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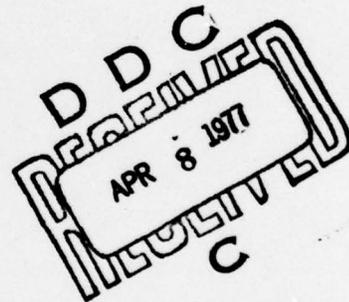
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MEASURING THE MONETARY VALUE
OF LIFESAVING PROGRAMS

by

Jan Paul Acton



Prepared for
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Conference on
The Value of Human Life

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I. INTRODUCTION

A multitude of public investment and regulatory decisions which have some effect on mortality and morbidity rates are made by legislatures, administrative agencies, and the courts every year. Typically, as in the case of highway safety engineering, the choice which confronts the public decision maker is between reduced mortality rates and hence longer life expectancy for some group and more resources available for other purposes (e.g., additional miles of highway construction or a reduction in taxes). A decision to require something other than the minimum technologically feasible mortality rate reflects in effect a judgment that mortality (or safety) is not to be given lexical priority in public decisions over all other commodities which money can buy - a judgment which is certainly reasonable and in accord with everyday decisions made by households. If mortality is not to be given lexical priority, some other standard or procedure is needed to determine which projects are worthwhile. In particular, a procedure is needed for measuring the benefits of such programs in units which can be readily compared with the costs.¹

In some constrained decision situations, the costs can be expressed in units of an identified commodity: For example, a school board may be faced with the decision of how much of its budget to spend on school bus safety, knowing that every additional dollar spent on bus monitors and drivers' salaries will reduce the quality of education by a certain amount. The choice between safety and the quality of education is easily understood and could be assessed directly according to the preferences of

the public as represented by the school board. More generally, money allocated to safety will be taken from a fungible source which has many alternative uses. In such cases, there is no good alternative to measuring the cost of safety in dollar terms, so that the evaluation of such a program will require the decision maker to place a dollar value on safety, at least in an implicit sense. (Even in the school bus safety example, it is not appropriate to phrase the safety valuation question in terms of educational quality units if changing school taxes is a viable option.)

How are we to go about placing a dollar value on the health and safety effects of a public program? The method which is in accord with the theoretical postulates of welfare economics is to measure benefit as the sum of all affected individuals' willingness to pay for the proposed program.² We can imagine each household being informed of the potential effect of the proposed program on its members' own safety and the safety of all those they care about, and then sending a ballot to the appropriate agency which indicates the maximum amount they would be willing to pay to have the program enacted. Their response will reflect the risk aversion, their anxiety of dying from the particular cause which is to be modified by the program, their financial circumstances, and the objective reduction in risk to them and their friends. If the aggregate willingness to pay exceeds the costs of the program, then the program is worthwhile in the sense that everyone could be made better off by its adoption: It is possible (though probably not administratively practicable) to charge each beneficiary less than it is worth to him and still cover the program costs. This "potential Pareto improvement" criterion is the formal

theoretical justification for cost-benefit analysis, and it applies as well to evaluation of programs to reduce mortality or morbidity as to more traditional subjects like irrigation evaluation.³

This method, then, would define the benefit of a program which can be expected to save ten "statistical" lives out of a population of 100,000 as the total value the 100,000 members of this population place on having the probability of each individual's death reduced by one in 10,000. An alternative method, and the one which is actually used in almost all evaluations of public health and safety programs, is to attempt to actually place a money value on the lives that the program would be expected to save if it were adopted. In the example above, the "benefit" of the program would be $10V$, where V represents the average "value of a human life." The method frequently used in practice for the heroic job of assessing V is to calculate the so-called "livelihood" measure -⁴ the present value of lifetime earnings for a representative individual. The normative viewpoint which apparently motivates this approach is either that (1) people are properly thought of as the chattel of the state, and the loss of a life has a cost to the state comparable to the cost of a slave's death to his owner; or (2) the proper objective of public policy is to maximize Gross National Product.⁵

A third procedure for benefit valuation has not been employed in the past, but is potentially valuable. Since various public agencies and legislatures have been confronted with many decisions which in effect involve tradeoffs between dollars and mortality rates, there is considerable precedent for current decisions of a similar sort. Analyzing

these precedents could help to increase the consistency of government decision-making.

Before proceeding to discuss these basic approaches to measuring the benefit of safety-enhancing programs in more detail, it is useful to indicate some of the seemingly related issues which, from a normative viewpoint, are in fact quite different. First, we are not dealing with the question of how much the government should spend to attempt to save the life of an identified individual (the coal miner trapped in a cave-in or the child in kidney failure) who is certain to die in the absence of government intervention. This is a very difficult issue because of, among other things, the symbolic importance of maintaining a public commitment to preserve life, which according to Calabresi and others is properly viewed differently from the safety investment issue.⁶ Second, we are not attempting to determine the appropriate amount of compensation or punitive damages award (to either the individual or his survivors) for injury or death. While this issue is related to ours, in that court settlements in such cases may well influence the amount which private firms and households invest in safety, the relationship is complicated by equity considerations and a number of other considerations--including the desire to establish correct incentives for people whose actions influence mortality rates.⁷ Third, we are not attempting to analyze the demand for life insurance, since this is determined by an individual's bequest motive and not by the value he places on his own safety.⁸

The remainder of the paper considers each of the procedures for benefit valuation mentioned above, but in reverse order. A final section summarizes the principle arguments and makes several recommendations for policy analysts.

II. POLITICAL PRECEDENT

The logical first place to look for a source of standards for evaluating public programs which enhance health or safety is to the political process. If decisions regarding these programs tend to reflect a consistent set of values, then these values have a claim to political legitimacy and should be brought to light.

First, what does it mean for these decisions to be internally consistent? Investment and regulatory proposals differ in many dimensions, including the identity of the target population, the cause of death or disability which is to be curtailed, the nature and magnitude of the projected effect,⁹ various side effects, and cost. To focus on the implicit valuations which such decisions place on improved mortality rates, two assumptions are useful: (1) Linearity: A program which reduces the probability of death by two in 1000 for each member of a specified group is worth twice as much as a program which causes only a one in 1000 reduction; and (2) Indifference to cause: The particular source of death which is to be curtailed by a program does not influence the program's value - all that counts is the number and perhaps characteristics of lives saved. If these assumptions are accepted, then a consistent procedure for assessing the benefit of programs is to value each of them by the number of lives which it is predicted will be saved, multiplied by some number representing what is often called the average "value of life" for the program's target population.¹⁰ Precedent decisions can be analyzed to ascertain whether they reflect a consistently applied set of life values.

For any number of reasons it comes as no surprise that public program choices do not reflect the type of consistency defined above. One study which examined a number of lifesaving programs found implicit values of life which ranged from a few thousand dollars (in highway safety design) to over a million dollars (in an ejection system for an air force bomber).¹¹ To some extent this variability may reflect deviations from one or both of the simplifying assumptions stated above. For example, a higher and more expensive standard of safety for airplanes vis-a-vis highways may be justified by the argument that the threat of a crash seems to produce greater anxiety in air passengers than in auto passengers, even though the objective probabilities of death/mile are lower for the former group - this may generate a disproportionate demand for air safety. (In this vein one could also point to the disproportionate concern about death by shark bite or being murdered by a stranger.)

Inevitably, however, much of the variability is the result of decentralized and varied decision-making processes, special political interests, and ignorance. Analyzing past decisions for precedents in defining the appropriate value of safety and health programs would be useful to the extent that it helped dispel this ignorance and yield understanding of the implications of consistency for decisions concerning programs under current consideration.

Ultimately, the study of precedent decisions does not yield an absolute standard by which to measure benefits of potential programs - it does offer a contingent standard which may be useful. If established program X is generally recognized as worthwhile, and proposed program Y

offers a comparable increase in life expectancy/dollar expended, then there is a good argument for adopting program Y. In the absence of a consistent set of values generated by the political decision process, however, there remains a pressing need for benefit values calculated on the basis of more fundamental normative considerations. It is this need which, rightly or otherwise, is currently being filled by the "livelihood" procedure for life valuation.

III. LIVELIHOOD-SAVING MEASURES OF VALUE

Livelihood-saving is the most commonly used formal method for assessing the value of reducing mortality, and has been used as such for over 50 years.¹² This measure is based on the net present value of changes in the person's earnings stream.¹³ By this criterion, if the expected livelihood-savings associated with a project exceed the costs of the project, it is worth undertaking,¹⁴ otherwise the project is not worthwhile. Despite considerable discussion and use of livelihood-saving measures in the literature, there does not appear a clear statement of why it might be desirable to employ such a criterion for funding public programs. In particular, there is no reason to believe a priori that changes in earnings streams bear any direct relationship to what society values in health or safety program outputs.¹⁵

The livelihood-saving approach may have received the attention it has because it is relatively easy to apply and gives the impression of providing an unambiguous numerical answer. It is easy because the analyst can consult a table to determine the livelihood at different ages, identified

by sex, race, and education.¹⁶ The impression of numerical precision is more apparent than real, however. A number of important assumptions underlie the tables, and unless the decision-maker is conscious of their meaning, he may be unconsciously supporting a social judgment that he would reject if he faced it explicitly.

A. Intrinsic Shortcomings of Livelihood Approaches

The major objection to a livelihood evaluation is that it lacks a satisfactory normative justification. It is possible to infer from the way this approach is discussed in the literature that it is supposed to be justified by analogy to the economic procedure for valuing a machine or other piece of capital equipment. If a machine is accidentally destroyed, the resulting economic loss is equal to either (1) the cost of replacing the machine, or (2) the present value of the services which the machine would have provided if it had been saved - whichever is less. If the market for such machines is competitive, then measures (1) and (2) are equal, and both valid. Furthermore, the value of the machines' services is equal to the implicit or explicit rental price of the machine. People can be viewed as embodying "human capital," the services of which are rented in the labor market or used in home "production" (housecleaning, child care, etc.) The rental rate (wage rate) for labor services will under some assumptions reflect the value of such services in production. If we are to accept the notion that the social value of a life is equal to the value of the labor services the person provides, then the present value of the person's expected earnings (including "implicit" earnings from home production) is the appropriate measure of this value.

People are not machines, however. If we accept the view that production is not an end in itself for people, but rather a necessary intermediate step which allows us to enjoy the fruits of production, then the "human capital" approach is clearly inappropriate. Increases in safety and life expectancy help to ensure the continuation of an individual's ability to enjoy the pleasures of his life and the pleasure which his family and friends derive from a continuation of their relationship with him, and it is the value of prolonging this enjoyment which should be assessed in measuring the benefit of public programs which affect safety. While this hedonistic view would not be appropriate in a slave society (at least from the owner's viewpoint) or in a society dedicated solely to increasing the Gross National Product, it seems entirely appropriate in an individualistic society where the government is viewed as serving the public rather than vice versa.¹⁷

The livelihood procedure might still be accepted in practice if it could be demonstrated that it provides a reasonable approximation to a measure which does have conceptual validity - or even to our intuitive notions of what equitable policy requires. For some judgments at least, this type of justification is clearly lacking. For example, it is an inescapable conclusion of this criterion that society should spend no money on programs that extend the lives of fatally ill children because the programs would produce no change in their future earnings. Furthermore, most persons would not agree that it is as important to save one worker earning \$10,000 per year as it is to save two workers with similar personal and family characteristics, but each earning \$5,000 per year. It is even more doubtful that most decision-makers would want to save men and women in proportions

that depend on their earnings--even if a homemaker's services are valued at the wages of a domestic worker rather than at zero. For instance, the livelihood-saving calculation presented below shows that a white man in his 50's is valued more highly than a white woman in her 20's. If we were using livelihood-saving as the measure of value for government health programs, this means we would rather approve programs that save 55-year-old men than programs saving the same number of 25-year-old women. It also indicates that it is worth about twice as much to save one 25-year-old man as to save one 25-year-old woman.

It is doubtful that these magnitudes reflect the rate at which most people would want public lifesaving and morbidity-saving resources allocated. There is little direct evidence on this point about societal preferences, but what exists explicitly contradicts this implication of the livelihood approach. In Acton,¹⁸ 91 persons were asked hypothetical questions about which person they would like to see saved if two seriously injured men arrived at an emergency ward and there were resources available to save only one of them.¹⁹ The respondents had to choose between several different pairs of ages. Approximately one-third (31) of the respondents always chose to save the younger person; 39 expressed a preference that was single-peaked in age (peaks generally occurred between 20 and 30 years of age as does the human capital curve); and 8 were indifferent to all age pairs. (The remainder were multi-peaked or inconsistent rankings.) Thus, somewhat less than half the respondents expressed a desire to save lives identified by age that corresponds to the shape of the livelihood curve.

The livelihood measure assigns a higher value to men than to women at almost all ages, but this sample rejected such a ranking when asked to

select a man or a woman of identified ages in the emergency-ward question above. The majority of persons (53) selected only on the basis of age and matched the same ranking they had expressed when selecting between two men. Nine respondents always selected the man over the woman, and nine always selected the woman over the man. In one question, the respondents were asked to choose between a 30-year-old man and a 30-year-old woman. Thirty-seven chose the man, 43 chose the woman, and 11 expressed indifference.

We are not aware of any other systematic empirical evidence about people's preferences for saving lives identified by age or by sex. However, this empirical evidence, along with casual observation of attitudes for public programs, suggests that a majority of people would at least reject the relative value of saving men and women that is implied by the simple livelihood method. In the provision of public services, where objectives may include allowance for factors such as income redistribution, and externalities such as the numbers of dependents that will be orphaned, the social evaluation may even vary *inversely* within measures of livelihood involved!

Even if we were satisfied that the livelihood procedure formed a conceptually sound basis for public program evaluation, an important practical issue remains to be resolved: Market earnings in some cases do not equal the productivity of an individual's labor.

B. The Issue of Earnings vs. Productivity

A person's earnings may differ significantly from his productivity for a number of reasons. For instance, workers in a strong union may earn considerably more than workers doing identical, nonunionized work. Some

groups may face earnings discrimination because of their race, ethnicity, or sex. Some people (e.g., people with job seniority) may be receiving an income substantially above their productivity. The livelihood measure is blind to these distortions. It merely says to add up the earnings of people who may be affected by different programs, and select the ones that save the most earnings. Since diseases typically do not affect different racial, sexual, or socioeconomic groups uniformly, a criterion that depends on earning differences among these groups will necessarily slant public programs in particular directions. If some diseases are found more often in people with higher earnings, the rule says to devote your attention and resources to these diseases.

The undesirable nature of this criterion is brought home acutely when we consider the implications for the treatment of women (although it applies in less extreme form to any case where wages do not reflect productivity). The national product accounts do not include the homemaker services of women if they are not purchased; but to exclude them from a measure of project benefit will seriously undervalue programs that affect women. The most common procedure is to value homemaker services at the full-time earnings of a domestic worker; compare Weisbrod,²⁰ Klarman,²¹ and Rice.²² Various arbitrary weighting rules have also been used (see, for example, Feldstein²³).

Using the earnings of a domestic servant is only partly satisfactory, however. In the first place, the homemaker may be providing quantity or quality of services that are not available in the market. For instance, when we observe a woman with advanced education who could take a job paying two or three times a domestic servant's income, she may be staying

home to raise her small child because she feels the first few years are important and because she does not feel she could hire such high-quality nurturing for her child. Under these circumstances, using the domestic servant's earnings will understate the value of this woman's home activities, as she sees them. In such circumstances, we could argue that her services at home should be valued at least as highly as the highest salary the woman could earn.²⁴ However, we probably do not really wish to adopt the implications of such reasoning. After all, many people accept jobs at a salary less than the maximum they could command in the market. They may do this in order to have better working conditions or in order to pursue a particular type of work. In the extreme, the implication of this foregone opportunity argument is that we should value everyone's services -- men's and women's -- at the highest possible wage they could earn. Ignoring the readjustment this would cause in the general wage scale, such a recalculation would raise the implicit earnings of society considerably.

A second objection to the standard treatment of home production is that it is assymetric with respect to sex. After all, women are not the only workers around the home. Morgan et al.²⁵ and Walker and Gauger²⁶ surveyed people about the hours they spend working around the house. They found that men spend between about one-eighth and one-third as much time as do women, depending on the employment status of the woman, and the ages and family sizes involved.²⁷ If we are imputing a value to individuals for their home production, then it seems appropriate to add an element to the man's livelihood calculation.

The third objection to the standard treatment of home production lies in the treatment of older women, especially over 65 years of age. Rice and

Cooper²⁸ attributed a full domestic worker's income to nonemployed women over 65, causing their livelihood to exceed significantly that of a man over 65. One could speculate that women over 65 start to slow down in their household activities, but it is difficult to find data. Walker and Gauger²⁹ did not survey older women. We analyzed the results of the Productive Americans Survey (partially reported in Morgan et al.³⁰). The number of observations is relatively small in the over-65 age group, but there appears to be a downturn in average number of hours worked at home by women and an increase in the hours worked by men. Women's hours declined about 19 percent in the over-65 age group and men's hours increased about 17 percent. This leaves women over 65 reporting about 35 hours of housework per week and men reporting about 6 1/2 hours. These figures may represent an overstatement of true contribution if productivity falls significantly in this age group. Furthermore, there may be some reporting error if the respondents have little else to do and therefore claim that most of their times goes to housekeeping.

Since there are no compelling theoretical arguments for one rule over another in accounting for household production, livelihood tables can be generated under a variety of assumptions about the value of women's and men's contributions.³¹ These calculations show significant variation in the livelihood, especially in the upper ranges, depending on the assumptions employed. For illustrations, Figs. 1 and 2 plot the livelihood at different ages for the four-way breakdown of sex and race under two of the assumptions possible for treating home production. The assumptions behind the calculations are discussed in more detail in Acton,³² but briefly, Fig. 1 (Assumption 1-1) assigns a value of \$4800 for the domestic work of nonworking

(Insert
Figs.
1 & 2)

women.³³ Figure 2 (Assumption 3-3) assigns a variable amount to women's homemaker function (depending on their employment status) and a uniform amount to men. After 64 years of age, women's contribution is reduced (19 percent) to reflect a drop in household activities, and men's is increased (17 percent). A 4 percent net discount rate is used for both figures.

We do not intend to focus on the nature of livelihood at different points in life or to concentrate on differences among races and sexes (although they are already quite substantial). These plots, however, serve to emphasize the substantial variability due to alternative assumptions about the valuation of household activities and the substantial impact this has on the relative and absolute amount assigned to women by this criterion. The effect of these alternative assumptions is significant at all ages -- but it is especially noteworthy in the over-65 age range where a substantial amount of mortality and morbidity is involved from such prominent ailments as heart and circulatory diseases and cancer.

The plots in Figs. 1 and 2 show a close similarity between the livelihood for white females (WF) and all other females (AOF). This is due to the relatively low work rates of women, combined with the assumption that all nonworking women are assigned the same value of household services regardless of race. The differences between white males (WM) and all other males (AOM) is about the same under the two assumptions and measures about \$60,000 higher for white men in their late 20's than nonwhite men of the same age. The difference between sexes is dramatic -- with the livelihood of white males at its peak about 2 1/2 times the level of white females at its peak under Assumption 1-1. When the household production of working

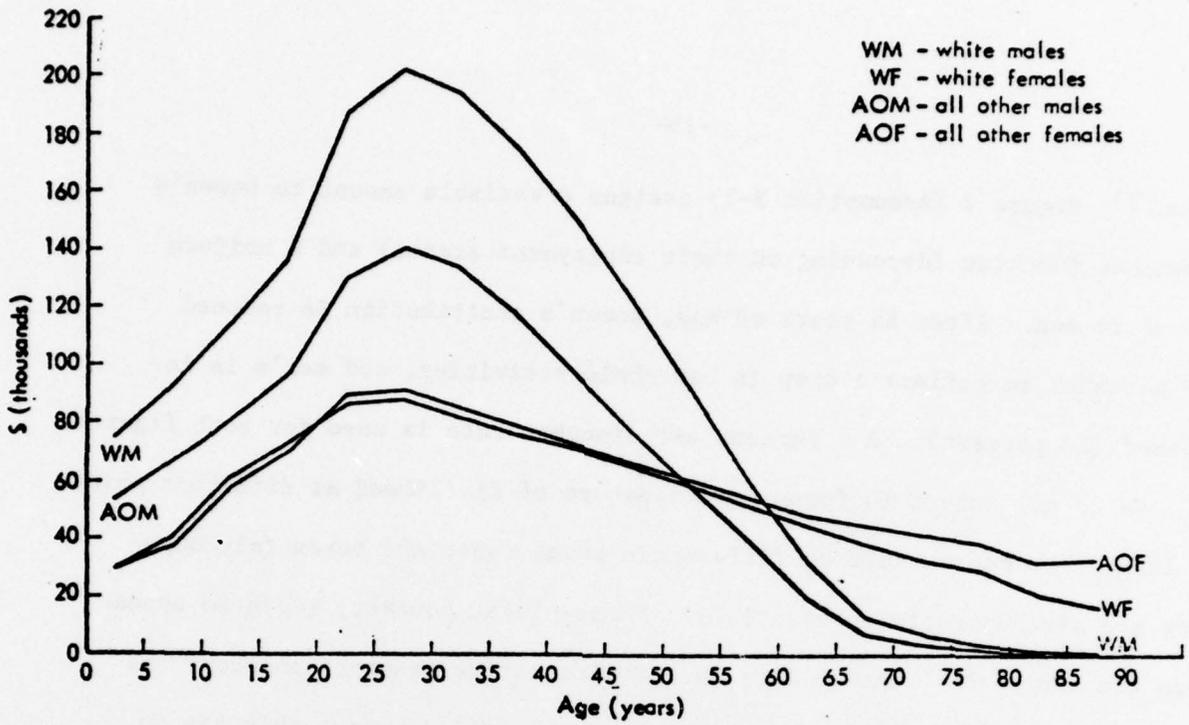


Fig. 1 - Basic human capital, assumption 1-1, interest rate = 0.04

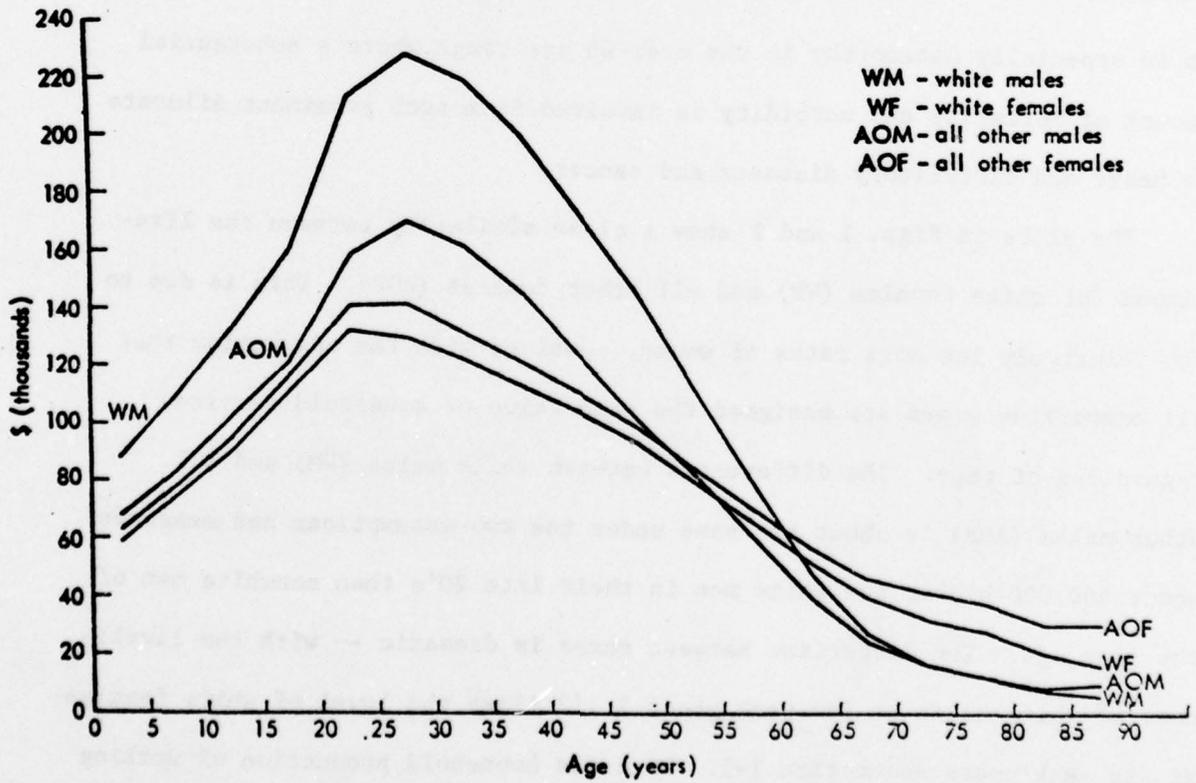


Fig. 2 - Basic human capital, assumption 3-3, interest rate = 0.04

men and women is given an imputed value (Assumption 3-3), the differences between the sexes narrow considerably. At its peak, white men's livelihood is only 1.7 times that of white women. The male:female ratio is even closer for nonwhites.

The other major effect of the different assumptions comes in the crossover between male and female livelihood in the upper age brackets. Under Assumption 1-1, female livelihood crosses male between 50 and 60 years of age -- due both to the lower life expectancy of men and the fact that women are assigned a value of household production while the generally retired men are not. Consequently, over 65 years of age, male livelihood falls to extremely low levels, while female livelihood remains between \$20,000 and \$40,000. Under Assumption 3-3, when a greater value is assigned to household production for men and for working women, the reversal for white men's and women's livelihood is postponed to the early 60's, and the livelihood of men is higher than before in both relative and absolute terms. The reversal for nonwhites is pushed to a lower age, but the difference at all ages is narrowed considerably.

IV. THE WILLINGNESS-TO-PAY MEASURE OF VALUE

A fundamental assumption of the willingness-to-pay procedure is that individual's preferences should count -- that citizens can and should play a role in policymaking for governmental services that affect them directly. Their health, their friends, their taxes, their pain and suffering, and their welfare are at stake. Understandably, they have an interest in the public activities that may be undertaken. Individuals are the ultimate recipients of the impact of programs.

Political justifications for using individual preferences go back at least to the 17th century and include the desire for no taxation without representation. Economic arguments for using individual's preferences date to the 19th century and include the utilitarian principles of Bentham. Dupuit,³⁴ a French engineer, argued that the nature and amount of public transportation facilities should be determined by what the potential users would be willing to pay for using it. Most contemporary economists who study public policy evaluation agree that an approach based on individual values is correct in principle.³⁵

The "potential Pareto improvement" standard which justifies the willingness-to-pay procedure has been criticized because it makes the estimated dollar benefit of a program dependent on the income distribution. This dependence has been criticized either because (1) it is felt that the income distribution is inequitable and hence not a just basis of public program evaluation; or (2) it is felt that whether or not the income distribution is equitable it is simply not an appropriate basis for determining the production and distribution of certain goods (possibly including adequate health care and safety) which are, like the vote, properly considered non-contingent privileges of membership in society.³⁶ The problem which has not been solved by critics is to devise an alternative benefit measure which satisfies such objections. The livelihood measure is even more directly tied to income distribution (viz., by definition) than is the willingness-to-pay measure, and it is not impossible that precedent political decisions were influenced by the economic power of various interest groups.

The principle practical problems with the willingness-to-pay procedure for benefit estimation is that developing accurate assessments of individuals' willingness-to-pay is difficult and expensive, and the validity of published attempts to apply various estimation techniques is questionable. Furthermore, the extent to which estimates of a particular population group's willingness to pay for a particular safety-enhancing project can be applied to other groups and other types of projects is unknown.

The two principle methods for measuring the values a household would place on a prospective public project are (1) Inferences of how much the household values mortality reduction based on observations of the implicit value the household places on safety and health in making private consumption and job-selection decisions; and (2) Survey questionnaires which ask household heads to state their willingness-to-pay for the program benefit which is under consideration.

A. Implicit Values

We can, in principle, infer the values individuals attach to mortality- and morbidity-reduction in the same manner as was proposed for governmental actions (Section II above). Since a revealed preference approach is followed with most market-produced goods that have few externalities.³⁷ We need not go into a detailed survey of relative preferences for, say, apples and oranges. People reveal the preferences they attach by their market behavior. This is the method we would like to use if we want to measure individuals' true preferences for the programs. It presents the strongest claim to validity because the people have to back up their preferences with action, and they do it in the context of other everyday decisions for spending money.³⁸ These choices may include the purchase of safety devices (for example, seat

belts), a marginal expenditure on health items (perhaps a doctor's examination and some antibiotics for an infection), or the premium demanded for accepting an elevated risk (for instance, higher wages for extrahazardous employment).

Recent studies by Thaler,³⁹ Thaler and Rosen,⁴⁰ Smith⁴¹ and Usher⁴² have provided measures of implicit willingness to pay for lifesaving. Thaler, Thaler and Rosen, and Smith examine the higher wages paid in occupations with above-average risk of death for evidence about the implicit value of lifesaving. Usher employs a life-cycle model of utility maximization and infers the tradeoff between consumption and probability of survival from a time series of the national income accounts and mortality statistics. Both approaches have the potential of overcoming some reservations about the survey-based willingness-to-pay approach because they examine behavior revealed through market activity and therefore have stronger claims to validity and stability than existent survey results.

Since the two Thaler studies and the Smith study rest on market wages, they have some drawbacks in common with the livelihood-saving approach. First, the measure requires that the person be working to determine a value. Therefore, it is difficult to determine the appropriate value for housewives, children, retired persons, and others who are not paid for their work. A second criticism relates to the representativeness of this group observed in riskier occupations. Presumably, those who are least risk-averse will enter a given occupation before those who are more risk-averse, all other things the same. Consequently, lower risk premiums will be paid to those who select the occupation that would be necessary to compensate a randomly chosen individual who was subjected to that level of risk, and these

measures will be a lower bound on "society's value." Third, the extra pay is compensation for assuming an above-average risk, and for that reason may not provide an appropriate measure of value for programs which are designed to reduce risk. The compensation which a risk-averse person would require to accept a Δp increase in the probability of his own death is greater than the amount he would be willing to pay for a Δp reduction in this probability -- although the amounts will be close to one another for small Δp . Fourth, the wage-premium observed will not necessarily reflect the externalities (to family and/or society) associated with a person's death -- although the externalities will be better captured with this measure than with the livelihood-saving approach if the employee includes his family in the job-choice decision and requires that the wage-differential be adequate to compensate them for his increased risk as well. Fifth, it is difficult to identify what portions of differences in compensation are due to the additional risk of death, risk of injury, and other working conditions. Sixth, although it is not a general phenomenon, there may be some occupations in which the participants receive some utility from the risk, and therefore the compensation is inadequate for a normal person. Being a stock car racer or being a test pilot may be extreme examples, but this consideration may be reflected to some degree in a number of occupations, some of which are included in Thaler's calculations. Finally, at the conceptual level, we do not know for certain what risks of death or injury the individual assumed were in force when he accepted the wage offer. Given the difficulty Thaler seems to have had in getting good data on death rates by occupation, the amount of uncertainty a given individual faces about the

risk at a particular job site may be substantial.

On the empirical side, Thaler found significant variation in implicit valuation depending on the data source used. With one data file, he inferred a value of between \$176,000 and \$260,000 per expected life saved (for a reduction in probability of 0.001 per year), which is remarkably close to the peak human capital value observed for young men and to the explicit willingness to pay obtained by Acton⁴³ in his survey for a reduction of 0.001 in heart attack death rate. On the other hand, the value implicit in the Bureau of Labor Statistics injury data was over \$2.6 million per expected life. Furthermore, Thaler's regression results with the BLS data yield an incorrect sign for the coefficient of risk of injury. The regression with the first data file did not include a variable for risk of injury, so his results are subject to omitted variable bias, and the difference between the first and second estimates are even more extreme than they appear.⁴⁴

Usher's study is an imaginative use of the (Canadian) national income accounts to infer a tradeoff between consumption over a life cycle and resources devoted to death reduction. He makes utility solely a function of consumption in each time period (which is equal in all time periods) as well as the probability of surviving, and employs strong assumptions about the form of the utility function to make his estimates. Given the strong assumption about functional form, the potentially severe aggregation bias from using such highly aggregated data to infer a utility function for individuals, and the absence of an indication of the level of statistical significance, we may wish to place most emphasis on the qualitative

findings. Usher's model implies that the value per expected life saved is greatest at a very young age (it peaks around age 2 for plausible values of his parameters) and decreases through increasing age. Its value in the age sample 20-30 is very similar to the human capital values reported for white males by Rice and Cooper.⁴⁵ Since utility is a function solely of consumption (not earnings) and since he assumes that every one consumes the same amount in each year of life, there is no difference between the value assigned to men and women in his model.

B. Explicit Statements of Individuals

The survey approach⁴⁶ permits measurement of the entity which is directly appropriate to evaluating a proposed public project - the maximum amount each affected household would be willing to pay to have the project adopted. In theory this procedure requires no assumptions about individual preferences (e.g., linearity, indifference to cause, absence of externalities) which other techniques require. Since the expense of conducting a special survey for every proposed project would be prohibitive, however, in practice we would want to generalize from the results of one survey in order to assess other project proposals - such generalizations will of course require some assumptions on preferences.⁴⁷

While willingness-to-pay surveys have been conducted successfully in recreation program evaluation,⁴⁸ the only published survey we have found of willingness to pay for health programs is contained in Acton,⁴⁹ and that survey deals only with programs that reduce chances of sudden accidental death or heart attack death. It sought preliminary evidence on the feasibility of applying willingness-to-pay responses to actual program evaluation

and addressed several questions:

- o Can questions be formulated that in principle get at willingness to pay?
- o Do people seem willing to answer and are they relatively comfortable in answering such questions?
- o Are the responses people make subject to a rational interpretation?
- o What seem to be the major factors influencing stated willingness to pay?

In total, approximately 125 persons were questioned about their willingness to pay for heart attack mortality reduction.⁵⁰ People were posed four types of questions:

1. Age choice questions -- Which of two seriously injured would you like to see saved in an emergency? Those results were discussed above in the critique of livelihood-saving measures.
2. Live in the community -- How much would you be willing to pay to have a heart attack ambulance that is expected to save X lives per year of the 10,000 people living around you?
3. Advice willingness to pay -- Suppose your neighbor has just been told his risk of heart attack is Y per year, and his chances of dying if he has a heart attack are Z. How much do you think he should be willing to pay per year for a heart attack program that would reduce his chances of dying to Z*?
4. Own willingness to pay -- Suppose your doctor tells you your chances of a heart attack are Y per year, and your chances of death, given the heart attack, are Z. How much are you willing to pay per year for a heart attack program that can reduce your chances of dying to Z*?

Each respondent answered 26 questions of type (1), two questions of type (2), and four questions each of types (3) and (4).

The results showed that we can pose questions that get at the underlying issues of willingness to pay. Furthermore, people were willing to complete the interview and seemed relatively comfortable and responsive in doing so (the refusal and breakoff rates were negligible). The question of rational interpretation of the responses was not clearly resolved in a single survey of this size. Responses varied significantly from one individual to the next (only part of this could be explained as sampling variance due to sample size). High variation per se is neither unexpected nor undesirable for these types of questions. We expect preferences and attitudes to vary from one individual to the next, even for identical expected benefits offered to individuals who appear to be similar in the socioeconomic and demographic profiles. Nevertheless, the responses of most persons could be given a rational interpretation, and predicted effects were found for important explanatory variables such as income, wealth, age, and sex. The empirical results are discussed in detail in Acton.⁵¹ Briefly, the principal statistically significant findings were that willingness-to-pay responses increase with increasing probability of death and with greater reductions that are offered -- but not in a linear fashion.⁵² Second, willingness-to-pay responses are greater the more concretely and immediately the hypothetical program is related to the individual.⁵³

If such willingness-to-pay responses were to be used routinely for program evaluation, we would wish to conduct a survey of a greater number of respondents (appropriately selected for statistical representativeness) where the questions included several different probabilities of mortality

and morbidity and several different reductions in the values of each health consequence. If it appeared conceptually or empirically desirable, separate sets of questions for major categories of diseases or risks should be prepared (for instance, heart diseases, cancer, accidents, and so forth). If satisfactory, statistically significant willingness-to-pay relationships were found, then it would probably be most efficient to use the results of multivariate regression equations to estimate the aggregate willingness to pay associated with a particular program -- taking account of the socioeconomic and demographic characteristics of the population affected and the anticipated changes in probabilities.

A number of issues are still left open in the feasibility of a survey-based method for eliciting value. These include the validity of the responses, their stability and replicability, problems with understanding and processing the information in these hypothetical situations, and strategic behavior in responding.

The validity of responses to willingness-to-pay questions has not been examined empirically. Indeed, it is not clear that the validity can ever be firmly established. A rigorous test of validity might be to survey a group of people and then come back and actually market the goods that had been described (say a heart attack ambulance) or raise their taxes in accordance with responses. Some people might refuse to act in accordance with their previous responses because of intervening factors which may be difficult to control for and which the respondent cannot even articulate.⁵⁴

The stability and replicability of these preliminary results have not been demonstrated. Further empirical work is clearly needed to see if the same people respond with a reasonable stable set of preferences when resurveyed at a later date. Furthermore, we should see if the results can be replicated in other geographic areas with different socio-economic and ethnic samples.

We face several competing objectives in asking questions that are both realistic and yet understandable for the respondents. Since many of the situations we pose to people are hypothetical (either the disease state or the consequences of the programs), we are uncertain about the individual's comprehension of the situation. For instance, although heart disease accounts for about 1/3 of all deaths per year, the realistic chance a person has of dying from a heart attack is less than 1 per 100 per year for the majority of adults. We are, as yet, uncertain about how well people understand and process such numbers.

Similarly, we do not necessarily know how well people understand the nature of certain disability states or recoveries. The operationally relevant point, however, is whether they understand the situation well enough during an interview that their preferences do not change significantly if a decision is made to inaugurate the program. The most direct way to test this assumption is to examine the stability of responses over time.

A fourth unresolved issue in willingness-to-pay elicitation is whether people will engage in strategic behavior when they respond. Lindahl⁵⁵ observed that when you try to find out people's preferences for public programs, they may have an incentive to underrepresent their true valuation if their taxes depend on their stated value. Acton⁵⁶ and Bohm⁵⁷

observed that the opposite case may also exist if people think the decision whether or not to have the program is based on aggregate value, but the cost-sharing rule is determined by a different rule. Under these circumstances, if the person feels he will be called on to bear a small proportion of the costs for a project he wants, he should overrepresent his willingness to pay for it. Dreze and Poussin⁵⁸ have shown that under some circumstances, people will have the correct incentives to reveal their true preferences for public goods that are already being produced. Bohm⁵⁹ suggests that people be posed questions where the payment rule is deliberately specified as yet-to-be-determined. In this manner, he expects to cancel the incentives to over- or underrepresent true feelings, because people will not be able to select a strategy for a misrepresentation of preferences that is guaranteed to make them better off than telling the truth.

Bohm⁶⁰ conducted an experiment to see how sensitive willingness-to-pay responses were to question wording and to analyze whether strategic behavior seemed present. The sample does not purport to be fully representative (only 211 of 605 randomly selected residents of Stockholm agreed to participate), but the experimental design is intriguing and to the point. He paid the volunteers Kr.50 (\$10) for a one-hour "interview" about television programs. When the respondents came to the studio, they were told the interview was delayed and they were put in a room with TV screens and given an opportunity to watch a comedy show with two very popular comedians. They were given the impression that several other respondents were in similar rooms around the building and that the program would be shown only if the aggregate willingness to pay exceeded the cost associated (Kr.500).

The different respondents were randomly given different instructions about what the decision rule for actual showing would be.⁶¹ If people were behaving strategically, some instructions should cause significantly higher responses than other instructions. Bohm's empirical results show no statistically significant difference (at 5 percent) in the responses from one question form to another.

At the moment, we can conclude that although strategic misrepresentation may exist in principle in the willingness-to-pay context, it has not been demonstrated to be a significant empirical factor. At the pragmatic level, it is relatively unlikely to be a serious problem with preliminary efforts to assess people's values, because people are not accustomed to having their tax bill react to such statements of value.⁶²

Many of these potential problems in implementing a willingness-to-pay measure will be clarified only with additional empirical evidence. For instance, the estimates of the true variance of responses in society and the mean value of the responses can only be judged by conducting surveys on representative populations of respondents. Similarly, the reproducibility and stability of responses over time can be measured, but have not yet been explored empirically. Some of the more basic concerns about the validity of the responses and the internal consistency of a given person's responses are more difficult to resolve. We have crude measures of what "internal consistency" means, but to demonstrate rigorously its existence (or nonexistence) hard thinking is needed. An interactive process of both conceptual development and refined empirical evidence seems to be the most

viable strategy for furthering our understanding in both areas. Furthermore, if done with some foreplanning, we can also provide useful interim survey results that can be used as one measure of social impact valuation for current evaluation efforts.

V. CONCLUSION

There are important *conceptual* and *empirical* differences between approaches to evaluation reviewed here. The choice of method is important and may change the ranking and value of health or safety programs significantly. The selection of a particular method involves tradeoffs between ease of application and conceptual soundness. The livelihood-saving approach is easy to apply (and has been used frequently in the past), but it has a number of drawbacks when its implications are examined in detail. An approach based on individual preferences (operationally, what people are willing to pay) meets the drawbacks of the livelihood approach and is conceptually most satisfactory. Preliminary evidence suggests that it is feasible to ask for explicit statements and that meaningful answers result, but a number of problems may arise in implementation on a large scale. There has been very little empirical experience with measuring implicit value or with conducting surveys of people's willingness to pay for public programs. In the revealed preference approaches we may not observe a representative group of people, and it may be difficult to know with certainty that observed behavioral differences should be attributed only to differences in level of risk. Correspondingly, we do not know what the stability of survey responses is over time nor what the sample variance is likely to

be. Furthermore, the validity and internal consistency of these responses is not yet established. It is difficult to specify rigorous tests of the external validity of these sorts of questions, but an interactive development of the conceptual underpinnings and empirical evidence provides promise of sharpening our understanding.

For many actual evaluations, both the livelihood-saving approach (with its known drawbacks) and an imperfect, crudely measured, willingness-to-pay methodology are clearly superior to no formal analysis. First, the analysis is frequently an order-of-magnitude evaluation. Under these circumstances, the drawbacks or questions we have about either approach are second-order magnitudes and do not affect the conclusion whether or not to undertake the program. Second, employing both criteria to see if they yield the same conclusion can reinforce one's confidence in the robustness of the decision. Third, in the range of expected effectiveness for many realistic programs, the approaches frequently lead to reasonably close measures of value.⁶³

When given a choice between livelihood-saving or willingness to pay as a basis for evaluating social impact, a strong case can be made for the conceptual superiority of willingness to pay. The livelihood measure does not bear any necessary relationship to what people want in the way of public programs. If we decide to fund programs by this criterion, we know that we could, in general, raise adequate revenues by taxing those whose livelihood is extended.⁶⁴ However, this criterion does not guarantee that society or any individual is made better off by adopting the program.

An individual preference approach (based on willingness to pay) does provide us with an assurance that society is made better off in some sense by the programs that pass the criterion. By approving only programs such that people are willing to pay, in the aggregate, more than the programs cost, we can make a strong case that society as a whole gains. It is clear that in general the program will be funded in a manner such that some people gain and some lose with a particular implementation. Nevertheless, since the aggregate *willingness* to pay exceeds the cost, it would be possible to spread the costs such that no one was made worse off by the program. That is, with the criterion we identify potential Pareto superior moves for society. Every member can be at least as well off as he was without the program, and at least one person is better off.

Although we started this paper with the objective of identifying means of placing a value on reductions in probability of death or disability, we should recognize that it may not be possible (or desirable) to have a unique value that can be used in several different contexts. Instead, it may turn out that preferences are such that we have one value for a change in probability for cancer death, another value for a change in probability of heart attack death, and yet a third value for change in probability of accidental death -- even for similar persons and identical starting risks and reduction in risks. Given the diversity of values now implicit in public decisionmaking, such a finding would not be unexpected. Furthermore, analysts like Zeckhauser⁶⁵ argue that the process by which public decisions are made may be at least as important as the actual numerical values used. An appropriate strategy for the decision-maker charged with evaluating lifesaving programs before additional

methodological and empirical research takes place may be to employ more than one of the techniques discussed. When the different approaches yield similar conclusions, he can gain confidence from the fact that his evaluation does not seem to be sensitive to the values employed. When they yield sharply different conclusions, he can probe his own preferences or seek additional evidence about the willingness to pay of the target population.

FOOTNOTES

*Economist, The Rand Corporation, Santa Monica, California. I wish to acknowledge with gratitude the comments of P. Cook, W. Manning, B. Mitchell, J. Newhouse, J. Vaupel, M. Weinstein, and A. Williams. The views are those of the author and do not necessarily reflect those of the Rand Corporation or any of its corporate sponsors.

1. Formal prospective evaluation of governmental programs, as discussed here, is a relatively young discipline. Water resource allocation has the longest history in the U.S., having been charged since the 1930's to determine "if the benefits to whomsoever they accrue are in excess of the costs." (From Flood Control Act of 1936, quoted in A. R. Prest and R. Turvey, "Cost Benefit Analysis: A Survey," in SURVEYS OF ECONOMIC THEORY, St. Martin's, New York, p. 150 (1966)). Most of these applications in water resources have been limited to economic benefits and costs, although considerations such as recreational values and their distribution have been added; see, for example, B. Weisbrod, "Income Redistribution Effects in Benefit Cost Analysis," in Stuart Chase (ed.), PROBLEMS IN PUBLIC EXPENDITURE ANALYSIS, The Brookings Institution, Washington, D.C., 177-209, (1968).

A number of economists have reviewed various aspects of the evaluation literature. Prest and Turvey (Id.) have a good background review of the cost-benefit literature. P. Steiner (PUBLIC EXPENDITURE BUDGETING, The Brookings Institution, Washington, D.C. (1969)) focuses on a number of issues in program budgeting for federal programs. H.

Klarman reviews literature related to health evaluation, focusing on the evaluation of health technology in "Application of Cost-Benefit Analysis to Health Systems Technology," in Morris Cotten (ed.), TECHNOLOGY AND HEALTH CARE SYSTEMS IN THE 1980's, USGPO, DHEW Publication No. HRA 74-3011, Washington, D.C. (1973). R. H. Thaler ("The Value of Saving a Life: A Market Estimate," Ph.D. dissertation, Department of Economics, University of Rochester, New York (1974)) reviews some historical attempts at valuation of lifesaving, and R. Zeckhauser ("Procedures for Valuing Lives," PUBLIC POLICY, Vol. 23, No. 4, 420-463 (Fall 1975)) provides a discussion of some recent applications. There are several essays on public expenditure in general. Dorfman and Chase have edited works focusing on particular problems of public expenditure evaluation; see R. Dorfman, MEASURING THE BENEFITS OF GOVERNMENT INVESTMENTS, The Brookings Institution, Washington, D.C., (1965), and S. B. Chase, PROBLEMS IN PUBLIC EXPENDITURE ANALYSIS, The Brookings Institution, Washington, D.C. (1968). R. H. Haveman and J. Margolis have edited a (sometimes revised) set of essays on the Planning, Programming, Budgeting System (PPBS) experience by a number of practitioners and critics, titled PUBLIC EXPENDITURES AND PUBLIC ANALYSIS, Markham, Chicago (1970). Some of the most extensive and successful applications of formal analysis have been in the defense area. Although they have tended to be cost-effective rather than cost-benefit analysis (i.e., How can we best achieve a defense or tactical or strategic posture without asking how expensive a posture we should have?), some techniques developed there form the basis for analysis,

especially regarding the general structuring of decisionmaking under uncertainty and the quantification of uncertain outcomes. A good introduction to this systematic approach to analysis, with a description of a variety of techniques, is found in a collection of essays edited by E. S. Quade and W. I. Boucher, *SYSTEMS ANALYSIS IN POLICY PLANNING*, American Elsevier, New York (1968).

2. See in general E. J. Mishan, "Evaluation of Life and Limb: A Theoretical Approach," *JOURNAL OF POLITICAL ECONOMY*, Vol. 79, No. 4, 687-705 (1971). An interesting discussion of whose interests should be reflected in benefit valuation which considers the intergenerational problem is to be found in J. A. Dowie, "Valuing the Benefits of Health Improvement," *AUSTRALIAN ECONOMIC PAPERS*, Vol. 9, No. 11, 93ff (1970).
3. This criterion was originally proposed by both N. Kaldor, "Welfare Propositions of Economics and Interpersonal Comparisons of Utility," *ECONOMIC JOURNAL*, Vol. 49 (1939); and J. R. Hicks, "The Foundations of Welfare Economics," *ECONOMIC JOURNAL*, Vol. 49 (1939). A good recent discussion in the "valuing lives" context is J. Hirshlerfer, "The Economic Approach to Risk-Benefit Analysis," in David Okrent (ed.) *RISK-BENEFIT METHODOLOGY AND APPLICATIONS* (processed) UCLA-ENG-7598 (December 1975).
4. A term due to Schelling (T. Schelling, "The Life You Save May Be Your Own," in S. Chase, ed., *PROBLEMS IN PUBLIC EXPENDITURE ANALYSIS*, The Brookings Institution, Washington, D.C., 127-176 (1968)) -- as distinct from the lifesaving, or willingness-to-pay, approach.
5. See Mishan, note 2 *supra*.
6. G. Calabresi, *THE COSTS OF ACCIDENTS: A LEGAL AND ECONOMIC ANALYSIS*, Yale Univ. Press, New Haven (1975).

7. R. Posner, (ECONOMIC ANALYSIS OF THE LAW, Little Brown, and Company, Boston (1972)) R. M. McKean ("Products Liability: Implications of Some Changing Property Rights," QUARTERLY JOURNAL OF ECONOMICS, Vol. LXXXIV, No. 4, 611-626 (Nov. 1970)) have explored conditions under which economic efficiency is improved by assigning liability to one party (say the producer of a good) rather than permitting the market to supply (or fail to supply) products that provide reductions in risk. Although, in general, these liability solutions imposed to improve economic efficiency will understate the value of lifesaving or disability saving that would be inferred from a direct assessment of willingness to pay, they cannot be used as an unambiguous lower bound because of transactions costs and lack of perfect information, possible differences between the group determining the law and those engaged in the transaction, punitive elements to settlements, or differences between the group affected ex ante and the group being compensated ex post.
8. See R. Eisner and R. Strotz, "Flight Insurance and the Theory of Choice," JOURNAL OF POLITICAL ECONOMY, Vol. 69, No. 4, 356-368 (August 1961).
9. J. E. Cohen ("Livelihood Benefits of Small Improvements in the Life Table," HEALTH SERVICES RESEARCH, 82-96, (Spring 1975)) reminds us that it is crucial to make clear the time course of the benefit for epidemiological as well as valuational reasons. Frequently, analysts have in mind a program that offers a reduction in probability of death that is effective for one year at a time. Cohen points out that some program benefits may be more accurately characterized in a different manner, and that the alternative definition may make a large difference in the measured benefit. He defines a "curative" benefit as one that offers a person a one-time save (or reduction in probability of death) from a disease, regardless of the age at which it occurs, and then the person

falls back into the normal risk pool. He defines a "preventive" benefit as one that eliminates a particular cause of death entirely. Cohen shows that substantial differences can arise in the measured total benefit when a curative or preventive benefit rather than a one-year exposure benefit is involved. In the case of kidney disease for U.S. males, his calculations yield a total benefit about 22 times as large as that of J. Hallan, et al., THE ECONOMIC COST OF KIDNEY DISEASE AND RELATED DISEASES OF THE URINARY SYSTEM. PHS Pub. No. 1940, U.S.G.P.O., Washington, D.C. (1968).

10. It should be noted that while the "value of life" terminology is convenient and frequently encountered within the philosophical framework of the livelihood procedure, it is strictly accurate only because of the linearity assumption. If decision makers are non-linear with respect to livelihoods saving (eg., if they are not indifferent between (a) saving one person's life [and livelihood] with certainty and (b) saving one hundredth each of 100 persons' livelihood), then one cannot even speak of the "value of a life" within the context of the livelihood measure. Within the context of willingness-to-pay measures, it is meaningless to speak of "the value of a life." In general, one can only refer to the expected value per life saved at a given initial risk of death and for a given reduction in risk. Suppose a given individual has an initial risk of death P , and is offered a chance to reduce it by ΔP . If he will be willing to pay an amount, X , to reduce the risk, then we may refer to the value Y (which equals $X/\Delta P$) as the expected value per life saved

for this set of circumstances. (It can also be viewed as the amount that a large number of people similarly affected and with similar tastes would pay, on the average, for each life saved in their group.) In general (because of risk aversion and because one's budget constraint is affected by non-trivial charges in risk of death), people will not be willing to pay an amount $2X$ for a reduction in risk of $2\Delta P$. Similarly, people's whose initial risk is Q instead of P , will generally be willing to pay something other than X for the same ΔP . We discuss some evidence about amounts people are willing to pay for different values of P and ΔP in Section IV.

11. J. Carlson, "Valuation of Life Saving," Ph.D. Dissertation, Harvard University (1963).
12. See, for instance, E. Crammond, "The Cost of the War," JOURNAL OF THE ROYAL STATISTICAL SOCIETY, Series A, Vol. 78, 361-399 (May 1915) or H. Boag, "Human Capital and the Cost of the War," JOURNAL OF THE ROYAL STATISTICAL SOCIETY, Series A, Vol. 79, 7-17, (January 1916). For a review of some relevant literature, see L. Dublin and A. Lotka, THE MONEY VALUE OF MAN, 1st and 2nd eds., The Ronald Press Co., New York (1931 and 1946) or D. Rice, "Estimating the Cost of Illness," AMERICAN JOURNAL OF PUBLIC HEALTH, Vol. 57, No. 3, 424-440 (1967). More recently, the livelihood-saving approach has been used in a number of governmental evaluation studies. See, for example, U.S. Department of Health, Education and Welfare, DISEASE CONTROL PROGRAMS: SELECTED DISEASE CONTROL PROGRAMS (1966a) and HUMAN INVESTMENT PROGRAMS: SELECTED HUMAN INVESTMENT PROGRAMS (1966b). B. F. Kiker ("The Historical Roots of

Human Capital," JPE, Vol. 74, No. 5, 481-499 (1966)) and L. Thurow (INVESTMENT IN HUMAN CAPITAL, Belmont, California (1970)) have reviews of its general application to other areas of analysis. D. Rice and B. Cooper ("The Economic Value of Human Life," AMERICAN JOURNAL OF PUBLIC HEALTH, Vol. 57, No. 11, 1954-1966 (1967)) have one most extensively applied set of livelihood tables.

13. That is, if the earnings in year 1 are E_1 , the probability of surviving until year is P_1 , and the discount (or interest) rate is r , then the livelihood of a person n years old is

$$\sum_{t=n}^{\infty} \frac{P_1 E_1}{(1+r)^{t-n}}$$

The choice of the discount rate, r , is not always unambiguous and may vary year by year.

14. That is, it passes the criterion of absolute merit. If resources are being rationed, there may be other uses of funds that generate an even greater net change in livelihood.
15. B. Conley ("The Value of Human Life in the Demand for Safety," AMERICAN ECONOMIC REVIEW, Vol. 66, No. 1 (45-55)) has recently argued that changes in expected present value of earnings provides a lower bound to individual willingness to pay for lifesaving programs. This conclusion requires a number of strong assumptions, however, on the nature of individual preferences and on a lack of interest by and for others in an individual's lifesaving valuation. Further, Conley recognizes that there is a range of income over which his conclusions do not apply. He assumes that this is at a very low level of income,

but there is no evidence to support or to refute this assumption.

P. Cook ("The Earnings Approach to Life Valuation: Reply to Conley," Draft Paper (1976)) suggests some illustrative values for the parameters of Conley's model which make it plausible that this will not be a lower bound for a large class of individuals.

16. Rice and Cooper, note 11 *supra*, and B. Cooper and W. Brody ("1972 Lifetime Earnings by Age, Sex, Race, and Educational Level," RESEARCH AND STATISTICS NOTE, DHEW (September 30, 1975)) have a widely used set of such tables.
17. The logical extension of the viewpoint which seems to motivate the livelihood procedure is to argue that an individual's consumption should be deducted from his earnings in calculating the value of his life - that his value is equal to the present value of the surplus he generates (note again the analogy with the slave). One implication of this "net livelihood" procedure is that society is made better off by the death of those whose expected net present value is negative - which is true of retired people and those who are near retirement, some of these receiving disability and public assistance payments, some children, and so on. Dissatisfaction with the implied judgment that society should not expend any effort to extend the lives of such people has led researchers to use income without excluding consumption: See, among others, R. Fein, THE ECONOMICS OF MENTAL ILLNESS, Basic Books, New York (1958); Klarman, Note 1 *supra*, and M. Feldstein, COST-BENEFIT ANALYSIS AND HEALTH PLANNING IN DEVELOPING COUNTRIES, Discussion Paper, Harvard University (1970).

18. J. P. Acton, EVALUATING PUBLIC PROGRAMS TO SAVE LIVES: THE CASE OF HEART ATTACKS, The Rand Corporation, R-950-RC (1973).
19. Thirty-six of these respondents were selected at random from three communities in Boston (half men and half women); 19 were men in a trade union program, and 36 were in an advanced management program at the Harvard Business School. See Acton (note 18 *supra*, pp. 83-85) for a description of these samples.
20. B. Weisbrod, "The Valuation of Human Capital," JPE, Vol. 69, No. 5, 425-436 (1961).
21. H. Klarman, "Syphilis Control Programs," in Robert Dorfman, MEASURING THE BENEFITS OF GOVERNMENT INVESTMENTS, The Brookings Institution, Washington, D.C., 367-410 (1965).
22. Rice, note 11 *supra*.
23. M. Feldstein, note 17 *supra*.
24. For instance, we could examine the earnings of women with similar education and training who are employed full time in the market and impute those earnings to the women who stay home. See Posner, note 6 *supra*, pp. 79-80 for this opportunity cost argument.
25. J. Morgan, I. Sirageldin, and N. Baerwaldt, PRODUCTIVE AMERICANS: A SURVEY OF HOW INDIVIDUALS CONTRIBUTE TO ECONOMIC PROGRESS, University of Michigan, Survey Research Monograph 43, Ann Arbor (1966).
26. K. E. Walker, W. H. Gauger, "The Dollar Value of Household Work," Cornell University, New York State College of Human Ecology, Information Bulletin No. 60, Ithaca (June 1973).
27. Rice and Cooper (note 11 *supra*) assumed that all nonemployed women contributed a full share to home production and assigned the full-time earnings of a domestic worker to those women, about \$2767 per year in 1964. They assigned no other value for household production to others.

This implies, among other things, that it is frequently better to save women who do not work than it is to save women who work part-time. In Cooper and Brody (note 16 *supra*) the value of housework measured by Walker and Gauger (note 26 *supra*) was used, but no adjustment is made for men or for changed productivity after age 65.

28. Rice and Cooper, note 11 *supra*.
29. Walker and Gauger, note 26 *supra*.
30. Morgan et al., note 25 *supra*.
31. J. P. Acton, MEASURING THE SOCIAL IMPACT OF HEART AND CIRCULATORY DISEASE PROGRAMS; PRELIMINARY FRAMEWORK AND ESTIMATES, The Rand Corporation, R-1697-NHLI (1975).
32. Id., Sec. IV.
33. After this work was completed, Dorothy Rice (personal communication) informed me that the domestic worker's earnings for 1972 were about \$4000. Resources did not permit recalculation of all the human capital tables to adjust for this fact, but we should note that it does not change the character of the methodological and empirical findings. If recalculated, the differential between men and women would increase during the working years and narrow somewhat over 65 years of age. The average amount for willingness-to-pay measure would increase further over the human capital amount.
34. J. Dupuit, "On the Measurement of the Utility of Public Works," (1844) translation reprinted in READINGS IN WELFARE ECONOMICS, K. Arrow and T. Scitovsky, eds., R. D. Irwin, Homewood, Illinois (1969).
35. See, for example, P. A. Samuelson, "The Pure Theory of Public Expenditure," REVIEW OF ECONOMICS AND STATISTICS, Vol. 36, No. 4, 387-389 (1954) and "Diagrammatic Exposition of the Pure Theory of Public Expenditure," REVIEW OF ECONOMICS AND STATISTICS, Vol. 37, No. 4,

- 350-356 (1955); P. Bohm, "An Approach to the Problem of Estimating the Demand for Public Goods," SWEDISH JOURNAL OF ECONOMICS, Vol. 73, No. 11, 55-66 (1971); M. S. Feldstein, M. A. Plot, and T. K. Sundareson, RESOURCE ALLOCATION MODEL FOR PUBLIC HEALTH PLANNING: A CASE STUDY OF TUBERCULOSIS CONTROL, World Health Organization, Geneva (1973); L. B. Lave and W. E. Weber, "A Benefit-Cost Analysis of Auto Safety Features," APPLIED ECONOMICS, Vol. 2, No. 4, 265-275 (1970); E. J. Mishan, note 2 *supra*, and Zeckhauser, note 1 *supra*.
36. See J. Tobin, "On Limiting the Domain of Inequality," JOURNAL OF LAW AND ECONOMICS, Vol. 13, (October 1970); A. M. Okun, EQUALITY AND EFFICIENCY: THE BIG TRADEOFF, The Brookings Institution, Washington, D.C. (1975).
37. That is, effects that extend beyond the principal economic agent. A good example of externalities is the pollution that may be generated in the production of some goods. Neither the manufacturer nor the consumer of the good pay for the smoke (at least until recently), although a number of people experience the effects, would like to see them reduced, and would be willing to pay to have them reduced.
38. Dreze, in particular has argued the merits of using this procedure. See J. Dreze, "L'utilite Social d'une Vie Humaine," REVUE FRANCAISE DE RECHERCHE OPERATIONELLE, Vol. 23, 93ff (1962).
39. Thaler, note 1 *supra*.
40. R. Thaler and S. Rosen, "The Value of Saving a Life: Evidence from the Labor Market," paper presented at the NBER Conference on Income and Wealth, Washington, D.C. (November, 1973).
41. R. S. Smith, "Compensating Wage Differentials and Hazardous Work," study for U.S. Department of Labor (August 1973).

42. D. Usher, "An Imputation to the Measure of Economic Growth for Changes in Life Expectancy," in Milton Moss, ed., THE MEASUREMENT OF ECONOMIC AND SOCIAL PERFORMANCE, NBER, New York 193-225 (1973).
43. Acton, note 18 *supra*.
44. That is, risk of injury is probably positively correlated with risk of death. Omission of the first variable will bias the coefficient of the second variable away from zero, causing his estimates with the first data file to be too high.
45. Rice and Cooper, note 11 *supra*.
46. Advocates of this approach include T. Schelling, note 12 *supra*; V. D. Taylor, HOW MUCH IS GOOD HEALTH WORTH?, The Rand Corporation, P-3945 (1969); and J. Acton, note 18 *supra*.
47. Recently, a number of researchers have considered the nature of the utility function that may underlie an individual's willingness to pay for lifesaving. H. Raiffa (PREFERENCES FOR MULTIATTRIBUTED ALTERNATIVES The Rand Corporation (1969) has shown under very general assumptions that a self-interested person, living alone (with no heir and a prepaid funeral), should pay more for a given reduction in probability of death if he is at a greater overall risk of death. J. Pliskin, M. Weinstein, and R. Shepard (UTILITY FUNCTIONS FOR LIFE YEARS AND HEALTH STATUS, Harvard School of Public Health, (October 1974)) and M. Weinstein, R. Shepard, and J. Pliskin (DECISION-THEORETIC APPROACHES TO VALUING A YEAR OF LIFE, Harvard School of Public Health (January 1975)) consider the valuing of life-years as a problem in multi-attributed utility theory, where the joint or conditional nature of the "good" being offered makes a difference to the inferred value. P. Cook and D. Graham ("The

Demand for Insurance and Protection: The Case of Irreplaceable Commodities," Draft paper (1975)] explore the relationship between willingness to pay to avoid a loss and the compensation required to make a person as well off after a loss. M. Jones-Lee ("Valuation of Reduction in Probability of Death by Road Accident," JOURNAL OF TRANSPORTATION ECONOMICS AND POLICY, Vol. 3, No. 1, 37-47 (1969)) provides an analysis of the compensating variation required for various changes in the probability of death or injury. Usher (note 42 *supra*) and Conley (note 15 *supra*) formulate the issue as a life-cycle model in which the individual is assumed to try to maximize his expected lifetime utility, which depends directly on his consumption in each time period. Actual application is rare, however, as most writers have stopped with a theoretical treatment or have chosen an admittedly inferior technique for actual measurement.

48. J. L. Knetsch and R. K. Davis, "Comparisons of Methods for Recreation Evaluation," (1966) in R. Dorfman and N. Dorfman, ECONOMICS OF THE ENVIRONMENT, W. W. Norton, New York (1972).
49. Acton, note 18 *supra*. Related work includes the survey of willingness to pay for selected disease entities conducted by M. Palmatier, "Willingness to Pay for Health Services: A Sampling of Consumer Preferences," Unpublished paper, Department of Economics, University of Southern California (January 18, 1969); a prototype survey for determining individual tradeoffs among attributes of disease reduction programs was developed by E. Keeler, MODELS OF DISEASE COSTS AND THEIR USE IN MEDICAL RESEARCH RESOURCE ALLOCATIONS, The Rand Corporation, P-4537. (1970). R. L. Berg ("Establishing the Values of Various Conditions of Life For A Health Status Index," in R. L. Berg, ed., HEALTH STATUS

- INDEXES, Hospital Research and Educational Trust, Chicago (1973)) and G. W. Torrance, D. L. Sackett, and W. H. Thomas ("Utility Maximization Model for Program Evaluation: A Demonstration Application," *Ibid*) have some imputed values for medical risk-taking based on the responses of physicians in their role as proxy decisionmaker for patients.
50. Part of the sample was a representative community sample in the Boston area, and part was a sample of young and middle-aged men in a business school program. A variety of questionnaire forms were used so it is not possible to report empirical results for the full sample to identical questions. The questionnaire for these surveys is contained in Acton (note 18 *supra*, Appendix).
 51. Acton, note 18 *supra*, esp. pp. 92-105.
 52. This finding is further evidence that individual preferences do not follow the implications of a livelihood-saving measure, which is strictly proportional to income. We can infer both risk aversion and an upper-limit on willingness to pay for a given mechanism of death reduction from these data.
 53. That is, the responses to question types (2) were generally less than the responses to types (3), which were generally less than responses to types (4).
 54. For instance, after thinking over what it might be like to be confined to a bed for a long period of time, his willingness to pay to avoid such disability might change.
 55. E. Lindahl, "Some Controversial Questions in the Theory of Taxation," (1928), translated by E. Henderson; reprinted in R. Musgrave and A. Peacock, eds., CLASSICS IN THE THEORY OF PUBLIC FINANCE, 214-232 (1958).
 56. Acton, note 18 *supra*.
 57. Bohm, note 35 *supra*.

58. J. H. Dreze and D. de la V. Pousain, "A Tatonnement Process for Public Goods," *REVIEW OF ECONOMIC STUDIES*, No. 38, 133-150 (April 1971).
59. Bohm, note 35 *supra*.
60. P. Bohm, "Estimating Demand for Public Goods: An Experiment," Reproduced, Department of Economics, University of Stockholm (no date).
61. For instance, "you pay your actual maximum willingness to pay," or you pay some fraction, or you pay a proportion yet-to-be-determined, and so forth.
62. Other means besides a willingness-to-pay survey can be used to elicit the explicit values of individuals, but none of them answers the operational question of evaluation: How much should be spent on programs that change people's chances of death or disability? The exception to this assertion is a scaling technique that employs von Neumann-Morgenstern lotteries to determine a utility function. C. R. Neu demonstrates that this is formally equivalent to a willingness-to-pay approach ("The Use of Individual Preferences in the Public Valuation of Life and Health," unpublished Ph.D. Dissertation, Department of Economics, Harvard University (1975)). The remaining techniques cannot provide the operationally needed answer. For instance, a variety of psychometric scaling devices could be employed to measure people's attitudes toward attributes of program impact (say, death or disability), or their attitudes toward programs (say, heart attack ambulance or anti-hypertension programs). The results of such a scaling, however, do not answer the fundamental question of evaluation: Should scarce resources be committed? Suppose I know that Program A scores 8 and Program B scores 4 on a 10-point scale where 0 is very bad and 10 is very good. We do not know whether or not to undertake either program.

- Suppose we include information about program cost and define the status quo as 5 on the scale, we would still not know if either program should be undertaken. Furthermore, even if such a scaling produced an indication that a program should or should not be undertaken, the results are of limited applicability because we know only the valuation of a few programs rather than having a procedure that can be generalized. Another approach would be to ask people if they would like to see more, less, or the same amount spent on a given public program. If we then asked how much more should be spent, and specified the person's share of the cost, we would have a result equivalent to willingness-to-pay results and would answer the question of evaluation. Furthermore, if we ask enough questions, this iteration will produce a majority rule situation, which has significant appeal as a public decisionmaking criterion.
63. For instance, in Acton (note 18 *supra*) the conclusions as to net benefit of five interventions for out-of-hospital heart attacks were very similar under both methods of evaluation.
 64. That is, if we were to tax away an amount up to the entire future earnings of individuals whose lives were saved, then we would cover the costs of such programs. In the absence of indentured servitude, we may not always realize even this situation.
 65. Zeckhauser, note 1 *supra*.

