

AN INTRODUCTION TO COST BENEFIT ANALYSIS
OF THE VOCATIONAL REHABILITATION PROGRAM:
A MODEL FOR USE BY STATE AGENCIES

by

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INTRODUCTION

State vocational rehabilitation agencies are increasingly being called upon to do cost-benefit analyses of their rehabilitation programs. State legislatures want such analyses done so that the desirability of rehabilitation programs can be gauged and compared to other programs. Also, the federal agencies involved in vocational rehabilitation want cost-benefit analyses done, for much the same reason. Often the State agency itself wants a cost-benefit analysis available for use in decision-making and program evaluation.

This paper is written to help State agencies use cost-benefit analysis. The paper attempts to present cost-benefit analysis as clearly as possible, without too much detail. In addition to presenting cost-benefit analysis, a model for doing cost-benefit analysis of rehabilitation programs is discussed. The model is also presented without too much detail. The mathematical formulation is presented in an appendix; a fuller statement of the model and some improvements on it will appear in a subsequent publication. Data specifications and new directions for the improvement of the model round out the paper. An appendix of selected (not comprehensive) readings on cost-benefit analysis in general and on the application of cost-benefit analysis to vocational rehabilitation programs is included for those who desire to read further.

The cost-benefit model itself requires for its use a minimal amount of data from the State agency. (See subsequent section on data specifications.) The model is also very flexible. Any additional data

or different ways of handling any of the parts of the model can easily be incorporated. The model and its parameters have been tested. A sensitivity analysis has been performed on all the parts and parameters of the model. The model has also been used to analyze the rehabilitation program at the federal level, for the years 1960, 1963, 1966, 1969, and 1970.¹

¹Christian Averous, with Konrad Stahl and Charles B. Cole, "Cost-Benefit Analysis of Rehabilitation Services Programs: A First Model and Its Sensitivity Analysis," Working Paper No. 163/RS001, Institute of Urban and Regional Development, University of California, Berkeley, November 1971.

CHAPTER I
INTRODUCTION TO COST-BENEFIT ANALYSIS

In order to introduce cost-benefit analysis the following topics are covered: cost-benefit analysis and its use, approaches to cost-benefit analysis, numerical results, costs, benefits, and social discount rate.

I.1. Cost-Benefit Analysis and Its Use

Cost-benefit analysis is a method for decision-making. The decisions are decisions on which programs or projects governments should undertake. Given several alternative projects or programs, how can the decision-maker choose among them? The choice among projects may be important because some of the projects may not be "worthwhile." Or, the choice among projects may be important because only enough money is available to undertake a certain dollar amount of projects.

Cost-benefit analysis is not an artificial way of looking at things. In fact, it is often implicit in day-to-day affairs. For example, you have arrived at the airport for a large city. The airport, however, is thirty miles from the downtown area, where you have a meeting. You ask at the information desk and find there are several ways to get from the airport to the city. You could take a taxi, helicopter, bus, limousine, monorail, or rent an automobile. Each of the different modes of transportation costs a different amount, each provides a different amount of comfort and speed, and each lets you off in the city with different degrees of closeness to your destination. You certainly would not want to just

take the cheapest mode. Although you would spend the least amount of money, you might get delivered on the other side of town two hours later. On the other hand, you might not want to take the fastest, most comfortable, closest-delivery mode, since that mode might be too expensive. In fact, the fastest mode might not be the most comfortable, and so on. What you would do would be to balance the costs and the multiple benefits and choose the mode of transportation on the basis of a comparison of the costs and benefits of all the modes. In a sense, you have done cost-benefit analysis, intuitively.

Several results come out of a cost-benefit analysis. Of course, there is the numerical result, for example, the cost-benefit ratio. More importantly, there is a list of assumptions and data used to get the numerical result. The numerical result is only as good as the assumptions made and the data employed. An important side result of a cost-benefit study is some additional understanding of the program being analyzed. For example, in doing a cost-benefit analysis an exhaustive list of program benefits is required. In making such a list, benefits that may not previously have been recognized as benefits come to be recognized as such.

What is the use of cost-benefit analysis? Cost-benefit analysis is certainly not a substitute for the judgment of the decision-maker. Nor is the economic emphasis of cost-benefit analysis designed to supplant the very important social and political considerations of a decision. Rather, cost-benefit analysis is an aid to decision-making, one more tool for the use of the decision-maker.

Two types of decisions are amenable to cost-benefit analysis. At one level there is the decision to undertake a program at all. Cost-

benefit analysis can be used to decide which alternative projects should be undertaken. However, the projects being compared should be projects that have the same goal. For example, it is not proper to use cost-benefit analysis to justify providing services to one group while denying services to another group, if Congress and state legislatures have shown that they want both groups served. Cost-benefit analysis is more properly used in deciding between alternative programs for serving the particular groups.

At another level, cost-benefit analysis is helpful in deciding on project scale. Cost-benefit analysis can be used to decide whether to contract or expand a program, and to decide how much to contract or expand a program. (Note that marginal, and not average, costs and benefits must be used for decisions involving program expansion and contraction. See subsequent discussion on marginal and average costs.) However, if a cost-benefit analysis shows that the costs of a program are greater than the benefits, then there is no necessary reason to contract the program. Rather such results indicate that new program strategies must be developed and implemented.

I.2. Approaches to Cost-Benefit Analysis

The heart of cost-benefit analysis is the enumeration of costs and benefits and the comparison of costs and benefits. The enumeration of costs and benefits depends mainly on what approach is taken toward cost-benefit analysis. These approaches are discussed immediately below. The comparison of costs and benefits can be accomplished several different ways, depending on the viewpoint taken and on the purposes for doing the analysis. These comparisons will be discussed below in the context of numerical results of a cost-benefit analysis.

There are two similar, but not exactly equal, dichotomies of types of approaches within cost-benefit analysis. One dichotomy is between real resource and financial approaches. The other dichotomy is between social and taxpayer approaches. The real resource approach is similar to the social approach, and the financial approach is similar to the taxpayer approach.

The real resource approach to cost-benefit analysis considers only costs and benefits that involve the use of real resources. For example, a cost such as the purchase of physical restoration services involves the use of real resources; that is, medical skills and supplies are consumed. Trainee remuneration in a manpower training program that trains unemployed individuals does not involve real resource costs, since the individuals were not previously employed. No previously engaged resources are taken from their use by the expenditure of the trainee allowances. The expenditure of the trainee allowance does not cause any opportunities for other actions or activities to be foregone. The financial approach includes all costs and benefits, regardless of whether they are real resource costs and benefits or not. For example, for an operating agency any expenditure made is considered as a cost.

The social cost-benefit approach takes the viewpoint of society at large; whereas, the taxpayer approach takes the viewpoint of taxpayers. That a rehabilitant earns more money as a result of the rehabilitation process does not benefit the taxpayer directly. Of course, society as a whole benefits by the amount of the rehabilitant's earnings; the total earnings of the society increase. (Often the social approach is likened to a "GNP" [Gross National Product] approach, because it counts costs and benefits in a way that the accounting methods of national income accounts

do.) On the other hand, the taxpayer does benefit somewhat by the rehabilitant's earnings. If the rehabilitant were on public assistance prior to rehabilitation, then the taxpayer would benefit from the rehabilitation program due to reduced public assistance payments. The taxpayer would also benefit by the increased taxes the rehabilitant would pay on his increased earnings. In the social approach, however, taxes are not a social benefit, since they involve only a transfer of money and not a net gain in production to the society.

To get an idea of the interplay of these two dichotomies and of the importance of the perspective involved, consider three levels of concern: society, central budget bureau, and operating agency. At the societal level only real resource costs and benefits are of concern. However, for the central budget bureau and the operating agency, any savings in expenditures that a program causes must be counted as a benefit, since those saved monies can be used for additional programs. For example, if manpower training programs lead to reduced public assistance payments, then these payments should be included as a benefit, from the perspective of the central budget bureau. From the society's viewpoint these reduced payments are not a benefit, since no additional production is generated. In addition, the operating agency concerned with the manpower training program does not benefit from reduced public assistance payments; the operating agency does not get any additional monies to spend. Thus, whether the benefits are counted as such depends on the perspective for the cost-benefit analysis. It should be noted that the legislature is often calling for a social perspective.

I.3. Numerical Results

The numerical results from a cost-benefit analysis come in many different forms. However, there are three important and generally used types of results:

1. the cost-benefit ratio
2. the discounted net present value
3. the payback period.

The cost-benefit ratio is simply the ratio of benefits to costs, that is B/C ($B \div C$), where the costs and benefits are discounted (see section on social discount rate). If the ratio is greater than one, then the project should be undertaken, provided that it can be afforded. The discounted net present value is the difference between the discounted benefits and the discounted costs, that is, $B - C$. Often the term "discounted net present value" is shortened to "discounted present value" or even "present value." If the present value of a project is greater than zero, then the project should be undertaken, provided that it can be afforded. When comparing two or more projects, projects with the higher ratio or present value are the preferred projects. The time that it takes for a project to pay back its costs is the payback period. The calculation can be viewed as follows: $C = \sum_{i=1}^P B_i$, where B_i is the amount of benefits in the i th time period, and P is the payback period. For example, if the cost of a project were \$100 and the benefits were \$70 in the first year and \$10 a year thereafter, then the payback period would be 4 years, since,

$$\$100 = \$70 + \$10 + \$10 + \$10$$

that is,

$$\$100 = \sum_{i=1}^4 B_i$$

When comparing two or more projects, projects with the shorter payback periods are preferred.

The choice of a numerical result depends on the properties desired in a result. The ratio approach has a straightforward and intuitive meaning, the rate of return per dollar invested. For example, a cost-benefit ratio of 20 (20/1) suggests that twenty dollars is the return for each dollar invested. However, the discounted present value approach has the advantage of indifference to the definition of costs as costs or as negative benefits, or the definition of benefits as negative costs or as benefits. This is not true for the ratio calculation. For example, the change in custodial costs as a result of the rehabilitation program can be counted as a benefit or as a negative cost. The advantage of the payback calculation is that it gives a time perspective, by stating the amount of time required to return an investment.

Although there is no necessary correspondence between the cost-benefit approach and the numerical result, quite often the social approach is linked with the calculation of a cost-benefit ratio or of the present value. On the other hand, a payback calculation is often performed within a taxpayer model. In fact, any of the three calculations could be made for any group, not just society at large or taxpayers.

I.4. Costs

The enumeration of costs depends on the program. Generally there are two types of costs: fixed costs and variable costs. Fixed costs are costs that occur regardless of the level of output. For example, certain administrative tasks must take place no matter how many rehabilitants are offered services. The same is true of building-rental costs. Variable costs are costs that can be varied. For example, the amount of vocational training available to those undergoing rehabilitation can be

varied. In a sense, all costs, including fixed costs, are variable costs in the long run.

Also, the enumeration of costs depends on the viewpoint chosen for the cost-benefit analysis. Maintenance payments paid to clients during rehabilitation are not a real resource or social cost but are indeed a financial or taxpayer cost.

Another important concept in discussing program costs -- or costs of any kind -- is the distinction between average and marginal costs. Average costs are costs over the entire range of output. Marginal costs are costs for adding the last increment or margin of output. For example, suppose that a decision is to be made concerning whether to try to help a particular group of clients. Furthermore, suppose that these clients will be very difficult (costly) to rehabilitate. If the average costs are considered, then the costs of the new group will be averaged in with the costs of all other rehabilitants. Average costs would probably not show a sharp increase. However, the costs of concern are not average costs but rather marginal costs. The costs that must be considered are the costs for adding this group. This marginal cost will be much higher than the average cost. The marginal versus average cost distinction is important when considering program expansion or contraction.

I.5. Benefits

The enumeration of benefits depends on the program. In the case of manpower training programs, a major benefit is the increase in earnings of the trainees, where this increase is due to the program. However, not all benefits are monetary benefits; that is, not all benefits can be readily quantified in dollar terms. For example, if a trainee were able to get a job as a result of the manpower training program, the trainee

might gain in self-esteem or might participate in the larger society -- for example, by voting -- to a greater degree. In the case of the rehabilitation program some very important additional non-monetary benefits include the reduction of attitudes linked to dependency and the change in the quality of life of the rehabilitant's family.

The enumeration of benefits also depends on the framework used for the cost-benefit analysis. One benefit of a manpower training program might be a reduction in unemployment compensation. As noted previously, unemployment compensation is a transfer payment and thus does not involve a change in resources. As such, in a social model a reduction in unemployment compensation is not a benefit. However, in a taxpayer model, a reduction in unemployment compensation is certainly a benefit, since costs to the taxpayer are reduced.

One major problem in identifying and measuring the benefits of a program is the problem of cause and effect. What does the program really change? For example, take the increase in earnings a rehabilitant experiences from acceptance to closure. Does the program bring about all of this change? Changes in general social and economic conditions could have occurred, such as a decrease in the unemployment rate or inflation. Would the rehabilitant unemployed at acceptance have found a job without the program? Perhaps he would have. On the other hand, would the rehabilitant with earnings at acceptance have lost even those earnings if he had not entered into rehabilitation? The problem is that time passes during the training process, often more than one year, and something may have happened to the client had he not come to the rehabilitation agency.

There are some ways to handle the cause and effect problem. The use of a control group may enable the determination of cause and effect.

Rehabilitants can be compared with a group similar in every way to the rehabilitants, except that the control group does not receive services akin to those provided by the rehabilitation program. However, control groups most often are generated through the denial of services, and it is ethically very difficult to justify the denial of services to those who need them. On the other hand, it may be possible to find a control group that is not generated through the denial of services. Some agencies have used 28 and 30 closures as control groups for evaluating program impact on rehabilitants. Such an approach often ignores that there may be significant differences between these groups in terms of disability and demographic characteristics, that the control group may receive services from other agency sources, and that some of the gains of the control group may be attributable to rehabilitation services received. Clearly, control groups are still a very difficult conceptual problem to handle. Another approach is to look at differences between programs already in operation. By comparing the results of programs to accomplish similar goals, program impact may be ascertainable. Quite often, however, in the absence of control groups or different programs, a before and after approach must be adopted. The differences between conditions after the program and prior to the program are assumed to be the result of the program.

I.6. Social Discount Rate

The concept of a social discount rate is very important in cost-benefit analysis. Using discounting reflects two simple facts, each of which is the flip side of the other. A dollar in your possession today is worth more to you now than a dollar in your hands tomorrow. As a result, you will pay additional money -- interest -- to get a certain

amount of money now, and pay back the principal and the interest at a later time. On the other hand, you can put your money in the bank now and get more back for it at a later time; that is, you get interest on your deposited money.

The social discount rate is similar to the interest rate but applies to the society as a whole. The discount rate handles the time dimension of the program analysis. The future costs and benefits of a program are brought to the present -- expressed in their present value -- because that is where the decision is to be made. In addition, the social discount rate can be viewed as having three basic components: time preference, opportunity cost, and uncertainty. The time preference component refers to the inclination of people to postpone present consumption for future consumption and vice versa. For example, some people are willing to put off buying a car and a home in order to continue their education, in the hope that their education will pay off in higher earnings in the future. The opportunity cost component refers to a concept frequently used in economics, that of opportunity cost. The opportunity cost of an action is the next best action that could have been undertaken, but was foregone. Opportunity costs are involved in the social discount rate since opportunities change with time. Also, by undertaking a project in the public sector, a project in the private sector may be foregone. Opportunity costs, then, are revealed in a comparison of public and private investment. The third component, uncertainty, takes into account the uncertainty of costs and benefits in the future. The uncertainty factor is especially crucial when costs and benefits are projected twenty or more years into the future, as is often done in cost-benefit analyses of programs.

The choice of a discount rate is important, since when one rate is used a project may seem to be justified, but when a higher discount rate is used it may not be justified. The social discount rate can be chosen on the basis of the particular program involved, on the basis of guidelines from some central budget bureau for a governmental unit, or on the basis of an examination of the three components of the discount rate. In any event the choice of a proper discount rate is not an easy matter.

CHAPTER II

A MODEL FOR COST-BENEFIT ANALYSIS OF
VOCATIONAL REHABILITATION PROGRAMS

Several models have been developed to do a cost-benefit analysis of vocational rehabilitation programs. A social model is presented herein. A taxpayer payback model has also been developed but is reported elsewhere. The model presented is within the context of a one-year period. Most costs occur in this year, and all closures in this year define the group of rehabilitants. (However, benefits do continue into the future.) Only those closed into status 26 are considered to benefit from the program, since it is assumed that only status 26 closures represent program successes.² The model and the parameters used in the model are essentially conservative. Costs are probably overestimated, and benefits are probably underestimated. Thus, the numerical results are minimum not maximum values. Even so, the numerical results indicate very substantial returns to vocational rehabilitation programs.

II.1. Costs

The major costs of the vocational rehabilitation program are of course the program costs. However, several adjustments have to be made to the program costs. First, some components of program costs must be deleted. Second, some additional costs must be included.

²Some state agencies treat increased earnings of 28 closures as additional benefits, while others use 28 closures as a control group to reduce the amount of earnings of 26 closures that are assigned causally to the rehabilitation program.

Program costs are the basic costs. For the federal level these costs are expenditures under sections 2 and 3 of the Vocational Rehabilitation Act and from Social Security Trust funds for the rehabilitation of Disability Beneficiaries. Program costs include both case service costs and overhead costs.

Costs that must be subtracted from program costs include carry-over costs and maintenance costs. The analysis is for a one-year period, but some rehabilitants closed in that year incurred expenditures the previous year, and some rehabilitants incurring expenditures in the year were not closed in that year. In a program in which the same number of rehabilitants are closed each year, the two departures from the one-year accounting scheme cancel each other out. However, in an expanding program, more rehabilitants incur costs in the year without being closed in that year than are closed in the year with costs incurred in previous years. Thus, the carryover cost adjustment is made for increases in expenditures in the year under analysis not the result of that year's closures. Maintenance costs are transfer payments, and thus are not real resource or social costs. The portion of program costs that are associated with maintenance payments must be excluded from consideration.

Additional costs that must be estimated include:

1. repeater costs
2. program costs not borne by the agency
3. research, demonstrations, and training costs
4. foregone output.

Repeater costs are future costs. Some rehabilitants closed in 26 status do come back for additional services. Although these costs may not be incurred in the year under analysis, these are costs attributable to the

closures in that year. Of course, future repeater costs only can be estimated on the basis of past repeater costs, if the analysis is being made on the current year's program. Some services are provided under the rehabilitation plan for which the rehabilitation agency does not pay. However, these costs borne by parties other than the rehabilitation agency are part of the overall social cost of rehabilitation. The addition of research, demonstrations, and training costs reflects the fact that closures in a given year benefit from previous research, demonstrations, and training. For example, the counselor receives training which benefits the rehabilitant. For part of the rehabilitation process, the rehabilitants are without earnings. If the rehabilitant had earnings at acceptance, then the rehabilitant must have foregone these earnings to enter the rehabilitation program. Moreover, these earnings are a loss to the economy and must be counted as a cost of rehabilitation.

One very real problem with costs occurs under disaggregation. Quite often, a cost-benefit analysis is performed for the part of the program dealing with a specific subgroup of the total population of clients. Case service costs for the subgroup are readily available from R-300 sources. The problem comes in allocating the overhead costs to the subgroup. The case service costs are variable costs, but there are also fixed costs involved in the rehabilitation of members of the subgroup, costs such as counselor salaries and administrative support. Deciding how much of the overhead costs to distribute to the different subgroups is a difficult problem, for which several not fully satisfactory approaches are available and are being studied. Furthermore, since case service costs are less than half the total costs incurred in rehabilitating clients, the allocation of fixed costs assumes great importance in determining the cost-benefit results for client subpopulations.

II.2. Benefits

The benefits of the vocational rehabilitation program include:

1. increase in earnings
2. increase in homemaking services and care of children
3. other nonpaid work, for example farming
4. unpaid work beyond normal occupation, that is, work after hours
5. savings in medical and custodial costs incurred by the client
6. savings in medical, custodial, and institutional costs incurred by the state
7. changes in the output of other family members; for example, if a rehabilitant gets a job, another family member may leave the labor force
8. psychic benefits, such as
 - a. improvements in functional capability for non-earnings-related activities, for example recreation
 - b. improvements in the family situation
 - c. insurance for the effects of disability for society in general

Additional taxpayer benefits include:

1. increased taxes on the increased earnings
2. savings in transfer payments, such as Social Security, public assistance, and Workman's Compensation

The benefits used in this model are the increase in earnings and the increase in nonpaid output, including homemaking and other nonpaid work. The other benefits are not included, either because additional work is being done to enable their estimation or because the benefits are difficult to quantify in dollar terms. Also, taxpayer benefits are left out since the model is a social one. By including only part of the benefits of rehabilitation, the total benefits are underestimated.

The paid earnings are a major benefit in a social model. On the other hand, nonpaid earnings are also an important component of the benefits of the rehabilitation program. However, the rehabilitation program shows significant returns even when paid earnings are the only benefit.

The increase in earnings computation is based on a before and after approach. Average weekly earnings of rehabilitants at closure are higher than average weekly earnings at acceptance. This difference is the increase in earnings attributable to the program. Nevertheless, the higher earnings of the rehabilitant at closure do not continue through time unchanged, nor do these increased earnings continue indefinitely. To get the total stream of earnings for all rehabilitants, the following modifications must be made to the increased earnings at closure:

1. retirement
2. mortality
3. labor participation
4. increases in earnings
5. time spent in rehabilitation, without earnings
6. discounting.

The earnings stream of a rehabilitant stops at retirement. For the purpose of this study, 65 was assumed to be the age of retirement.

The modification for mortality recognizes that the earnings stream of a rehabilitant might be cut short due to death. To calculate the number of surviving rehabilitants at any time, the cohort-survival method of population studies is used. To perform such a calculation the ages of the rehabilitants at acceptance and the probability of surviving

from one time period to the next for each age group must be known.

(The probability of surviving is one minus the mortality rate.)

The concept of labor participation is used to denote the number of rehabilitants who have earnings at a particular time. Some clients closed in status 26 do not have earnings at closure. Of those that do have earnings at closure, some quickly, within a year or two after closure, lose their jobs. These job losses can be considered to be an indicator of the failure of the program, failure in the sense that services were not sufficient in removing vocational handicaps so that the rehabilitant could continue to be employed, even though he had been employed for at least thirty days after closure. Over a longer period of time, some additional rehabilitants will drop out of the labor market, for example due to the worsening of disability or changes in family situation.

The wages of rehabilitants may rise due to one of two factors: learning or secular rises in wages. The younger rehabilitant or the rehabilitant entering a new profession may show sharp increases in wages due to his mastering his new job. In addition, wages in general increase in the economy; some suggest that data for the United States shows that the annual increase in productivity has been around 2.5%.

An additional adjustment to the earnings stream recognizes that the time spent in rehabilitation is also time spent without earnings. The amount of earnings that would have been made in the period during rehabilitation without earnings (during the last few months of rehabilitation the clients often have earnings) must be subtracted from the earnings stream.

Furthermore, the earnings stream must be discounted, for reasons previously discussed.

To illustrate these several modifications, a hypothetical group of rehabilitants will be taken through time, and some of the modifications will be made to their earnings stream, using hypothetical data. Suppose that 1000 clients between the ages of 20 and 24 are closed into 26 status in a specific year. Furthermore, suppose that the average annual earnings of those with earnings at closure are \$2500. However, only 95% of the rehabilitants have paid earnings at closure. From past follow-up data it is thought that earnings will go up by 25% by the fourth year after closure. After that, earnings will increase at a rate similar to that of the general increase in wages in the economy, 2.5%. Also, follow-up data suggests that it is likely that 20% of those with earnings at closure will leave the labor force by the fourth year after closure. From the fifth year on it is estimated that .5% of the rehabilitants will leave the labor force each year. A discount rate of 7% is used.

The results of the modifications are displayed in Table 1. Note that no adjustment has been made for time spent in rehabilitation. Also, total earnings for the 5-year period are not shown due to some further modifications that have to be made for the distribution of mortality over the 5-year period. Without such a modification total 5-year earnings could easily be calculated, by multiplying total annual earnings by 5. What is shown is the total annual earnings of all rehabilitants. Furthermore, only nine 5-year periods are shown, since after 45 years all of the rehabilitants are over 65. The formulas used to make these calculations are given in Appendix I.

Several things are apparent from looking at the figures. Even though average annual earnings increase a great deal over the 45 year period, this increase is more than offset by the effects of mortality

TABLE I. MODIFICATION OF EARNINGS THROUGH TIME USING HYPOTHETICAL DATA

5-year time period	age	mortality rate	(1) number surviving below age 65	(2) labor participation rate ¹	(3)=(1)x(2) number with earnings	(4) average annual earnings ²	(5)=(3)x(4) total annual earnings	(6) discount factor ³	(7)=(5)x(6) discounted total earnings
initial			1000	.950	950	\$2500.00	\$2,375,000.		
1	20-24	.100	1000	.855	855	2812.50	2,404,687.	.877	\$2,108,911.
2	25-29	.100	900	.734	660	3716.88	2,453,138.	.626	1,535,664.
3	30-34	.100	810	.716	580	4205.31	2,439,081.	.446	1,087,830.
4	35-39	.100	729	.698	509	4757.81	2,421,727.	.318	770,109.
5	40-44	.100	656	.681	447	5383.13	2,406,257.	.227	546,220.
6	45-49	.125	590	.664	392	6090.31	2,387,403.	.162	386,759.
7	50-54	.150	516	.648	334	6890.94	2,301,573.	.115	264,681.
8	55-59	.175	439	.632	277	7796.25	2,159,561.	.082	177,084.
9	60-64	.200	362	.616	223	8820.94	1,967,069.	.053	116,057.

¹Based on .5% annual decrease in proportion of rehabilitants still in labor force after 4 years and 20% decrease in first 4 years.

²Based on 2.5% annual increase in earnings of rehabilitants starting 4 years after closure and 25% increase in first 4 years.

³Based on discount rate of 7%.

and by the decline in labor participation. In addition, once the discounting adjustment is made, earnings in the later years are much smaller than in the earlier years. To get the total increased earnings stream the discounted earnings for the nine periods must be added. Instead, since only one-year earnings are portrayed, this addition is not done. Anyhow, this earnings stream is not the benefit stream. The earnings that the rehabilitants would have had (had they not entered into rehabilitation), the before-rehabilitation earnings, must be subtracted from the after-rehabilitation earnings -- part of whose calculation is shown -- to get the total benefits assigned to the rehabilitation program.

The current approach taken to estimate the benefits of nonpaid work (including homemaking) relies on an analysis of the relationship between the productivity of paid output and the productivity of nonpaid output. The results of this analysis are then applied to the calculation of paid output to get the amount of nonpaid output benefits. While this approach is useful, further work is being done, as discussed in a subsequent section, to estimate the benefits of nonpaid output in some other, better ways.

II.3. Numerical Results

To give an idea of the results obtained from a cost-benefit analysis using actual program data with a model very similar to the one discussed in this paper, the following numerical result is presented. Using fiscal year 1969 data for the federal level, and a social discount rate of 8%, an analysis of the vocational rehabilitation program produced a cost-benefit ratio of 8.3.

CHAPTER III

DATA

Most of the data needed to calculate a cost-benefit ratio or net present value figure is available from an analysis of the R-300 forms. Additional information is available from follow-up studies of rehabilitants -- studies to find out the subsequent earnings and labor participation experience of rehabilitants after closure -- and from other studies.

The data specifications for the present cost-benefit model are contained in Appendix II. Note that the minimum necessary data requirements refer only to data normally available from analyses of R-300 forms, except for program costs. Program cost information should be available from budget sources. Other types of refinements of the model can be accomplished through the provision of additional data, as shown in the Appendix.

Some of the parameters in the model, however, depend on information from other studies. For example, some of the additional cost components are expressed as proportions of the total program cost. These proportions are presently gleaned from federal analyses, although information from any source could be used. Another example is mortality; the Railroad Retirement Board and private insurance and actuary companies are the sources of mortality data.

CHAPTER IV

NEW DIRECTIONS

The model presented herein is not a final product. Much more work is being done on the cost-benefit analysis of vocational rehabilitation programs. Within the context of a social cost-benefit model, new directions of analysis are being explored in the following areas:

1. valuation of homemaker and other nonpaid output
2. control group use in the estimation of benefits attributable to the program
3. costs for disaggregated groups
4. earnings profiles
5. labor participation profiles
6. repeater, costs
7. changes in labor force participation and homemaking activities of other family members
8. avoidance of loss of earnings
9. custodial, medical, and institutional costs
10. displacement of other job-holders due to rehabilitants entering the labor market.

A revised cost-benefit model incorporating the above research will be available for state agency use.

Also, models for estimating the payback period to the public sector from rehabilitation program investments are being developed for use by state and federal agencies.

APPENDIX I. MATHEMATICAL FORMULATION

In this appendix the formulas for the calculation of costs and benefits of the vocational rehabilitation program are given. To aid the understanding of the formulas, both notes on the individual formulas and a glossary (in alphabetical order) of the terms used are included.

I.1. FormulasCosts

$$DC = R - DRC - DRM + DRR + DRP + RRT + OF \quad (1)$$

$$= R - CDRC \cdot R - CDRM \cdot R + CDRR \cdot R + CDRP \cdot R + CRRT \cdot R + OF \quad (2)$$

where,

$$OF = TIMREH \cdot [W1A1 + NPP \cdot W2A1] \cdot ERA \cdot \sum_{j=1}^{10} POP1_j \quad (3)$$

Benefits

$$DB = DOR \quad (4)$$

$$= DER + DNPOR \quad (5)$$

DER

where,

$$DER = \sum_{\ell=1}^{10} DERV_{\ell} \quad (6)$$

where,

$$DERV_{\ell} = EARN_{\ell} \cdot DIS_{\ell} \cdot YRSLIF_{\ell} \quad \ell = 1, \dots, 10 \quad (7)$$

where,

$$EARN_1 = [W1C_1 \cdot ERC \cdot (PRODC_1 - TIMREH/5)] - [W1A_1 \cdot ERA \cdot (PRODA_1 - TIMREH/5)] \quad (8)$$

$$EARN_{\ell} = [WIC_{\ell} \cdot ERC \cdot PRODC_{\ell} - WIA_{\ell} \cdot ERA \cdot PRODA_{\ell}] \quad \ell=2, \dots, 10 \quad (9)$$

where,

$$WIC_1 = \frac{(N+1) \cdot WIC1 + (10-N-1) \cdot WICN}{10} \quad (10)$$

$$WIC_{\ell} = \frac{WICN}{5} \cdot \sum_{k=5\ell-4}^{5\ell} \frac{1}{(1+\pi)^{k-1}} \quad \ell=2, \dots, 10 \quad (11)$$

$$WIA_{\ell} = \frac{WIA1}{5} \cdot \sum_{k=5\ell-4}^{5\ell} \frac{1}{(1+\rho)^{k-1}} \quad \ell=1, \dots, 10 \quad (12)$$

where,

$$PRODC_1 = \frac{(M+1) + (10-M-1) \cdot PRODCM}{10} \quad (13)$$

$$PRODC_{\ell} = \frac{PRODCM}{5} \cdot \sum_{k=5\ell-4}^{5\ell} (1+\alpha)^{k-1} \quad \ell=2, \dots, 10 \quad (14)$$

$$PRODA_{\ell} = \frac{1}{5} \cdot \sum_{k=5\ell-4}^{5\ell} (1+\beta)^{k-1} \quad \ell=1, \dots, 10 \quad (15)$$

where,

$$DIS_{\ell} = \frac{1}{5} \cdot \sum_{k=5\ell-4}^{5\ell} \frac{1}{(1+I)^{k-1}} \quad \ell=1, \dots, 10 \quad (16)$$

where,

$$YRSLIF_{\ell} = \sum_{j=\ell}^{10} POP_{\ell,j} \cdot [5 - (2.5 \cdot MORT_j)] \quad \ell=1, \dots, 9 \quad (17)$$

$$YRSLIF_{10} = POP_{10,10} \cdot [2.5 - (1.25 \cdot MORT_{10})] \quad (18)$$

where,

$$POP_{i,j} = POP1_j \quad j=1, \dots, 10 \quad (19)$$

$$POP_{\ell,j} = POP_{\ell-1,j-1} \cdot (1 - MORT_{j-1}) \quad \begin{array}{l} \ell=2, \dots, 10 \\ j=\ell, \dots, 10 \end{array} \quad (20)$$

DNPOR

where,

$$\text{DNPOR} = \sum_{\ell=1}^{10} \text{DNPORV}_{\ell} \quad (21)$$

where,

$$\text{DNPORV}_{\ell} = \text{NEARN}_{\ell} \cdot \text{DIS}_{\ell} \cdot \text{YRSLIF}_{\ell} \quad \ell=1, \dots, 10 \quad (22)$$

where,

$$\begin{aligned} \text{NEARN}_1 = \text{NPP} \cdot ([\text{W2C}_1 \cdot \text{ERC} \cdot (\text{PRODC}_1 - \text{TIMREH}/5)] - \\ [\text{W2A}_1 \cdot \text{ERA} \cdot (\text{PRODA}_1 - \text{TIMREH}/5)]) \end{aligned} \quad (23)$$

$$\text{NEARN}_{\ell} = \text{NPP} \cdot [\text{W2C}_{\ell} \cdot \text{ERC} \cdot \text{PRODC}_{\ell} - \text{W2A}_{\ell} \cdot \text{ERA} \cdot \text{PRODA}_{\ell}] \quad \ell=2, \dots, 10 \quad (24)$$

where,

$$\text{W2C}_{\ell} = \frac{\text{W2C1}}{5} \sum_{k=5\ell-4}^{5\ell} \frac{1}{(1+\sigma)^{k-1}} \quad \ell=1, \dots, 10 \quad (25)$$

$$\text{W2A}_{\ell} = \frac{\text{W2A1}}{5} \sum_{k=5\ell-4}^{5\ell} \frac{1}{(1+\phi)^{k-1}} \quad \ell=1, \dots, 10 \quad (26)$$

I.2. Notes on Formulas

- (2) all costs except R are expressed as a proportion of R
- (4) model considers as benefits only changed output of rehabilitants
- (8),(23) divide TIMREH by 5 since want average for 5 years
- (10) $N = 1,2,3,4$; if data is for 5 years after closure, still $N = 4$;
 this equation simply allows a linear interpolation between $W1C1$
 and $W1CN$ to get an average; the decrease in labor participation in-
 volved in $W1C_1$ includes both failure of the program and normal
 attrition of labor force (besides death and retirement)
- (11) the decrease in labor participation involved in $W1C_\ell$ includes only
 normal attrition of the labor force
- (13) $M = 1,2,3,4$; if data is for 5 years after closure, still $M = 4$; this
 equation simply allows a linear interpolation between 1 and PRODCM
 to get an average; the change in earnings reflected in $PRODC_1$ includes
 both the effects of learning and normal productivity increases
- (14) the change in earnings reflected in $PRODC_\ell$ includes only normal
 productivity increases
- (17),(18) rehabilitants live 5 years in the time period, except in the
 last age period, 60-64, where rehabilitants spend an average of 2.5
 years before reaching 65, where earnings stop; however, rehabili-
 tants dying in a period spend on the average only 2.5 years in the
 period, except for the last period, where they spend only 1.25 years
- (17),(20) the j index goes only from ℓ to 10 since, for example, in
 the ninth 5-year period there are only those in ninth and tenth
 age categories
- (21) a method similar to the one for DNPOR can be used to estimate the
 value of homemaker services separately

I.3. Glossary for Formulas

A	at acceptance; not a variable but used in variable names
C	at closure; not a variable but used in variable names
CDRC	ratio of DRC to R
CDRM	ratio of DRM to R
CDRP	ratio of DRP to R
CDRR	ratio of DRR to R
CRRT	ratio of RRT to R
D	change in a quantity due to the program; not a variable but used in variable names
DB	total benefits ascribable to the program
DC	incremental social costs of the program
DER	total discounted present value of the increase in earnings ascribable to the program
DERV _ℓ	discounted present value of the increase in earnings ascribable to the program, in the ℓth period
DIS _ℓ	discounting factor in ℓth period
DNPOR	total discounted present value of the increase in nonpaid output ascribable to the program
DNPORV _ℓ	discounted present value of the increase in nonpaid output ascribable to the program, in the ℓth period
DOR	increment of output due to rehabilitants, ascribable to the program
DRC	carry over costs
DRM	maintenance costs
DRP	costs borne by parties other than the rehabilitation agency
DRR	repeater costs
EARN _ℓ	average increase in earnings, ascribable to the program, in the ℓth period
ERA, ERC	average annual earnings at acceptance (at closure) of 26 closures with earnings at acceptance (at closure)

I	social discount rate
j	subscript for 5-year age group, for example, j = 1 means 15-19, j = 10 means 60-64
k	subscript for calculating the average of a quantity in a 5-year period
ℓ	subscript for 5-year periods into the future (years after acceptance by 5-year time periods), for example, $\ell = 1$ means years 1-5; $\ell = 10$ means years 46-50
M	number of years after closure follow-up earnings data was collected
MORT _j	mortality of jth age group
N	number of years after closure follow-up labor participation data was collected
NEARN _{ℓ}	average increase in nonpaid output, ascribable to the program, in the ℓ th period
NPP	ratio of productivity of nonpaid output to paid output
OF	output foregone during the rehabilitation process
POP _{ℓ, j}	age structure of 26 closures in the ℓ th period, in the jth age group
POP1 _j	age structure of 26 closures at acceptance, in the jth age group
PRODA _{ℓ} , PRODC _{ℓ}	productivity factor to adjust for increase or decrease in average earnings at acceptance (at closure), in the ℓ th period
PRODCM	productivity factor to adjust for increase or decrease in average earnings at closure, M years after closure
R	program costs
RRT	research, training, and demonstrations costs
TIMREH	time spent in rehabilitation process without earnings, expressed as a proportion of a year
W1A _{ℓ}	proportion of 26 closures who would have had earnings in the ℓ th period, without the program
W1C _{ℓ}	proportion of 26 closures with earnings in the ℓ th period
W1A1, W1C1	proportion of 26 closures with earnings at acceptance (at closure)

W1CN	proportion of 26 closures with earnings N years after closure
W2A _ℓ	proportion of 26 closures who would have had nonpaid output in the ℓth period, without the program
W2C _ℓ	proportion of 26 closures with nonpaid output in the ℓth period
W2A1, W2C1	proportion of 26 closures with nonpaid output at acceptance (at closure)
YRSLIF _ℓ	man-years of life of surviving 26 closures below age 65 in ℓth period
α	annual rate of change in the yearly earnings of 26 closures
β	annual rate of change in the yearly earnings of 26 closures, without the program
π	annual rate of change in the labor participation of 26 closures
ρ	annual rate of change in the labor participation of 26 closures, without the program
σ	annual rate of change in the proportion of 26 closures with nonpaid output
φ	annual rate of change in the proportion of 26 closures with nonpaid output, without the program

APPENDIX II. DATA SPECIFICATIONS

I. Minimum Necessary Data

1. Age at acceptance, of 26 closures

<u>Age group</u>	<u>Number</u>
15-19	_____
20-24	_____
25-29	_____
30-34	_____
35-39	_____
40-44	_____
45-49	_____
50-54	_____
55-59	_____
60-64	_____

2. Number of 26 closures with paid earnings at acceptance

3. Number of 26 closures with paid earnings at closure

4. Average weekly earnings at acceptance, of 26 closures with earnings at acceptance

5. Average weekly earnings at closure, of 26 closures with earnings at closure

6. Program costs, i.e., expenditures under sections 2 and 3 of the Vocational Rehabilitation Act, and from Social Security Trust funds for the rehabilitation of Disability Beneficiaries.

II. Optional Data

A. Data for valuing nonpaid output, if desire any valuation of nonpaid output (supply data only for categories for which desire valuation):

1. Number of 26 closures who were classified as homemakers at acceptance; at closure

2. Number of 26 closures who were classified as sheltered workshop workers at acceptance; at closure
 3. Number of 26 closures who were classified as nonpaid workers (other than homemakers or sheltered workshop workers) at acceptance; at closure
- B. Data for Further Sharpening of the Calculations:
1. Followup data on the number of 26 closures with earnings some period after closure, i.e., number with earnings, and the period of time after closure the data was collected
 2. Followup data on the earnings of 26 closures some period after closure, i.e., average weekly earnings, and the period of time after closure the data was collected
 3. Number of program repeaters, i.e., current 26 closures who have received rehabilitation services and have been closed in the 26 status previously
 4. Average weekly earnings of female 26 closures with earnings at closure (supply only if the valuation of homemaker services is desired; however, this piece of data is optional in the valuation of homemaker services, and homemaker services can be valued without it)
 5. Percentage of program costs that are used to provide maintenance support to clients
- C. Data for Calculation for Disaggregated Groups:
1. Average case service costs for the program subpopulation of interest
 2. Total overhead costs for the program
 3. Average case service costs per rehabilitant in the overall program

APPENDIX III. FURTHER READING

Cost-Benefit Analysis in General

Hinrichs, H.H. "Government Decision Making and the Theory of Benefit-Cost Analysis: A Primer," Program Budgeting and Benefit-Cost Analysis, H.H. Hinrichs and G.H. Taylor, editors. Pacific Palisades, California: Goodyear Publishing Co., 1969, pp. 9-20.

Prest, R. and R. Turvey. "Cost-Benefit Analysis: A Survey," Economic Journal, (December 1965), pp. 683-735.

Schultze, C.L. "Why Benefit-Cost Analysis?" Program Budgeting and Benefit-Cost Analysis, H.H. Hinrichs and G.H. Taylor, editors. Pacific Palisades, California: Goodyear Publishing Co., 1969, pp. 1-8.

Cost-Benefit Analysis as Applied to Vocational Rehabilitation Programs

Conley, R.W. "A Benefit-Cost Analysis of the Vocational Rehabilitation Program," Journal of Human Resources, IV (Spring, 1969), pp. 226-252.

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