# Estimating the Indirect Cost of Illness: An Assessment of the Forgone Earnings Approach

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ABSTRACT

*Objectives.* This study attempted to assess (1) the accuracy of estimates of the indirect cost of illness and death computed with the human capital (forgone earnings) method and (2) the sensitivity of these estimates to key assumptions and parameters.

*Methods.* The study used data from the annual Current Population Surveys of 1964 through 1988 to compare the earnings experience of cohorts of White men aged 18 through 65 with predictions made with the human capital method. The study then assessed the sources and magnitude of the observed differences.

*Results.* Predictions of forgone earnings can be as much as 18% greater or 20% smaller than actual earnings, under identical assumptions, depending on the data used. While in most cases errors are quite small, alternative, equally plausible estimates of forgone earnings may differ by as much as 50%. Estimates differed mainly because of (1) the cross section chosen to make the predictions and (2) assumptions about future earnings growth. However, other factors, such as cohort size, also contributed to variation.

*Conclusions.* Researchers and policymakers should be very careful in making and interpreting estimates of the indirect cost of illness and death. (*Am J Public Health.* 1996;86: 1723–1728)

## *Introduction*

In an era of scarce public resources, policymakers have become increasingly interested in justifying regulatory and expenditure decisions in terms of dollar-valued costs and benefits. Public health analysts and advocates have responded to this emphasis by producing estimates of the dollar costs of morbidity and mortality associated with various illnesses,[1–3] and by quantifying, in dollar terms, the potential health benefits of public health measures.[4,5]

The appropriate method for measuring the dollar value of lives lost owing to morbidity and mortality has been the subject of much controversy. Neoclassical welfare economics supports the use of measures based on the "willingness to pay" for increased risk.[6] Unfortunately, empirical estimates of willingness to pay for increases in risk exhibit extreme variation. Furthermore, estimates of willingness to pay for subcategories of the population (such as younger and older people) generally do not exist, and this technique is thus of limited usefulness for comparing programs that affect different groups.

Among public health analysts, the most commonly used approach to measuring the value of life is the forgone earnings approach, which consists of estimating the earnings forgone by an individual who dies prematurely. These earnings are usually estimated by the human capital method, that is, by examining the earnings of comparable individuals in a cross section of the population.[7] For example, the expected forgone earnings of a 23-year-old White male would be estimated by summing the appropriately discounted average annual earnings (adjusted to reflect average rates of labor force participation) of 24-year-old White males, 25-year-old White males, and so on, adjusted by the probability of survival to each age. The estimates are customarily discounted (using a range of discount rates) to adjust for the difference in the value of benefits received today and in the future.

There exists a considerable literature that assesses whether (and under what circumstances) the forgone earnings approach to valuing human life is theoretically justifiable.[8–10] Some theoretical work suggests that this approach provides a measure of the impact of death and illness on the material welfare of society.[6] Other work argues that forgone earnings estimates of the value of life may bear some consistent relationship to the true (willingness-to-pay) value of life lost.[9,11] This paper focuses on the empirical strength of the usual method of estimating forgone earnings. In keeping with Mishan's 1971 admonition that "there is more to be said for rough estimates of the precise concept than precise estimates of economically irrelevant concepts," economists have focused on refining estimates of the willingness-to-pay value of life, rather than critically evaluating the accuracy of the human capital method.[8] In the 25 years since Mishan's critique, though, the forgone earnings approach has continued to be widely used, particularly in assessing the costs of illness and the benefits of public health measures. This paper seeks to investigate to what extent this method, as currently used, provides a reliable and internally consistent estimate of the earn-

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ings forgone through premature death and illness.

The availability of multiple cross sections of the US population permits us to evaluate the accuracy of this method in predicting the forgone earnings of an individual. Below, we use data from the Current Population Survey (of the US Bureau of the Census, Suitland, MD) from 1964 through 1988 to examine the comparability of forgone earnings estimates from synthetic cohorts (i.e., population cross sections) with the experience of actual cohorts. We focus on three sources of differences between the estimates: business cycle effects, cohort size effects, and the effect of economic growth. Our study focuses on White males, the group likely to have been least affected by these three sources of error. Nonetheless, we find that these factors can cause different but quite defensible estimates of lifetime forgone earnings for identical populations to vary by as much as 50%.

## *Why Might Estimates of Forgone Earnings Differ from Actual Forgone Earnings?*

The level of average annual earnings of people of a particular age (such as 25-year-olds) at a point in time is the product of their level of wages and annual hours worked. Wages and hours, in turn, depend on the equilibrium supply and demand in the market for this type of labor. The total supply of labor of those of a particular age is the product of the size of this population and its propensity to work. The demand for labor depends on economic conditions, such as prices and the level of productivity (which is a function of the availability of capital and technology).

An important determinant of variation in the demand for labor across individuals, and therefore of their annual earnings, is the difference in the demand for labor of different types—in practice, for workers of different ages. But, as the discussion above suggests, other sources of variation in both demand and supply may also be important. Variation in demand may occur through changes in prices that affect the demand for labor (such as those that occur over the business cycle) and changes in productivity (e.g., through new technological developments) that lead to real earnings growth. Variation in the average hours of labor supplied by individuals with particular characteristics has been an important determinant of recent changes in the average annual earnings of older men and of women, through changes in labor force participation rates and education levels. Changes in the size of the population have had important consequences for workers in the large baby boom cohorts.

As described above, the usual method of estimating forgone earnings is to examine data from a single cross section of the population. This technique is often called the "human capital" method because the underlying model suggests that variation in earnings over the life cycle is due principally to the accumulation of human capital through on-the-job training and work experience. A cross-sectional view of the population can capture the effects on lifetime earnings of a stable age–earnings profile. However, the cross-sectional approach is likely to omit some components of true lifetime earnings and overemphasize others. In particular, the cross-sectional method ignores the effects of real earnings growth and cohort size on lifetime earnings while overemphasizing the importance of transitory business cycle effects.

Real earnings growth may cause estimates of forgone earnings derived from a single cross section to diverge from actual earnings. If earnings growth is positive, the earnings of individuals of a given age at a point in the future will be greater than those of individuals of the same age in an earlier year. Historically, the rate of real earnings growth in the United States has averaged about 2% per year. Over the past two decades, however, average levels of real hourly earnings have *declined* at an average rate of nearly 0.7% a year.[12]

Cross-sectional estimates of forgone earnings will also diverge from true earnings because they are likely to reflect prevailing economic conditions in the year of the survey. A recession, for example, is likely to reduce employment (and may also reduce wages) of individuals at all ages within a cross section.

The negative effect of cohort size on earnings has been extensively documented.[13] Cohort effects have been shown to be especially important during a cohort's first years in the labor force. Although there is some evidence that large cohorts adjust their human capital investments and may eventually increase their annual earnings to the level of smaller cohorts, the *lifetime* earnings of members of large cohorts are likely to be lower than the earnings of members of small cohorts.

## *How Large Are the Prediction Errors When the Human Capital Method Is Used?*

While earnings growth, business cycle, and cohort effects may lead to errors in the estimation of forgone earnings, the magnitude of these errors is unknown. We measure the size of the error by comparing estimates of the forgone earnings of groups of White men defined by age and cohort with their actual earnings experience.

We focus on White men for three reasons. First, the hourly earnings, hours worked, and labor force participation rates of women and minorities may be a consequence of social and labor market discrimination, as well as competitive market forces. Second, our economy does not provide monetary compensation for work in the home. The annual earnings of those who provide valuable, but unpaid, housekeeping and child care services are a significant underestimate of their contribution to the nation's economy. For these two reasons, researchers who use the human capital method typically make adjustments to the standard calculation to better proxy the economic contribution of women and minorities (e.g., by adding an estimate of the value of housekeeping services produced to forgone earnings).[7] Third, for the purposes of the analyses in this paper, changes in the economic behavior and experience of White men over the period under study have been substantially smaller than changes among women and minorities. From 1965 to 1987, the labor force participation rate of White men fell from 84.2% to 78.4%, while that of Black men fell from 84.1% to 74.7%. Labor force participation rates of women increased dramatically: from 37.5% to 55.6% for Whites, and from 50.7% to 60.7% for Blacks.[12] These changes in the labor force behavior of women and minorities suggest that the experience of earlier cohorts provides little basis for making estimates of future earnings for these groups. Thus, our focus on White males provides a very conservative measure of the variability associated with the human capital method.

Forgone earnings measures of the value of life are usually estimated from published data drawn from the Current Population Survey or the Census.[7] In this study, data are drawn from the Mare-Winship uniform extracts from the March Current Population Surveys for 1964 through 1987, and from the 1988 March

Current Population Survey. For each survey, the sample consists of White males aged 18 through 65 who did not live in group homes.

These data were grouped into 1200 age–year cells. Each cell contains the average wage and salary earnings of *all* individuals in the cell, both labor market participants and nonparticipants. Thus, the averages include real wage, employment, and participation effects. Although they are often estimated separately, we combine real wage and employment (labor force participation and unemployment) effects, in accordance with the literature on the human capital method, to simplify the presentation of the results.[7] We deflate average earnings in each cell to 1980 dollars using the consumer price index (X-1) so that our estimates accurately reflect the purchasing power of earnings at each point in time. Wages do not always fully adjust to changes in the consumer price index. If wages do not rise as much as the index, people cannot buy as much with their wages; real wages have fallen. Adjusting earnings through the use of the consumer price index means that equal earnings estimates drawn from different years reflect an equal level of economic well-being.

In the calculation of the cell averages, all data were weighted by the Current Population Survey population weights. All data were uniformly top-coded at $50 000 in 1980 dollars, to conform with the top-coding in the 1981 March Current Population Survey. Cell sizes for the samples for 1968 through 1988 ranged from 940 through 1450 for 18-year-olds, from 665 through 1225 for 30-year-olds, and from 423 through 632 for 65-year-olds. The 1964, 1965, and 1967 samples are somewhat smaller. Note that all wage and salary data in the Current Population Survey represent earnings in the year *prior* to the year of the survey. (All year references that follow refer to the year *prior* to the Current Population Survey year.)

The cell averages were arranged in a matrix where each year of the Current Population Survey was represented by a column of cells and each row corresponded to an age from 18 through 65. Each column of this matrix (Current Population Survey year) then contained the data needed to compute estimates of forgone earnings for White males of any specified starting age from 18 through 65. With the human capital method, the estimated forgone earnings (E) over 15 years for an individual of age $n$ in year $m$ would be:

$$\sum_{i=1}^{15} E_{n+i,m}$$

The top half of Table 1 provides cross-sectional estimates of the present value of the next 15 years of earnings for selected years from 1963 through 1973 for 20-, 30-, and 40-year-olds. As is customary, the estimates in Table 1 were calculated with alternative discount rates: 4% and 6%. Higher discount rates reduce average earnings, especially the earnings of individuals who have not yet reached peak earnings. Higher discount rates also place less weight on estimates in the more uncertain distant future.

In the matrix constructed above, the actual earnings experience of a cohort is described by the cells on the diagonals beginning in each year–starting-age cell. Actual 15-year earnings (E) of an individual age $n$ in year $m$ would be:

$$\sum_{i=1}^{15} E_{n+i,m+1}$$

The bottom half of Table 1 describes the present value of actual 15-year earnings for selected years from 1963 through 1973 for 20-, 30-, and 40-year-olds.

The human capital method uses the cross-sectional estimates in the top half of Table 1 to predict earnings. The accuracy of these predictions can be measured by comparing these estimates with the actual cohort estimates in the bottom half of the table. Using the 1963 population cross section and a 4% discount rate, an analyst would have predicted that a representative 20-year-old would earn a total of $129 914 through 1977. In fact, the average person who had been 20 years old in 1963 earned a total of $153 970 by 1977, 18.5% more than the analyst would have predicted. By contrast, an analyst using the 1973 population cross section (and a 4% discount rate) would have predicted that a representative 30-year-old would earn a total of $231 416 by 1987. Instead, the average 30-year-old earned just $204 513 by 1987, 11.6% less than the analyst's prediction.

Table 2 summarizes the prediction errors for 15-year earnings predictions made with a 4% discount rate. Estimates drawn from some samples (e.g., the 1967 cross section) provide reasonably precise projections of future earnings—even for distant years. For example, the 1967 cross section provides better estimates of forgone earnings for 1973 through 1987 than does the 1973 cross section. For the majority of estimates, the differences are quite small (under 10%). But some cross sections yield rather inaccurate estimates. The 1963 cross section consistently underpredicts earnings, especially for the early

**TABLE 1—Estimated and Actual 15-Year Earnings Using Current Population Survey Cross Sections and Cohorts (1980 dollars)**

| | Year Earnings of Cohort Begin | | | |
|---|---|---|---|---|
| Type of Earnings/Age | 1963 | 1967 | 1969 | 1973 |
| Estimated, 4% discount rate | | | | |
| 20 y | 129 914 | 149 921 | 158 015 | 161 157 |
| 30 y | 177 143 | 206 510 | 220 409 | 231 416 |
| 40 y | 177 612 | 201 863 | 215 237 | 230 054 |
| Estimated, 6% discount rate | | | | |
| 20 y | 112 719 | 130 025 | 136 850 | 139 654 |
| 30 y | 157 548 | 183 647 | 195 997 | 205 417 |
| 40 y | 158 895 | 180 351 | 192 233 | 205 757 |
| Actual, 4% discount rate | | | | |
| 20 y | 153 970 | 144 207 | 134 181 | 128 723 |
| 30 y | 208 461 | 216 052 | 209 538 | 204 513 |
| 40 y | 203 581 | 211 724 | 213 979 | 208 214 |
| Actual, 6% discount rate | | | | |
| 20 y | 133 546 | 125 302 | 116 897 | 112 375 |
| 30 y | 184 479 | 192 573 | 186 783 | 182 031 |
| 40 y | 180 832 | 189 025 | 191 656 | 186 248 |

*Note.* Sample consists of all White males in the 1964 through 1987 Mare-Winship extracts of the March Current Population Survey and in the 1988 March Current Population Survey who were not living in group homes. Data have been converted to 1980 dollars using the consumer price index X-1 deflator. Estimated earnings are based on Current Population Survey cross sections and actual earnings on Current Population Survey cohorts.

TABLE 2—Difference between Cross-Sectional Predictions and Actual 15-Year Cohort Earnings (as a Percentage of Predicted Earnings), 4% Discount Rate[a]

| Year of Earnings/Age | Year Earnings of Cohort Begin 1963 | 1967 | 1969 | 1973 |
|---|---|---|---|---|
| Cross-sectional estimates for 1963 | | | | |
| 20 y | 18.5 | 11.0 | 3.3 | −0.9 |
| 30 y | 17.7 | 22.0 | 18.3 | 15.5 |
| 40 y | 14.6 | 19.2 | 20.5 | 17.2 |
| Cross-sectional estimates for 1967 | | | | |
| 20 y | 2.7 | −3.8 | −10.5 | −14.1 |
| 30 y | 0.9 | 4.6 | 1.5 | −1.0 |
| 40 y | 0.9 | 4.9 | 6.0 | 3.1 |
| Cross-sectional estimates for 1969 | | | | |
| 20 y | −2.6 | −8.7 | −15.1 | −18.5 |
| 30 y | −5.4 | −2.0 | −4.9 | −7.2 |
| 40 y | −5.4 | −1.6 | −0.6 | −3.3 |
| Cross-sectional estimates for 1973 | | | | |
| 20 y | −4.5 | −10.5 | −16.7 | −20.1 |
| 30 y | −9.9 | −6.6 | −9.5 | −11.6 |
| 40 y | −11.5 | −8.0 | −7.0 | −9.5 |

[a]Differences are calculated from cross-sectional and cohort estimates in Table 1.

cohorts, whereas the 1973 cross section consistently overpredicts earnings. For younger age groups, the accuracy of the predictions varies widely, depending on the size of the younger cohorts in the cross section selected.

## *Variation across Estimates*

The pattern of prediction errors described in Table 2 is consistent with the existence of business cycle, cohort, and earnings growth effects. The standard deviation of earnings (discounted at 4%) drawn from different cross sections (which encompasses business cycle and earnings growth effects) is equal to about 8% of average earnings over 15 years. The standard deviations across cohorts of different sizes are almost as large for the 20-year-old age group, but decline to less than 2% of actual earnings for 15 years for older individuals. For all but this youngest group, the variation across cross sections is about five times as great as the variation across cohorts.

This pattern of variation yields substantial differences among predictions that are made for different cross sections and that do not reflect underlying changes in actual forgone earnings. For example, the estimated value of forgone earnings of a 30-year-old for 15 years at a 4% discount rate increases by $54 000 from the 1963 to the 1973 cross section in the top half of Table 1. By contrast, the actual earnings of a 30-year-old beginning in 1963 were $4000 *more* than the earnings of a 30-year-old beginning in 1973. How "big" is this $54 000 difference? One way to gauge its magnitude is to compare it with the effect of changing discount rates in an analysis. Analysts recognize the importance of examining the sensitivity of their results to alternative discount rates and typically report results using a range of discount rates. This $54 000 difference in forgone earnings is more than twice as large as the difference between using a 4% discount rate and a 6% discount rate in the calculation of actual forgone earnings for any of the cohorts in the bottom half of Table 1.

As the 15-year estimates suggest, predictions of lifetime earnings generated from different cross sections may vary substantially. Consider the following example, which uses a 4% discount rate. The forgone earnings estimate of earnings to age 65 for a 30-year-old based on either the 1963 or the 1982 cross section is approximately $290 000. This figure is roughly equivalent to the estimate of earnings to age 65 of a 40-year-old if the estimate is taken from the 1969 Current Population Survey cross section, and also roughly equivalent to the estimate of earnings to age 65 of a 35-year-old if the estimate is taken from either the 1980 or the 1987 Current Population Survey cross section. Simply using the 1963 cross section, instead of a cross section 6 years later, has the same effect as pushing back by 10 years the age at which mortality or morbidity occurs. Similarly, using the 1982 cross section, instead of a cross section 2 years earlier or 5 years later, has the effect of pushing back by 5 years the age at which mortality or morbidity occurs.

The effects of business cycles and cohort size on earnings can be seen in Figures 1 and 2. Figure 1 maps an index of the 15-year forgone earnings estimates for 35-year-olds using a 4% discount rate (1963 = 100) against an index of the White male unemployment rate (1963 = 100). The coefficients from linear regressions of forgone earnings estimates on the unemployment rate and a dummy variable for the 1960s provide an indication of the magnitude of business cycle effects. They suggest that a 1-point difference in the unemployment rate between two cross sections, the difference between the 1978 and the 1981 cross sections, would be associated with a difference of $7330 in estimates of forgone earnings over 15 years at a 4% discount rate, about 3% of the discounted value of earnings.

Figure 2 maps an index of the 15-year forgone earnings estimates for cohorts of 20- and 30-year-olds (1933 cohort earnings = 100) against an index of cohort size (1933 births = 100). Cohort size varied by less than 150 000 births from 1912 to 1926, and by less than 300 000 births from 1929 to 1942, but increased by over 40% from 1943 to 1955. All cohorts in this study over 31 years of age were born before 1943. Regressions of cohort earnings on a 5-year average of cohort size suggest that an increase in the size of the birth cohort of 20-year-olds from 2 918 600 to 3 976 600, such as occurred from 1963 to 1973, is associated with a $29 200 decline in earnings over the next 15 years (under a 4% discount rate). Estimates for ages greater than 32 are extremely erratic and rarely significant, as might be expected given the limited variation in cohort size for this group.

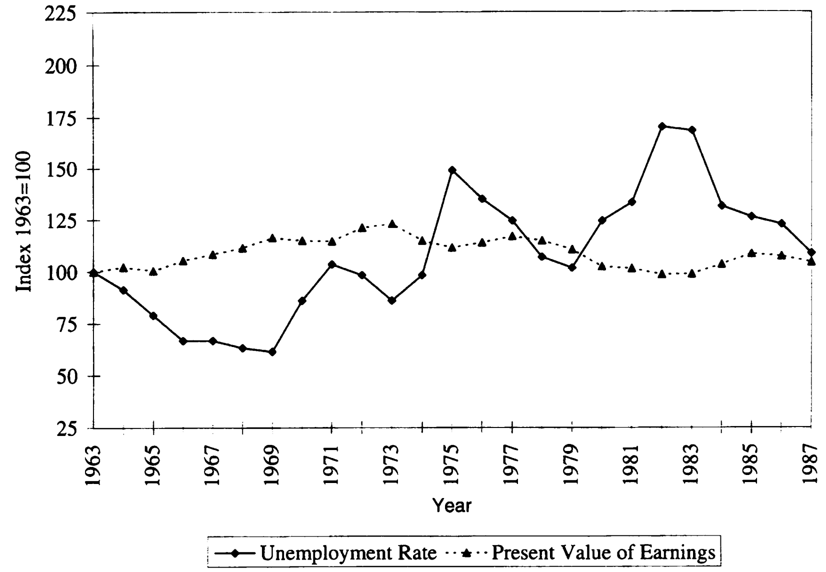
In addition to business cycle and cohort effects, cross-sectional estimates may incorrectly predict future earnings because real earnings growth occurs. Unlike information about the cohort size of current 20-year-olds and about business cycle effects for past years, real economic growth in the future, caused by changes in productivity and technology, cannot be easily predicted. To take these effects into account, researchers using the human capital method sometimes include an estimate of earnings growth in their predictions.[7,14] Assumptions about this growth rate can have significant effects on earnings estimates. For example, one important set of estimates made in the mid-1980s used an earnings growth rate of 2% per year. Unfortunately, actual earnings growth in the 15 years since that study averaged −0.4% per year; this implies that the study would have overpredicted the earnings to age 65 of a 25-year-old by about 45% (more recent work by the study authors has used an estimated growth rate of 1% per year).[14]

The effect of real earnings growth on future earnings depends on the pattern of earnings over the lifetime. The error introduced by ignoring earnings growth depends on the level of actual earnings and on the length of time until the projection year. The size of the projection error from ignoring real earnings growth will be largest for individuals who have not yet reached peak earnings. Using an earnings function constructed from the data in the matrix described above (which incorporates wage, hour, and labor force participation effects), we found that earnings peak at about age 40.

Estimates of this earnings function were used as weights in measuring the effect of earnings growth on lifetime earnings. The estimates suggest that if real earnings grew at 1% (as they did during the 1960s), estimates of 15-year earnings from a cross section with a 4% discount rate would underestimate actual earnings by about 7% for those under 40 and by about 6% for those over 40. If earnings grew at −0.5% (as they did during the early 1980s), such a cross-sectional estimate would overestimate actual earnings by about 3%.

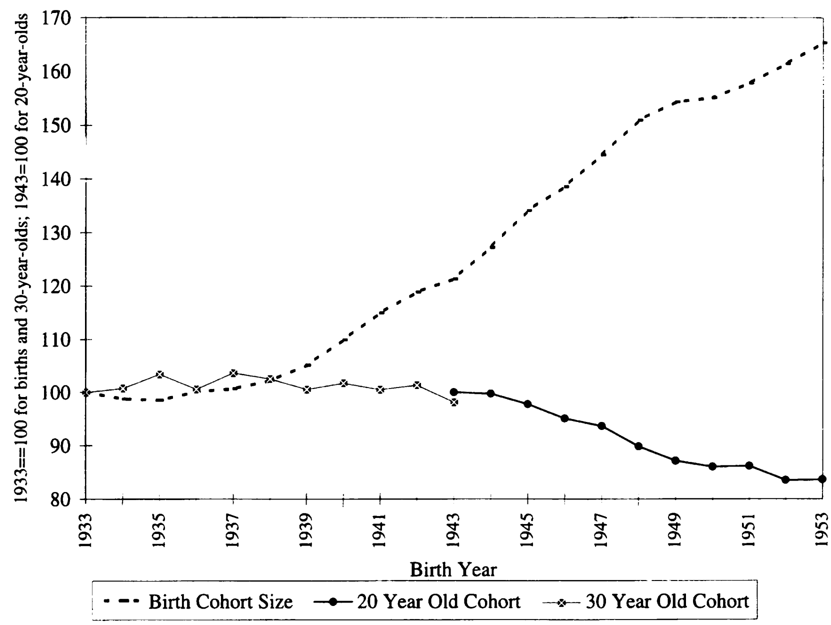
## *Conclusion*

The above results suggest that business cycle, cohort, and earnings growth effects can sometimes lead to substantial differences in indirect costs predicted with the human capital method. For example, with a 4% discount rate, an estimate of forgone earnings to age 65 for 25-year-olds drawn from the 1974 Current Population Survey under the assumption of 1% future real earnings growth is about 50% greater than the corresponding estimate from either the 1964 or the 1983 Current Population Survey under the assumption of no real earnings growth. (The 1964 and 1983 Current Population Surveys produce estimates of $236 000 and $238 000, respectively, at a 0% growth rate. The 1974 Current Population Survey produces an estimate of $303 000 at a 0% growth rate—28% higher than the 1964 estimate—and produces an estimate of $360 000 at a 1% growth rate—53% higher than the 1964 estimate under a zero-growth assumption).




*Note.* Earnings estimates for a White male are from the Current Population Survey; unemployment rate for all civilian workers is from reference 12.

**FIGURE 1—Cross-sectional estimates of 15-year earnings for a 35-year-old White male and unemployment rates for all workers (index 1963 = 100; 4% discount rate).**




*Note.* Earnings estimates for White males aged 20 and 30 are from the Current Population Survey.

**FIGURE 2—Cohort 15-year earnings for 20- and 30-year-old White males and birth cohort size (index 1933 = 100 for births and 30-year-olds; 1943 = 100 for 20-year-olds; 4% discount rate).**

This significant level of variability among estimates raises concerns about the desirability of using forgone earnings estimates of indirect costs, particularly given economists' long-standing concerns over the theoretical foundation of this method. Fortunately, a few simple measures can greatly reduce the potential errors associated with this approach.

The most significant of the three sources of error is business cycle effects. Errors due to business cycle effects can be corrected through a careful choice of cross section. In the analysis above, estimates drawn from the 1967 and 1969 cross sections (years with close to average earnings growth and slightly below average unemployment relative to the surrounding years) are more accurate than estimates drawn from the 1963 or 1973 cross sections, which reflect years of relatively weak and relatively strong economic performance, respectively. In the recent past, the 1987, 1990, and 1991 cross sections are likely to yield more accurate estimates than the 1989 (peak) or 1992 (trough) cross sections. Researchers should conduct sensitivity analyses to determine the possible bias due to business cycle effects. Cohort size has, at least in the past, had little effect on the future earnings of cohorts over 30, although this may change as the baby boom cohorts age. Corrections for cohort size can again be avoided through a careful choice of cross section. Ideally, the cross section chosen should include cohorts of individuals aged 20 through 30 that are about the same size as the cohort whose earnings are to be estimated. This may necessitate using different cross sections to make estimates for different cohorts. Cohort effects are likely to be particularly important in the estimation of forgone earnings for women and minorities. For younger members of these groups, estimates of forgone earnings that utilize information on the experience of older cohorts should be viewed with skepticism.

It is more difficult to adjust for errors in the choice of real earnings growth rate, but estimates of forgone earnings under different assumptions about real earnings growth can be easily calculated. An analysis of the sensitivity of estimates to the choice of growth rate should be a part of all studies of the value of lives lost, along with the customary analysis of the sensitivity of estimates to the choice of discount rate.

The continued popularity of the forgone earnings measure of the value of life rests in part on a belief that it is a simple, reliable way of obtaining consistent estimates for different subgroups of the population. While the forgone earnings approach is certainly less complicated than measuring the willingness to pay for increased risk, it will not provide appropriate or consistent estimates unless it is used with great care. □

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