PROBLEMS IN MEASURING EARNINGS FOR BENEFIT COST ANALYSES OF HUMAN INVESTMENT PROGRAMS

John Bishop, Institute for Research on Poverty
University of Wisconsin--Madison

I. Introduction

The standard method of calculating benefit cost ratios or social rates of return of human investment programs involves comparing earnings gains received by program participants to the foregone time cost of their participation and the direct costs of the program. Neoclassical production theory implies a correspondence between such earnings measures and the true contribution to real output of a program if all markets are competitive and taxes, fringes and marginal externalities are all zero. Since these assumptions seldom hold, standard benefit cost calculations will often be biased. This paper explores the practical implications of relaxing the assumption of zero taxes and fringes and of competitive product markets. The more difficult problems posed by externalities and noncompetitive labor markets can only be dealt with in the context of the specific type of human investment involved, therefore these issues are left for another paper.

The true contribution to real output of a marginal increment in a given factor of production (MVP) is the price consumers pay for the product times its marginal physical product. Thus, what we desire to measure is MVP (MVP = P · MPP). The paycheck of the worker and, therefore, his reported earnings (E) can be substantially smaller than this.

A profit-maximizing firm arranges its use of factors so that the total cost of employing a marginal increment of a factor equals that factor's marginal revenue product (MRP = MR · MPP). The paycheck consequently will equal the factor's MRP minus fringe benefit payments and taxes on the factor's use.

$$E = \frac{MRP}{(1+t_s+f)} = \frac{MVP}{(1+t_s+f)} \cdot \frac{MR}{P} = \frac{MVP}{(1+t_s+f)(1+t_e+\pi_m)}$$

where t_s = average rate of employer-paid Social Security tax
f = average rate of fringe benefit contribution
t_e = excise tax rate
π_m = average rate of monopoly profit.

The marginal revenue (MR) is lower than the product's price to the extent that there are excise or value-added taxes on output or less than infinitely elastic firm demand curves.

An additional potential source of error in calculating the social benefits of programs is inaccuracy in the reporting of earnings. In section II each of these five potential sources of discrepancy between MVP and reported earnings (E_r) will be examined and their magnitude estimated. In section III average and marginal rates of tax and fringe benefit payments are calculated for each of six earnings classes. When all five discrepancies are put together, the resulting average MVP/E_r for the 1970 Census declines from 1.15 at low earnings levels to 1.11 at high earnings levels. Section IV examines how these estimates of coverage bias affect the benefit cost ratios and rates of return of human investment programs.

II. Discrepancies between MVP and Reported Earnings (E_r)

Fringe Benefits

Fringe benefits are a large and growing part of labor compensation. As a percentage of total earnings they have risen from 1.1 percent in 1940 to 4.7 percent in 1959 and 6.2 percent in 1969. Some fringes are given disproportionately to high-income individuals--e.g., stock options and pensions. Others such as health insurance, food and housing received as pay, and farm products consumed at home are a larger portion of the compensation of employees with low earnings.

Recent studies by the Social Security Administration of pension and group medical insurance eligibility of a national probability sample of workers and of the pension receipts of recent retirees allow us to make some rough calculations of fringe benefit coverage (Kolodrubetz, 1974; Kolodrubetz and Landay, 1973). Columns 1 and 6 of Table 1 present the proportion of full-time wage and salary workers that are covered by group medical insurance and by private retirement plans in May, 1972. Since private pensions are generally supplemental to Social Security, the need and demand for them is greater among better paid workers. Coverage by retirement plans rises from 26 percent for those earning less than $5000 to 70 percent for those earning more than $20,000. Coverage by group health plans also rises with income but is high throughout.

Part-time and self-employed workers are not likely to be covered by group medical or retirement plans. In order to estimate the pattern of coverage for all workers, the estimates of coverage in columns 1 and 6 have been revised downward to take into account the incidence of part-time and self-employed workers by income group.

The next step is to estimate for eligible workers the relationship between the individual's earnings and the amount of fringe benefit costs incurred on his behalf by his employer. The Survey of New Beneficiaries (Kolodrubetz, 1973) recently completed by the Social Security Administration has found that the median ratio of pension to earnings on an employee's longest job follows a gentle U-shaped pattern as he moves up the earnings distribution (column 8). The increase in this ratio that occurs as the individual's earnings rise from $5000 to $15,000

is quite gentle, however, and is due to the greater length of service of the higher earnings retirees.

Unlike pensions, whose costs are roughly proportional to earnings, medical insurance costs should be more or less constant across individuals. On the one hand, government and private establishments with high wage structures tend to have the most comprehensive insurance coverage. On the other hand, people in low wage occupations are more likely to use the coverage they have so the cost of their insurance may be higher. The net effect of these counteracting influences is assumed to produce an elasticity of group medical insurance expenditures to earnings of about one-third. Dollar amounts of group health insurance per covered employee were, therefore, assumed to rise one dollar for every 100 dollars of income.

The aggregate amount of employer contributions to employee benefit plans is obtained by summing National Income Account estimates of other labor income, federal employee pensions, state employee pensions and one-half of defense health expenditures. Pensions are approximately one-half the total, and medical insurance approximately one-third. The rest is made up of life insurance and temporary disability plans. This category is distributed among workers in proportion to earnings. Estimates of the total amounts of and distribution of food and housing expenditures received as wages are taken from a study by Herriot and Miller (1972). Line 2 of Table 2 presents rates per dollar of earnings. After calculating average fringe benefit estimates for workers at their specific earnings level, the marginal rates of fringe compensation were calculated by relating the difference between these averages to the earnings increment.

Taxes on Labor Input (t_s)

The second source of discrepancy between reported earnings and the marginal revenue product are the Social Security and Unemployment Insurance taxes paid by employers. The effective average rate of tax for earnings brackets below the maximum taxable wage is equal to the proportion of workers covered (.873) times the statutory rate. In 1969 the Social Security tax was paid on the first $7800 of wages, so for incomes above $7800 average tax rates are the maximum tax, $327, times .873 divided by the midpoint of the earnings interval. The unemployment insurance tax rate (.0138) and maximum taxable wage ($3400) is a weighted average of varying state provisions.

Excise Taxes

State and federal sales and excise taxes, not including alcohol and tobacco taxes, totaled $27.6 billion in 1968. Alcohol and tobacco taxes are excluded because they are assumed to reflect the negative externalities one's use of these products imposes on others.

A separate calculation was carried out for retail gasoline taxes (9.187 billion in 1970) in order to account for their greater incidence on imports and property income. With backward shifting the 1967 input-output table implies that the burden falls 3.4 percent on imports, 26.8 percent on the property income of petroleum extraction, refining, wholesaling and retailing, 19.4 percent on employee compensation of these industries and 50.4 percent on purchases from other industries. In 1969, the ratio of fuel taxes assigned to oil industry employee compensation to economy-wide employee compensation is .00315. The ratio of general and specific sales taxes (including .504 of the gas tax) to GNP was .0294. The incidence of excise taxes on labor compensation is, therefore, .03255.

Monopoly Power

Whether monopoly power makes a further correction desirable depends upon the source of the monopoly and which factor of production is receiving the monopoly rents. If monopoly rents add equal percentage increments to workers' wages and to capital's return, no problem arises, for our compensation data has already captured them. If a firm faces an infinitely elastic long-run demand curve at its limit price, but nevertheless receives monopoly rents because of the ownership of some unique factor of production (e.g., patents, control of the best raw material sources, government licenses), no adjustment is required. An add-on is required only where $P > LRMR = LRMC$ and where the monopoly rents do not get paid to labor.

How large might such monopoly profits be? Harberger's (1954) upper bound estimate of the welfare impact of monopoly implies that one-third of manufacturing profits are excess profits. Assuming that the share of monopoly rents $[(P - LRMC)q]$ in corporate profits is one-third for manufacturing, we obtain an upper bound estimate of $17.7 billion for 1969, or 1.9 percent of GNP. The results presented in Tables 2 and 3 do not include an adjustment for monopoly distortions or for systematic economies of scale. The reader may make his own adjustment for monopoly with his own assumption about monopoly by simply multiplying the average and marginal ratios of social benefit to reported income in Table 3 by a number between 1 and 1.019.

Underreporting

It is possible to determine the average degree of under- or overreporting by Census interviewees for each type of income by comparing national income aggregates derived from establishment sources with the aggregates implied by the Census household data. While 96 percent of wage and salary income was reported in the Current Population Survey, only 52 percent of farm income was reported (Projector and Brety, 1972). The percent of aggregate earnings missed was only 1.5 percent in the 1970 Census, .67 of a percent in the 1960 Census, and 5.4 percent in the 1970 and 1971 CPSs.

Census and CPS aggregates may be low either because people are missed or because on average each person understates his earnings. Only the latter source of discrepancy will cause a bias

in measures of benefits of human investment programs. The Bureau of the Census has developed estimates of the amount by which the nation's population was understated in the Census and CPS (Siegel, 1967 and 1974). By applying age, sex, and race-specific undercount rates to 1970 Census estimates of their earnings aggregates, and assuming that those not enumerated earn two-thirds the average, we can estimate the effect of the Census undercount on earnings aggregates. The undercount adjustments of Census aggregates were 2.14 percent in 1960 and 2.8 percent in 1970. This implies in turn that per capita earnings in the Census overstated the true level of per capita earnings by 1.47 (2.14-.67) percent in 1960 and 1.34 percent in 1970. The CPS understated true per capita earnings by 2.8 percent.

III. Combining the Estimates

In Table 2 we collect our estimates of earnings-bracket-specific correction factors. We find that the average social productivity benefit of a person's work--the sum of after-tax earnings and taxes generated--averages about 113 percent of reported earnings. As earnings rise, the ratio of social benefit to census-reported earnings tends to fall from 1.15 to 1.11. The fall in the ratio is a consequence of imputations not rising as fast as income and the zero marginal Social Security tax on wages above $7800.

Dividing the Social Return into Private and Public Components

What portion of this total or social return can the individual be expected to take into account when he makes his own decisions? Splitting the social return into private and public components is necessarily more arbitrary than calculating the total return. Lines 9 and 14 of Table 2 present lower bound estimates of the ratio of private benefits to reported earnings. It is based upon the assumption that extra earnings do not, on the margin, place any additional burden on the government's provision of services. This is a valid assumption for pure public goods such as defense, foreign affairs, space, and police and fire protection. Providing an individual with more of a pure public good inevitably means everyone else gets more.

However, for many government services provided at zero or nominal cost, giving the service to one person means it must be denied to someone else. If usage of such services rises with income, extra after-tax income places an additional burden on other taxpayers. Some directly provided services of this kind are education, libraries, airports, congested high ways, recreation, sewers, water supply, and garbage collection. From a life cycle perspective the largest of the transfer programs, Social Security, also provides larger dollar benefits to people with higher earnings. Usage of certain other services--Food Stamps, directly subsidized housing, Medicaid, unemployment insurance and AFDC--go down as earnings rise. Studies that lump all these effects together obtain small (about 4 percent) positive marginal effects of earnings on net usage of government services (Reynolds and Smolensky, 1974). Consequently, assuming marginal induced government services to be zero places a lower bound on the private benefit. Our estimate of the private benefit to reported earnings ratio is thus simply the MVP/E_r ratio minus the average rate of personal, excise and labor input taxation.

In 1970 the average rate of tax for the income tax and Social Security (employee share) together rises from 7.9 percent of earnings in the $2000-$4000 bracket to 17.2 percent in the $15,000-$25,000 bracket. The ratio of after-tax compensation to reported earnings, therefore, falls from .98 to .89 as one moves from low to high brackets. The ratio of all taxes generated to reported earnings rises from .17 to .22 as earnings rise.

Marginal rates of tax are higher, ranging from .26 to .21. Marginal ratios of MVP and after-tax compensation to earnings are required because the effect of most human investment programs is a rise in the individual's earnings. After-tax income and total tax generated are calculated for the representative family in each bracket using average ratios and the midpoints of the intervals as family income. The difference between the predicted figure for adjacent income brackets is divided by the rise in income from the midpoint of one bracket to the next to obtain marginal ratios. The marginal ratio of after-tax compensation to reported earnings is below the average ratios and tends to fall with income from a high of .935 to .87. The marginal ratio of social or total return to reported earnings is also below the average, falling from 1.12 in low brackets to 1.08 in high brackets.

IV. The Impact of Coverage Bias on Benefit-Cost Ratios and Rates of Return

Benefit-cost ratios and rates of return express a relationship between benefits received in the future and costs incurred now. The net effect of coverage bias on a benefit-cost ratio or rate of return depends upon the relative size of the bias in measuring each component.

In most benefit-cost or rate of return calculations, benefits are assumed to accrue to individuals as gains in earnings. We have seen that traditional measures of these social benefits understate benefits by 8 to 15 percent. The coverage bias in measures of cost varies even more from situation to situation for there are three distinct types of cost: government budgetary costs, forgone work time costs and forgone leisure time. Each will be discussed in turn.

Net Coverage Bias When all Costs are Budgetary

The coverage bias issue has a counterpart in the measurement of budgetary cost. Correct measurement of a program's cost requires the inclusion of pension cost and other fringe

benefits being earned by individuals assigned to the program. This occurs as a matter of course when the task or service is provided by an independent agency on a contract basis. Separate calculation of an appropriate fringe benefit rate may be necessary when government-wide pension programs are financed on a pay as you go basis. Accounting procedures for allocating fringe benefit costs to programs are already well developed so we will assume that budgetary costs are correctly measured (i.e., fringes are included).

The net coverage bias in the benefit-cost ratio of programs which do not require a time input on the part of the beneficiary is equal to the coverage bias inherent in the particular benefit being analyzed. The GNP benefit of a health program that reduces mortality is the marginal value product of the workers whose deaths are averted. If these workers earn $20,000, the true GNP effect is 10.8 percent greater than the earnings loss. (The coverage bias ratio = MVP/E_r = 1.108.) If the program averts the death of workers earnings $3000, traditional benefit measures understate the GNP effect by 14.8 percent. The degree of understatement is greater for health investments in low-wage workers.

In most cases a human investment program produces marginal increases in the earnings of individuals. Under these circumstances, the appropriate coverage bias ratio is $\Delta MVP/\Delta E_r$. It can be found on line thirteen of Table 2 and in the first three columns of Table 3. An improvement in the quality of education, or training, or a health program that deals with a nonfatal disease are examples of such a program. Traditional measures of the benefits of a training program targeted at low-wage workers have a coverage bias ratio of between 1.12 and 1.129. The coverage bias ratio for improved graduate education is 1.09. As with mortality reduction programs, the understatement is greatest for low-wage workers.

Net Coverage Bias When Forgone Work Time Is Part of the Cost

In most training programs a major part of the social cost is the work time sacrificed by the trainee. Decisions to expand the number of people attending college or receiving training necessarily imply reductions in labor supply during the training period. Measures of earnings forgone because of the reduction in labor supply are subject to the same type of coverage bias as benefit measures. Since the loss of earnings during the training period generally occurs when the individual is young and has a low earnings capacity, the coverage bias ratio of this cost element is typically larger than the ratio for the corresponding benefit. The adjustment factor for forgone earnings costs of schooling are given in columns 7-9 of Table 3. The social costs of schooling include, however, a government expense component that does not suffer coverage bias. The coverage bias of total costs depends upon the relative importance of these two elements. Instructional costs of the first two years of college are approximately .37 of total costs, so the coverage bias ratio for the costs of the first two years of college is roughly 1.076 (.63 (1.12) + .37 (1.0) using 1970 Census data. The net coverage bias ratio is thus 1.023 (1.10/1.076). For this and other schooling increments in which forgone wages are more than half the social cost, the coverage bias in our measure of cost almost exactly counterbalances the coverage bias in the benefit measures.

Net Coverage Bias When Time Costs Are Leisure Forgone

In many instances the time costs of schooling come wholly or partly at the expense of leisure. The 3.4 million part-time students in degree credit college classes are generally working full-time as well. A substantial portion of a full-time student's studying and class time involves a reduction of leisure. Using National Longitudinal Survey data, Parsons (1974) has estimated that the share of leisure time in the 1300 hours required for full-time school attendance is 52 percent for 17 year olds, 34 percent for 19 year olds, and 21 percent for 21 year olds.

The social cost of a sacrificed hour of leisure time is not as great as the social cost of a sacrificed hour of work. The difference is in the tax revenue produced by the work. Young people adjust their hours of work until, on the margin, they receive approximately equal satisfaction from extra leisure and from extra work. The dollar value of leisure time is, therefore, roughly equal to the after-tax wage rate. If we have valued forgone leisure time at the money wage rate, we have exaggerated its cost. The ratio of the social value of leisure to the reported wage rate is equal to ratio of the private value of work to reported earnings. These ratios, the combined tax and coverage bias when a benefit or cost is nonpecuniary, are given in columns 4-6 and 10-12 of Table 3.

If a human investment program is structured so that time inputs are forgone leisure, net coverage bias is quite large. In the junior college example dealt with above, tax and coverage bias in our estimate of cost is .63 (.9) + .37 (1.0), or .937. Net coverage bias in the benefit cost ratio is 1.174 (1.10/.937) when all time inputs result in a sacrifice of leisure.

The net coverage bias is also easy to calculate when both work and leisure have been reduced. For a 19 year old full-time student the coverage bias in the time cost is .34 (.9) + .66 (1.12) or 1.045. Net coverage bias in the cost-benefit ratio for full-time attendance of a 19 year old in junior college is, therefore, 1.10/(.63 (1.045) + .37 (1.0)) or 1.070. Taking into account the fact that part of the time input of schooling results in a sacrifice of leisure and not of work raises the magnitude of the net coverage bias, especially of young students. Adopting Parson's estimates of work's share of time inputs, our new estimate of

net coverage bias in benefit-cost ratios for additional students is 1.131 for 9th and 10th grade, 1.103 for the last two years of high school, 1.057 for the last two years of college, and 1.031 for graduate school. These differentials in the coverage bias reflect the fact that the social efficiency of a human investment is sensitive to whether the time invested comes at the expense of work or of leisure.

Net Coverage Bias in Rates of Returns

The net coverage bias in rates of return can be calculated by a slight modification of the procedure used in our examples. Adjustment factors are applied separately to costs and benefits, the present value of costs are set equal to the present value of benefits, and the equation is solved for the internal rate of return. The change in the rate of return that the coverage bias adjustment produces is similar to the net coverage bias of the corresponding benefit-cost ratio. If there is no time variation in the level of benefits or costs, the ratio of the new to old rate of return will equal the net coverage bias ratio, the correction factor for benefit-cost ratios. Since, however, the dollar size of the benefit tends to rise with age, the proportionate change in the rate of return produced by the coverage bias adjustment will tend to be smaller than the proportionate change of benefit-cost ratios.

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Table 1

Calculation of Marginal Fringe Benefit Rates

Earnings	Group Health Insurance					Retirement					Total	
Men	% FTWS with group health[1]	% all with group health (est)[2]	Avg cost per emp (est)[3]	Avg % of earnings	Marg % of earnings	% FTWS covered by ret. plan[4]	% all workers covered[5] (est)	Median pension earnings ratio[6]	Avg % of earnings	Marg % of earnings	Marg fringe benefit	Increment in earnings (000's)
less than 5000	.61	.53	202	3.57		.26	.17*	.30	.98		5.66	0→ 3
					1.8					3.19		
5-6000	.75	.69	222	2.78				.23			6.10	3→ 5
					2.5							
6-7000	.82	.77	232	2.75				.22			6.50	5→ 7
					2.0	.58	.50*		2.31			
7-8000	.86	.82	242	2.65				.24			7.90	7→ 9
					2.1							
8-9000	.91	.87	252	2.58				.25			7.75	9→ 12.5
					.9					5.64		
9-10000	.91	.87	262	2.40				.25				
					1.1							
10-15000	.93	.89	292	2.08		.74	.70*	.27	3.64			
					.9					4.50	6.49	12.5→ 17.5
15-20000	.93	.89	342	1.74		.76	.72*	.28	3.89			
					.9					3.89	5.88	17.5→ 30
more than 20000	.92	.89				.70	.72*	.28	3.89			
All FT	.80					.47		.25				
Avg All			252	2.11					3.22		6.49	
Women												
less than 5000	.59	.50	202	3.36		.31	.22	.19	.80		5.27	0→ 3
					1.76					2.16	5.03	3→ 5.5
5-6000	.77	.70	222	2.82		.58	.44	.17	1.44			
					1.61					4.02	6.74	5.5→ 8
6-10,000	.81	.76	257	2.44			.51	.23	2.26			
					.95					2.54	4.60	8 - 15
more than 10,000	.84	.80	327	1.74		.60	.54	.23	2.39			

Table 2

Incidence of Overreporting, Fringe Benefits, and Taxes

by Income Class in 1969

Family Income (in thousands)	2-4	4-6	6-8	8-10	10-15	15-25
Average Percent of Earnings						
Under or overreported	-1.34	-1.34	-1.34	-1.34	-1.34	-1.34
Food and housing received as wages	1.69	.82	.57	.43	.32	.21
Health and Pensions	5.66	5.84	6.03	6.44	6.82	6.62
Social Security tax on employer	4.19	4.19	4.19	3.64	2.62	1.64
Unemployment insurance tax	1.0	.70	.50	.38	.28	.17
Personal income tax	3.67	6.45	8.64	10.12	12.21	14.54
Excise Tax % of Compensation	3.26	3.26	3.26	3.26	3.26	3.26
Ratio of MVP to E_r	114.8	113.8	113.5	113.1	112.2	110.8
Ratio of after-tax compensation to E_r	97.6	94.1	91.9	91.3	90.7	89.1

Earning Increments (in thousands of dollars)	1→3	3→5	5→7	7→9	9→12.5	12.5→20
Impacts of Earning Increments (percent)						
Marginal fringe benefits	4.66	5.6	6.5	7.90	7.75	6.5
Employer-paid taxes on labor input at margin	5.19	4.39	4.19	1.68	0	0
Marginal income tax	5.00	11.12	14.13	15.30	17.60	18.40
$\frac{\Delta MVP}{\Delta Repted\ earnings}$	112.0	112.2	112.9	111.8	109.9	108.6
$\frac{\Delta After\text{-}tax\ compensation}{\Delta Repted\ earnings}$	93.6	88.4	86.3	89.4	88.8	86.8

Table 3

Coverage Bias in Traditional Measures of the Benefits and Costs of Education (Ratios of True Productivity Benefits or Costs to Reported Money Earnings for Males)[1]

	Productivity Benefits						Student's Time Costs					
	Social			Private			Social[2]			Private[3]		
	Census			Census			Census			Census		
	1959	1969	CPS	1959	1969	CPS	1959	1969	CPS	1959	1969	CPS
Finish Elementary[4]	1.08	1.12	1.16	.87	.88	.92	1.11	1.15	1.20	1.02	1.01	1.05
Elem. to HSDO[4]	1.08	1.12	1.16	.87	.88	.92	1.11	1.15	1.20	.95	.94	.98
HSG	1.08	1.11	1.15	.87	.89	.93	1.08	1.13	1.17	.93	.92	.96
Coll. Dropout	1.07	1.10	1.14	.87	.89	.93	1.08	1.12	1.16	.91	.90	.94
Coll. Grad.	1.07	1.10	1.14	.87	.88	.92	1.08	1.12	1.16	.90	.89	.93
Grad. School	1.06	1.09	1.13	.85	.87	.91	1.08	1.12	1.16	.89	.88	.92

[1]By a simple manipulation of these factors, rates of return and benefit-cost ratios may be adjusted for taxation and coverage bias. Calculate the cost adjustment by taking a weighted average of the student time cost factor and one. The weights are the conventionally calculated foregone earnings and either instructional cost or out of pocket tuition and book costs. This average is divided into the productivity benefit adjustment factor. Female productivity benefit ratios will tend to be lower because of lower fringe benefits and higher income taxes and higher because of the greater relative importance of Social Security taxes.

[2]If time spent in schooling would have been spent working.

[3]The social cost if time at school comes at the expense of leisure or the private cost no matter how the school time would have been spent.

[4]Foregone time costs adjustment for students through 10th grade use the average ratio rather than the marginal ratio that is assumed for all other levels of schooling. In other words, until the 10th grade, it is assumed that those in school hardly earn anything at all. For all others, it is assumed those in school already work some and that the effect of dropping out is to increase the amount of work and leisure from an already existing base and that therefore, marginal rates of taxation and coverage bias apply. It is further assumed that elementary students pay only Social Security taxes on their earnings.