

[43] John Bishop, "Is the Test Score Decline Responsible for the Productivity Growth Decline?" *American Economic Review 79* (March *1989): 178-197.*

[44] M . Bossiere, J. Knight, and R. Sabot, "Earnings, Schooling, Ability, and Cognitive Skills," *American Economic Review 75* (December *1985): 1016-1031,* and Ethel B. Jones and John D. Jackson, "College Grades and Labor Market Rewards," *Journal of Human Resources 25* (Spring *1990): 253-266.*

enhance worker productivity by improving cognitive skills. Advocates of the signaling viewpoint cite a substantial literature suggesting there is almost no demonstrated relationship between schooling expenditures and student performance on *tests of cognitive* skill.[45] Advocates of the human capital view, however, find support in studies of *earnings* and school quality. These studies generally indicate that students attending higher-quality schools (that is, ones with greater resources per student) have higher subsequent earnings, other things equal.[46]

Clearly, assessments of the social returns to schooling that examine the role of school quality have so far yielded somewhat ambiguous results. Better schools may enhance labor market earnings, but evidence that they enhance measured cognitive abilities is relatively weak. One possibility, of course, is that better schools enhance productivity by teaching useful problem-solving skills or better work habits-characteristics that may be valued in the labor market but not captured especially well by standardized tests of cognitive achievement. Another possibility, however, is that better schools give students better information about their own interests and abilities, thus helping them to make more successful career choices. Some important questions, then, remain unanswered.

DOES THE DEBATE MATTER? In the end, perhaps the debate between advocates of the signaling and human capital views of schooling is not terribly important. The fact is that schooling investments offer *individuals* monetary rates of return that are comparable to those received from other forms of investment. For individuals to recoup their human capital investment costs requires willingness on the part of employers to pay higher wages to people with more schooling; and for employers to be willing to do this, schools must be providing a service that employers could not perform more cheaply themselves.

For example, we argued earlier that to profit from an investment of $100,000 in a college education, college graduates must be paid at least $3,652 more per year than they would have received otherwise. Naturally, this requires that they find employers who are willing to pay them the higher yearly wage. If college directly or indirectly adds to one's labor market productivity, it is obvious why employers should be willing to pay this premium and how society benefits from human capital investments. But what if colleges merely help to *reveal* who is More productive?

---

[45] See Eric A. Hanushek, "The Economics of Schooling: Production and Efficiency in Public Schools," *76urnal of Economic Literature 24* (September *1986): 1141-1177,* and more recently, Eric A. Hanushek, "When School Finance 'Reform' May Not Be Good Policy," *Harvard _7ournal on Legislation 28* (Summer *1991): 423-456.* For contrary evidence, see Susanna Loeb and John Bound, "The Effect of Measured School Inputs on Academic Achievement: Evidence from the *1920s, 1930s,* and *1940s* Birth Cohorts," working p;per no. *5331,* National Bureau of Economic Research, Cambridge, Mass., November *1995.*

[46] For a review of these studies, see David Card and Alan B. Krueger, "Labor Market Effects of School Quality: Theory and Evidence," working paper no. *357,* Industrial Relations Section, Princeton University~ January *1996.* For a recent study with largely contrary evidence, see James J. Heckman, Anne Layne Farrar, and Petra Todd, "The Schooling Quality-Earnings Relationship: Using Economic Theory to Interpret Functional Forms Consistent with the Evidence," working paper no. *5288,* National Bureau of Economic Research, Cambridge, Mass., October *1995.*

If employers believed they could create tests or other devices that reveal productivity characteristics for less than a yearly cost of $3,652 per worker, they would have strong incentives to adopt these alternative modes of screening workers. The fact that employers continue to emphasize (and pay for) educational requirements in the establishment of hiring standards suggests one of two things. Either more education *does* enhance worker productivity, or it is a *less expensive* screening tool than any other that firms could use. In either case, the fact that employers are willing to pay a high price for an educated workforce seems to suggest that education produces social benefits.[47]

IS PUBLIC SECTOR TRAINING A GOOD SOCIAL INVESTMENT?

The same developments leading American policyrnakers to ask resource allocation questions about elementary and secondary schooling have also led to similar questions about job-training programs. Much of the job training available to workers is provided formally or informally at the workplace, and as indicated in Chapter 5 (Example 5.3), there is some evidence that American workers receive less employer-provided training than other workers in the developed world. Higher turnover rates among American workers might be a partial explanation, as might the lower cognitive achievement levels among those who end their formal education with high school.[48] If American workers are ill equipped to receive-or are for some other reasons not receiving-job training in the private sector, would increased public sector training programs be a good social investment?

During the past four decades, the federal government has funded a variety of training programs that primarily targeted disadvantaged men, women, -and youth. Some of these programs have provided relatively inexpensive help in searching for work, while others have directly provided work experience or (in the case of the Job Corps) comprehensive services associated with living away from home. Over these decades, however, roughly half of those enrolled received classroom training at vocational schools or community colleges, and another 15 percent received in-plant training. The per-student costs of these latter two types of programs have been in the range of $3,000 to $6,000 (in 1994 dollars).[49]

Evaluating these programs requires comparing their costs to an estimate of the present value of their benefits. The programs were intended to increase the productivity of trainees, and in the case of this kind of (general) training, enhancements of trainee productivity should be reflected by their increased earnings. Thus, evaluators have set out to estimate by how much the earnings of trainees were increased as a result of their training. Measuring this increase in earnings

---

[47] Kevin Lang, "Does the Human Capital/Educational Sorting Debate Matter for Development Pol*icy?" American Economic Review 84,* no. I (March *1994): 353-358,* comes to a similar conclusion through a more formal argument.

[48] For a summary of major issues and a comparative overview of job training in Europe, North America, and Japan, see Lisa Lynch, "Introduction," in *Training and the Private Sector: International Comparisons,* ed. Lisa Lynch (Chicago: University of Chicago Press, *1994), 1-24.*

[49] Robert J. LaLonde, "The Promise of Public Sector-Sponsored Training Programs," *Journal of Economic Perspectives 9,* no. *2* (Spring *1995): 149-168,* gives a brief history of federally sponsored training programs and summarizes several issues relevant to evaluating their efficacy.

involves estimating what the trainee would have earned in the absence of the program, and there are several thorny issues the researcher must successfully confront. Nevertheless, a recent summary of two dozen credible studies came to some rather firm conclusions about the benefits of these programs.

First, adult women were the only group among the disadvantaged that clearly experienced earnings gains as a result of training; adult men and youth show d no consistent earnings increases across the various studies. Second, the estimated average increase in earnings for women in the various studies was typically around $1,500 per year.[50] Although one evaluation found enhanced earnings seven years after training, the typical study was unable to follow the trainees' earnings for very long after the program, so little is known about the long-run effects on earnings. Third, most of the earnings increases resulted from higher rates of employment, and there is little evidence that *wage rates* were increased by training.

For disadvantaged men and youth, then, investments in federally sponsored training apparently had a negative return; costs were expended, but no clear-cut increases in productivity resulted. For disadvantaged women, earnings increases did result. Were these latter increases large enough to justify program costs?

The programs had direct costs of $3,000 to $6,000 per trainee, but they also had opportunity costs in the form of forgone output. The typical trainee was in her program for 16 weeks, and while many of the trainees had been on welfare prior to training, the opportunity costs of their tirpe surely were not zero; indeed, the student will recall from Chapter 7 that a person can be productive in the home as well as the workplace. If one were to place a value on time at home equal to $18,000 per year (see Example 7.2 in Chapter 7), spending one-third of a year in training had opportunity costs of roughly $6,000. Thus, the total costs of training were probably in the range of $9,000 to $12,000 per woman.

If benefits of $1,500 per year were received annually for 20 years after training, and if the appropriate discount rate is 2 percent, the present value of benefits comes to $24,500.[51] Benefits of this magnitude are clearly in excess of costs. Indeed, the present value of benefits would still be in excess of $12,000 even if the yearly earnings increases lasted for only 9 years. Therefore, it appears likely that federally sponsored training for disadvantaged women has been a social investment worth making.

---

[50] Robert La Londe, "The Promise of Public Sector-Sponsored Training Programs," Table 1.

[51] The real rate of interest-that is, the: nominal rate less the rate of inflation-on government securities has been in the neighborhood of 2 percent during the postwar period. The real rate of interest is the appropriate discount rate if, as in our example, benefits are not inflation-adjusted.

APPENDIX 9A

A "Cobweb Model" of Labor Market Adjustment

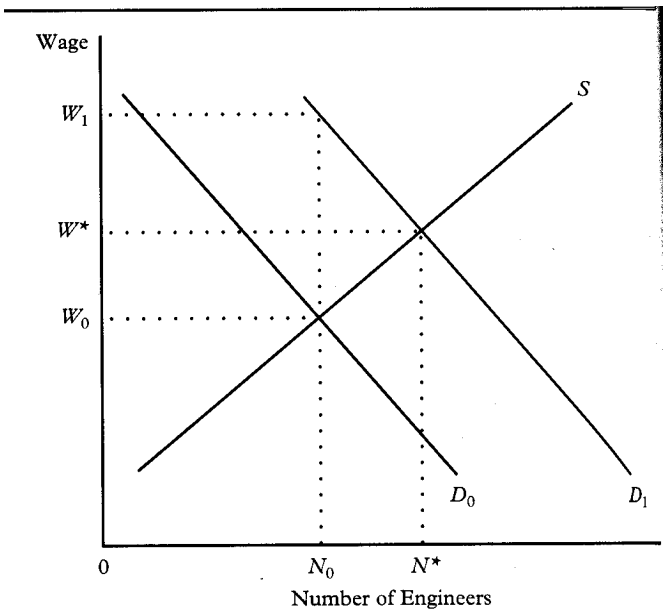
The adjustment of college enrollments to changes in the returns to education is not always smooth or rapid, particularly in special fields, like engineering and law, that are highly technical. The problem is that if engineering wages (say) were to go up suddenly in a given year, the supply of graduate engineers would not be affected until three or four years later (owing to the time it takes to learn the field). Likewise, if engineering wages were to fall, those students enrolled in an engineering curriculum would understandably be reluctant to immediately leave the field. They have already invested a lot of time and effort and may prefer to take chances in engineering rather than devote more time and money to learning a new field.

The failure of supply to respond immediately to changed market conditions can cause *boom-and-bust cycles* in the market for highly technical workers. If educational planners in government or the private sector are unaware of these cycles, they may seek to stimulate or reduce enrollments at times when they should be doing exactly the opposite, as illustrated below.

An Example of *"Cobweb "Adjustments*

Suppose the market for engineers is in equilibrium, where the wage is WO and the number of engineers is *No* (see Figure 9A.1). Let us now assume that the demand curve for engineers shifts from *D,* to *D,* Initially, this increase in the demand for engineers does *not* induce the supply of engineers to increase beyond N_o, because it takes a long time to become an engineer once one has decided to do so. Thus, while the increased demand for engineers causes more people to decide to enter the field, the number available for employment *at the moment is No.* These *No* engineers, therefore, can *currently* obtain a wage of W, (in effect, there is a vertical supply curve, at *No,* for a few years until the supply of engineering graduates's increased).

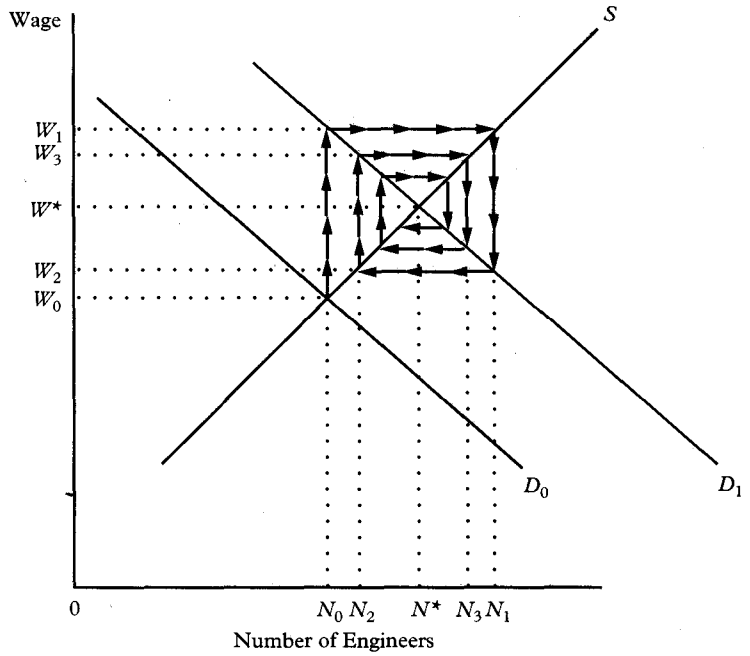
FIGURE 9A. I
The Labor Market for Engineers



Now W_1, the *current* engineering wage, is above W*, the new *long-run* equilibrium wage caused by the intersection of D, and S. The market, however, is unaware of W*, observing only W_1. If people are myopic and assume W, is the new equilibrium wage, *N*, people will enter the engineering field (see Figure 9A.2). When these *N*, all graduate, there will be a *surplus* of engineers (remember that W_1, *is above* long-run equilibrium).

With the supply of engineers now temporarily fixed at N_1, the wage will fall to W_2. This fall will cause students and workers to shift *out* of engineering, but that effect will not be fully felt for a few years. In the meantime, note that W_2 *is* below long-run equilibrium (still at W*). Thus, when supply *does* adjust, it will adjust too much-all the way to N_2. Now there will be another shortage of engineers, because after supply adjusts to N_2, demand exceeds supply at a wage rate of W_2. This causes wages to rise to W_3, and the cycle repeats itself. Over time, the swings become smaller, and eventually equilibrium is reached. Because the adjustment path in Figure 9A.2 looks somewhat like a cobweb, the adjustment process described above is sometimes called a *cobweb model.*

FIGURE 9A.2
The Labor Market for Engineers: A Cobweb Model



Worker Expectations of Future Wages

Critical to cobweb models is the assumption that workers form myopic expectations about the future behavior of wages.[52] In our example, they first assume that W, will prevail in the future and ignore the possibility that the occupational choice decisions of others will, in four years, drive the wage below W_1. just how workers (and other economic actors, such as investors and taxpayers) form expectations about future wage (price) levels is very important to the understanding of many key issues affecting the labor market.

The simplest and most naive way to predict future wage levels is to assume that what is observed today is what will be observed in the future; this naive assumption, as noted above, underlies the cobweb model. A more sophisticated way to form predictions about the future is with an *adaptive expectations* approach. Adaptive expectations are formed by setting future expected wages equal to a weighted

[52] Also critical to cobweb models is that the demand curve be flatter than the supply curve; if it is not, the cobweb "explodes" when demand shifts and an equilibrium wage is never reached. An exploding cobweb model is an example from economics of the phenomenon of "chaos," which has attracted much scientific attention recently. For a general introduction to this fascinating topic, see James Gleick, *Chaos* (New York: Penguin Books, 1987). For an article on chaos in the economic literature, see Williarn J. Baumol and Jess Benhabib, "Chaos: Significance, Mechanism, and Economic Applications," *Journal of Economic Perspectives 3,* no. I (Winter 1989): 77-106.

average of current and past wages. While more weight may be given to current than past wages in forecasting future wage levels, changes'in those levels prior to the current period are not ignored; thus, it is likely that wage expectations formed adaptively do not alternatively "overshoot" and "undershoot" the equilibrium wage as much as those formed using the naive approach. If, however, adaptive expectations also lead workers to first overpredict and then underpredict the equilibrium wage, cobweb-like behavior of wages and labor supply will still be observed (although the fluctuations will be of a smaller magnitude if the predictions are closer to the mark than those made naively).

The most sophisticated way to predict future market outcomes is to use a full-blown model of the labor market. those who believe in the rational *expectations* method of forming predictions about future wages assume that workers do have such a model in their heads, at least implicitly. Thus, they will realize that a marked increase in the earnings of engineers (say) is likely to be temporary, because supply will expand and eventually bring the returns to an investment in engineering skills in the line with those for other occupations. Put differently, the rational expectations model assumes workers behave as if they have taken (and mastered!) a good course in labor economics and that they will not be fooled into over- or underpredicting future wage levels.

Clearly, how people form expectations is an important empirical issue. In the case of engineers, lawyers, and dentists, periodic fluctuations in supply that characterize the cobweb model have been found.[53] Whether these fluctuations are the result of naive expectations or not, the lesson to be learned from cobweb models should not be lost on government policymakers. If the government chooses to take an active role in dealing with labor shortages and surpluses, it must be aware that, because supply adjustments are slow in highly technical markets, wages in those markets tend to overadjust. In other words, to the extent possible, governmental predictions and market interventions should be based on rational expectations. For example, at the initial stages of a shortage, when wages are rising toward W, (in our example), the government should be pointing out that W, is likely to be *above the* long-run equilibrium. If instead it attempts to meet the current shortage by *subsidizing* study in that field, it will be encouraging an even greater surplus later on. The moral of the story is that a complete knowledge of how markets adjust to changes in demand or supply is necessary before one can be sure that government intervention will do more good than harm.

---

[53] 'See Richard B. Freeman, "A Cobweb Model of the Supply and Starting Salary of New Engineers," *Industrial and Labor Relations Review 29* (January *1976): 236-246,* and Michael G. Finn and Joe G. Baker, "Future Jobs in Natural Science and Engineering: Shortage or Surplus?" *Monthly Labor Review 116,* no. *2* (February *1993): 54-61.* Gary Zarkin, "Occupational Choice: An Application to the Market for Public School Teachers," *Quarterly Journal of Economics 100* (May *1985): 409-446,* and Peter Orazem and Peter Mattila, "Human Capital, Uncertain Wage Distributions, and Occupational and Educational Choices," *International Economic Review 32* (February *1991): 103-122,* use rational expectations models of occupational choice.

APPENDIX 9B

A Hedonic Model of Earnings and Educational Level

Chapter 9 employed human capital theory to explore the demand for education and the relationship between education and pay. This appendix uses the hedonic theory of wages to more formally explore the factors underlying the positive association between wage and educational levels. Thus, it treats the higher pay associated with a higher education level as a compensating wage differential.

In Chapter 9 we argued that the prospect of improved lifetime earnings served as a major inducement for people to invest in an education or training program. Indeed, unless education is acquired purely for purposes of consumption, people will not undertake an investment in education or training without the expectation that, by so doing, they can improve their stream of lifetime earnings or psychic rewards. In order to obtain these higher benefits, however, *employers* must be willing to pay for them. Therefore, it is necessary to examine both sides of the market to fully understand the prediction made over two hundred years ago by Adam Smith that wages rise with the "difficulty and expense" of learning the job.[54]

Supply (Worker) Side

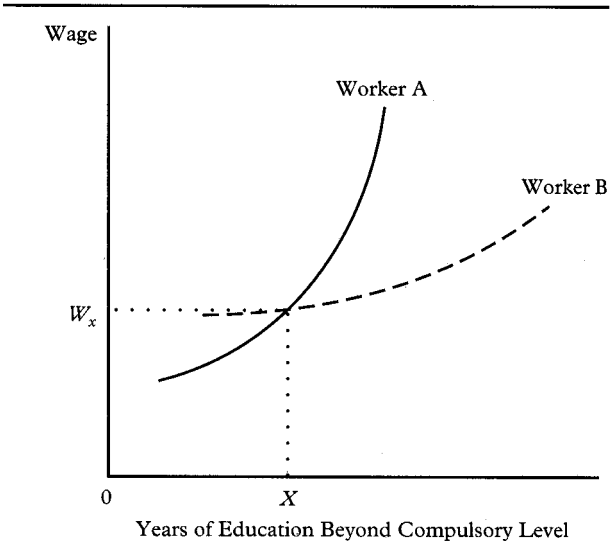
Consider a group of people who have chosen selling as a desired career. These salespersons-to-be have a choice of how much education or training to invest in given their career objectives. In making this choice they will have to weigh the returns against the costs. Crucial to this decision is how the *actual* returns compare with the returns each would *require* in order to invest.

Figure 913.1 shows the indifference curves between yearly earnings and education for two workers, A and B. To induce A or B to acquire X years of education would require the assurance of earning W., after beginning work. However, to induce A to increase his or her education beyond X years (holding utility constant) would require a larger salary increase than B would require. Xs greater aversion to making educational investments could be explained in several ways. Person A could be older than B, thus having higher forgone earnings and fewer years over which to recoup investment costs. Person A could be more present-oriented and thus more inclined to discount future benefits heavily, or could have less ability in classroom learning or a greater dislike of schooling. Finally, A may find it more difficult to finance additional schooling. Whatever the reason, this analysis points up the important fact that people differ in their propensity to invest in schooling.

---

[54] 'See Adam Smith, *Wealth of Nations, Book I,* Chapter 10. The five "principal circumstances" listed by Smith as affecting wages were first discussed in Chapter 8

FIGURE 9B. I
Indifference Curves for Two Different Workers

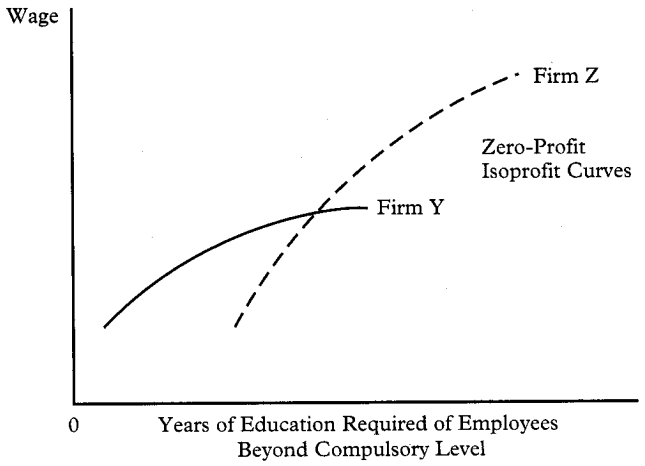


Demand (Employer) Side

On the demand side of the market, employers must consider whether they are willing to pay higher wages for better-educated workers. If they are, they must also decide how much to pay for each additional year. Figure 913.2 illustrates employers' choices about the wage/education relationship. Employers Y and Z are *both* willing to pay more for better-educated sales personnel (to continue our example) because they have found that better-educated workers are more productive.[55] Thus, they can achieve the same profit level by paying either lower wages for less-educated workers or higher wages for more-educated workers. Their is profit curves are thus upward-sloping (see Chapter 8 for a description of is profit curves).

[55] 'Whether schooling causes workers to be more productive or simply reflects-or "signals"-higher productivity is not important at this point.

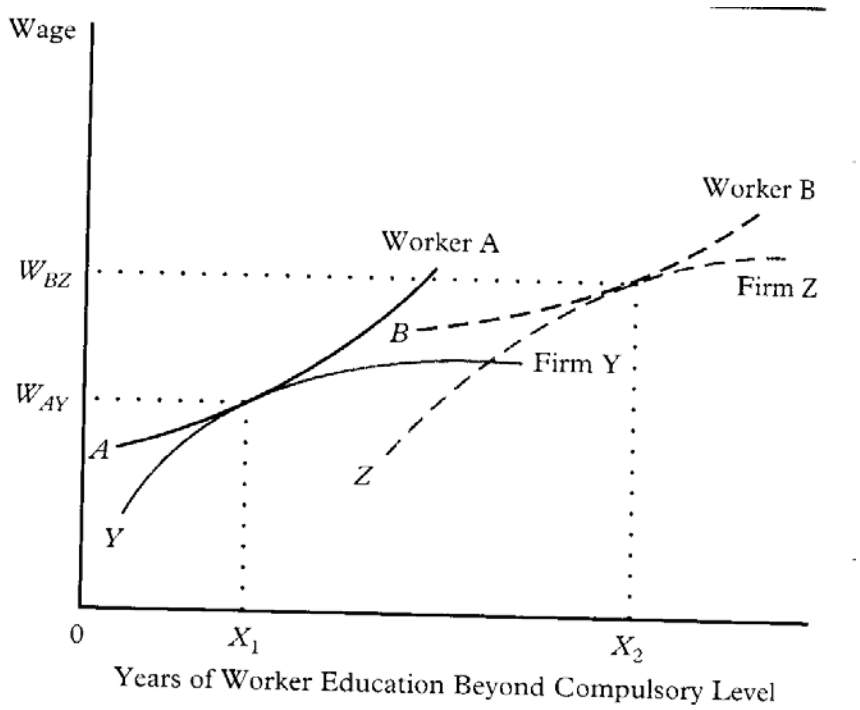
FIGURE 9B.2
Isoprofit Curves for Two Different Firms



The isoprofit curves in Figure 9B.2 have three important characteristics:

1. For each firm the curves are concave; that is, they get flatter as education increases. This concavity results from the assumption that, at some point, the added benefits to the employer of an additional year of employee schooling begin to decline. In other words, we assume that schooling is subject to diminishing marginal productivity.
2. The isoprofit curves are the *zero-profit curves.* Neither firm can pay higher wages for each level of education than those indicated on the curves; if they did so, their profits would be negative and they would cease operations.
3. The added benefits from an extra year of schooling are smaller in firm Y than in firm Z, causing Y to have a flatter isoprofit curve. Firm Y, for example, may be a discount department store in which "selling" is largely a matter of working a cash register. While better-educated people may be more productive, they are not *too* much more valuable than less-educated people; hence, firm Y is not willing to pay them much more. Firm Z, on the other hand, may sell technical instruments for which a knowledge of physics and of customer engineering problems is needed. In firm Z, additional education adds a relatively large increment to worker productivity.

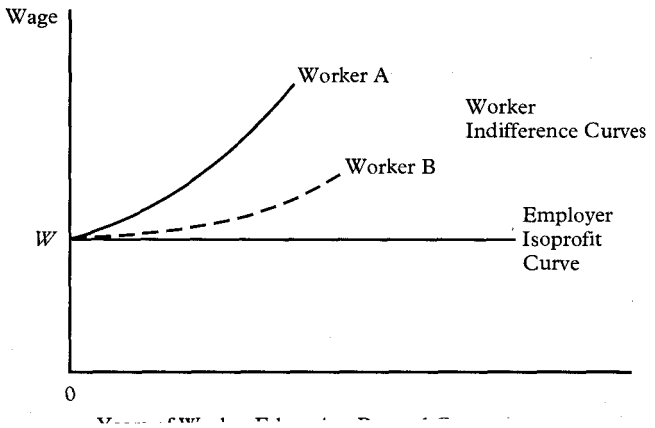
FIGURE 9B.3
The Education/Wage Relationship



Market Determination of *The Education/Wage Relationship*

Putting both sides of the market for educated workers together, it is clear that the education/wage relationship will be positive, as indicated in Figure 9B.3. Worker A will work for Y, receiving a wage equal to W_{Ay} and obtaining X, years of education. The reason for this matching is simple. Firm Z cannot pay higher wages (for each level of education) than those shown on the isoprofit curve in Figure 9B.3, for the reasons noted above. Clearly, then, worker A could never derive as much utility from Z as he or she could from Y; working for firm Z would involve a loss of utility to worker A. For similar reasons, worker B will accept work with firm Z, obtain X2 years of schooling, and receive higher pay (W_{BZ}).

FIGURE 9B.4
Unwillingness of a Firm to Pay for More Education of Employees



When examined from an overall social perspective, the positive wage/education relationship is the result of a very sensible sorting of workers and employers performed by the labor market. Workers with the greatest aversion to investing in education (A) will work for firms where education adds least to employee productivity (Y). People with the least aversion to educational investment (B) are hired by those firms most willing to pay for an educated workforce W.

Given the assertion by the critics of the human capital view of education that education adds nothing to worker productivity, it is interesting to consider the implications of an unwillingness by employers to pay higher wages, to workers with more education. If employers were unwilling to pay higher wages for more-educated workers, no education-related differentials would exist and employer isoprofit curves would be horizontal. Without a positive education/ wage relationship, employees would have no incentive to invest in an education (see Figure 9B.4). The fact that educational wage differentials exist and that workers respond to them when making schooling decisions suggests that, for some reason or other, employers are willing to pay higher wages to more-educated workers.

Cálculo del Valor Presente Neto.

Al momento de escoger entre dos (o más) inversiones es necesario conocer sus rentabilidades. Para saber qué alternativa es más rentable, debemos comparar el ***Valor Presente Neto*** de los flujos totales de ambas opciones.

El Valor Presente de una inversión o proyecto (cualquiera) se calcula como la suma de los flujos monetarios de cada período, descontados a la tasa de rentabilidad relevante para dicha inversión:

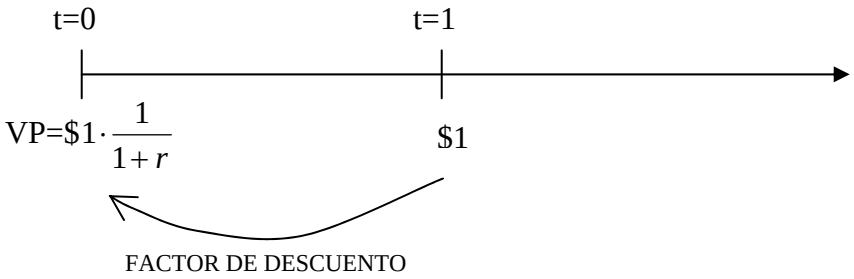
$$VP = \sum_{t=1}^{T} \frac{F_t}{(1+r)^t} = \frac{F_1}{(1+r)^1} + \frac{F_2}{(1+r)^2} + \ldots + \frac{F_T}{(1+r)^T} \qquad (1)$$

Donde: T= último período del proyecto
F_t= flujo monetario del período t
r= tasa de rentabilidad relevante (que en este caso es la misma para todos los períodos)

La justificación de este cálculo se basa en el siguiente principio financiero: "*$1 hoy vale más que $1 mañana*"; ello debido a que $1 hoy puede invertirse (por ejemplo en un depósito bancario) para obtener intereses en el futuro.

Así, el Valor Presente de un ingreso (flujo) monetario, aplazado en 1 período, puede hallarse multiplicando dicho flujo por un factor de descuento, que es menor a 1 (si el factor de descuento fuera mayor a 1, $1 hoy valdría menos que $1 mañana). Este factor de descuento se expresa como el inverso de 1 más la tasa de rentabilidad relevante (correspondiente a la tasa de rentabilidad de la inversión alternativa, como por ejemplo, el depósito bancario):

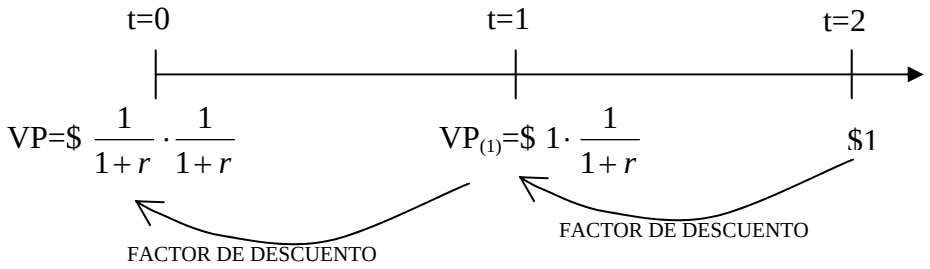
Factor de Descuento = 1 / (1+r)



Es decir, el equivalente monetario "hoy" de $F "mañana" es su valor presente:

$$VP = \frac{F}{(1+r)}$$

Supongamos, ahora, que esperamos recibir un ingreso de $1, aplazado en dos períodos, y sabemos que la tasa de rentabilidad relevante, por cada período, es r (constante en ambos períodos). Para obtener el Valor Presente de dicho flujo, debemos proceder en dos etapas: primero obtenemos el Valor Presente al período 1 y luego actualizamos dicho valor al período actual (t=0)



De esta forma, el Valor Presente para el ingreso de $F , aplazado en dos períodos más es de:

$$VP = \frac{F}{(1+r)^2}$$

En el caso de flujos monetarios aplazados en tres o más períodos, el razonamiento es análogo.

Una propiedad interesante de los Valores Presentes es se encuentran en la misma unidad de medida. Por lo tanto, si tenemos un proyecto con diferentes flujos en cada período, basta con sumar los valores presentes de cada uno de estos flujos:

$$VP = \sum_{t=1}^{T} \frac{F_t}{(1+r)^t} = \frac{F_1}{(1+r)^1} + \frac{F_2}{(1+r)^2} + \ldots + \frac{F_T}{(1+r)^T}$$

Finalmente, el ***Valor Presente Neto*** se obtiene de agregar el flujo monetario inicial (generalmente en proyectos de inversión este flujo es negativo, ya que corresponde al costo de la inversión inicial):

$$VPN = -C_0 + VP = -C_0 + \sum_{t=1}^{T} \frac{F_t}{(1+r)^t} = -C_0 + \frac{F_1}{(1+r)^1} + \frac{F_2}{(1+r)^2} + \ldots + \frac{F_T}{(1+r)^T}$$