THE VALUE OF HUMAN LIFE: AN EMPIRICAL PERSPECTIVE

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Efficient allocation of scarce resources to public programs which affect human health necessarily involves measuring the benefits of life saving. Accordingly it is with the increasing concern for systematic evaluation of job safety requirements, environmental standards, highway safety regulations and biomedical research proposals that the interest in valuing life saving is growing. In a recent review article, Linnerooth (1979) ably synthesizes the major theoretical contributions of Usher (1973), Conley (1976), Jones-Lee (1976) and Cook and Graham (1977) relating other work including her own to theirs. She focuses on what is considered potentially the most useful result, the relationship between the value of life saving and the discounted present value of expected labor earnings (future earnings).[1] Linnerooth (p. 71) concludes that there are no theoretical grounds for establishing an empirically useful relationship since any quantifiable relationship follows from the misleading equivalence of the utility of living with the utility of lifetime consumption. One intuitive (not the only) explanation suggested by Linnerooth, and Blomquist and Tolley (1977) is that value of life will exceed future earnings because of nonmarket activity. Strict attention to market earnings ignores important nonmarket (household) production and consumption and full earnings and commodity consumption are greater than their market counterparts.[2]

This paper examines recent empirical studies which reveal an imprecise yet consistent relationship between value of life and future earnings and relates the evidence to Linnerooth's theoretical review. Section I of the paper presents estimates of the value of life. The methodology and analytical tools employed and meticulous manner in which the studies are conducted are described as evidence of the creditability of the estimates. Shortcomings are noted briefly. Section II interprets the empirical results in terms of the theoretical literature regarding the relationship between the value of life and future earnings and the implied elasticity

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1. Value of life is the marginal rate of substitution between consumption or wealth and probability of survival. For easy comparison and lack of an accepted unit of account only, the value of the marginal change is extrapolated to a unit (0 to 1) change. Value of life saving is used interchangeably with the value of life in this paper, although Conley uses the former to include the value of life and the excess of lifetime income over lifetime consumption.

2. Cook (1978b) and Jones-Lee (1978) also question whether one can show theoretically that there is a useful relationship between the value of life and future earnings for several reasons. One, they argue, is that the elasticity of lifetime utility with respect to lifetime consumption is not always less than one. Bailey (1978) shows theoretically that for the person who has no assets and buys insurance to fully cover his future earnings. Cook (1978a) questions whether this holds for those who insure only a small share of future earnings.

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of lifetime utility with respect to consumption. The last section is an assessment of existing contributions and the usefulness of economic advice on public policy which affects human health.

TABLE 1

Summary of Empirical Studies on the Value of Life Saving

Description (1)	Value of Life Saving (V)[a] (2)	Y[b] (3)	V/Y (4)	Elasticity[c] α (5)
Based on Observed Behavior				
Production Activity				
Dillingham	$330 thousand	$118 thousand	2.8	.36
Thaler & Rosen	430	99	4.3	.23
Brown	930	—	—	—
Smith[d]	2400	91	26	.04
Viscusi	2500	93	27	.04
Consumption Activity				
Blomquist	410	163	2.5	.40
Ghosh, Lees & Seal	310	45	6.8	.15
Based on Questionnaire Response				
Acton	50	39	1.3	.71
Jones-Lee	8900	83	107	.01

[a]All values are in 1979 dollars. Conversions to 1979 dollars are made using the average annual Consumer Price Index, except for 1979 when the June figure is used.

[b]Future earnings are approximations calculated from data reported in the studies using mortality tables for the U.S. and a 10 percent discount rate. Use of a different discount rate changes the ratios, but not the basic findings reported as discussed in Footnote 5. The earnings for Dillingham's study were supplied by Dillingham. Acton's estimate is based on his calculation of Y using an 8 percent discount rate.

[c]Column 4 is the elasticity of lifetime utility with respect to lifetime consumption which in the Usher-Conley models is α. With the assumptions noted in the text, $\alpha = Y/V$.

[d]The estimate of $2.4 million is from Smith (1976). In his earlier study, Smith (1973), the value of life is 5.5 million, but the later study is generally regarded as more reliable because of better control for job characteristics other than risk of death.

I. ESTIMATES OF THE VALUE OF LIFE

There is a growing body of empirical evidence concerning premiums individuals are willing to pay (accept) to reduce (increase) the risk of death by a small amount. Two types of evidence dominate this work: one is based on the implications of individuals' observed behavior in production or consumption activity and the other is based on replies to questionnaires which pose risky situations to individuals. Existing studies of both types are summarized in Table 1 where column 1 identifies the studies and column 2 contains estimates for the value of life (V). The values have a range from $50 thousand to $8.9 million, the extremes of which come from the two studies based on questionnaire responses. The range of values from labor market studies is $330 thousand to $2.5

million. The two studies of consumption activity yield estimates of $310 thousand and $410 thousand.[3] The range of values should not be cause for dismissing the estimates, for as Linnerooth emphasizes the theory suggests that the value of life varies and there is no single value which is correct for all groups or circumstances.

These estimates of value of life deserve serious consideration. Each study estimates the theoretically relevant value of life which is one based on individual willingness to pay rather than some calculation of future earnings which is of questionable relevance. The studies either advance the theory, enrich it through careful and imaginative application or both. The quality of the studies can be seen by briefly examining each. Looking at the studies of the labor market, Thaler and Rosen (1975) develop further the theory of hedonic price and implicit markets of Rosen (1974) and apply it by matching actuarial data to earnings data to estimate the premium individuals are willing to accept in the labor market for assuming extra risk of death. For the 900 workers in 37 risky occupations they estimate the value of life to be $430 thousand using standard econometric techniques. Smith (1976) uses a much broader sample of employees in manufacturing industries to estimate the value of life in a similar way. For these 3,183 workers who are more risk averse and less able to deal with risk, the value of life is $2.4 million. Viscusi (1978) uses a broad sample of 496 employees in blue-collar industries and investigates the importance of job characteristics other than risk of fatality. He finds a value of life of $2.5 million. Viscusi's value is considerably less than the $5.5 million estimated by Smith (1973) in an earlier study where there is more variation in omitted job characteristics. Viscusi attributes the difference between his estimate and Smith's early estimate to the positive correlation between these characteristics and risk of death. Dillingham (1979) using more individual-specific data for injuries, industry-by-occupation, for a broad sample of 4,000 workers from jobs in blue-collar manufacturing and construction, and using similar multiple regression techniques finds a value of life of $330 thousand.

Looking at the studies of consumption activity, there are two studies of automobile driver behavior. Blomquist (1979) uses a simple model of life-saving activity to show how a value of life is implied by consumption activity. The premium an individual is willing to pay to reduce risk is estimated using a probit analysis of seat belt use and is found to be $410 thousand. Ghosh, Lees and Seal (1975) develop a model of optimal highway speed and estimate a production function for accidents using regression analysis. Given the actual values of speed observed on British motorways, the price of gasoline, and the value of time they estimate a value of life of $310 thousand.

There are two rather well-known studies which seek to determine a value of life by asking people how much they will pay. Acton (1973) sur-

3. All values are in June 1979 dollars.

veys approximately 100 Bostonians, chosen through a stratified random sampling procedure, as to what they would pay for quick-response coronary care systems. The results of the experiment conducted with each respondent imply a value of life of $50 thousand. Jones-Lee (1976), whose work is predominantly theoretical, conducted a similar experiment concerning airline safety and for a sample of 30 academic and research workers finds a value of $8.9 million. Each study reports detailed analysis of responses to determine their veracity and each author feels confident enough to make policy recommendations with the appropriate words of caution.

While these estimates of the value of life are indeed worthy of serious consideration, one should bear in mind their limitations. Estimates based on observable behavior depend upon accurate perception of risk by the individuals and accurate assignment of risk to individuals by the investigator. Labor market estimates depend upon the hedonic wage regression yielding the demand for life saving. Estimates from consumption activity are sensitive to the value of time and the disutility component of the activity while estimates from survey data are doubted because of the hypothetical nature of the questions.[4] These problems await future work to determine their importance in estimating a value of life.

4. That these limitations should not be taken too lightly follows from a more detailed, though not exhaustive, critique of the estimates of the value of life. Those estimates derived from observable behavior depend upon individuals perception of risk and to the extent the perceived risk differs from the presumably more accurate objective estimates of risk based on experience the values of life are incorrect. Estimates based on observable behavior typically assign risk to individuals which is based on some class, e.g., all workers in a particular industry, and this problem of errors in variables biases the values of life. The estimates based on production activity are subject to the additional problem that the hedonic wage regressions need not yield a value of life for workers. If there are distributions of workers preferences and employers production surfaces, then the hedonic wage equation yields only a market clearing function. A value of life would be obtained by estimating the demand for job safety and appropriate integration. A thorough critique of the work on compensating wage differentials by Smith (1979) contrasts the existing studies and discusses their strengths and weaknesses. Smith reports on an earnings study by Veljanovski who finds a value of life of $4.1 million using firm and industry data and another study by Olson who finds a value in excess of $3.5 million using data and method similar to Smith's. Viscusi (1978) presents a more limited, yet still insightful comparison of labor market studies which focuses on his and Thaler and Rosen's work. Brown (forthcoming), whose cross-sectional analysis of individual earnings and occupation characteristics implies a value of life of $0.8 million, offers evidence of varying hedonic coefficients which he feels is inconsistent with the theory of compensating wage differentials. However, since the hedonic equation is a market clearing function it depends on the number of workers with different tastes and employers offering certain job conditions. For instance, even though risk of death on the job is undesirable on average, if there are sufficient workers who are indifferent (or even seek risky jobs and higher pay), then job risk will command no premium at the margin. Earnings studies could yield different hedonic coefficients on job risk and have similar underlying demand functions for job safety and values of life. Linneman (forthcoming) makes the same point for hedonic studies of housing markets. Data limitations seem to have prevented estimation of the demand functions themselves. The studies of consumption activity, also based on observable behavior have their own limitations. One might question how sensitive the estimate of the disutility component of seat belt use and the value of life is to the estimation procedure. One can question the value of time used to get a value of life from British motorway speeds. Using responses to questionnaires has drawbacks as well. There is the problem of the hypothetical nature of the experiments and whether people consider them meaningful. From a public choice perspective there is the question of why people should spend any resources to give informed considered responses when there is little incentive to do so. There is also the question of how representative the sampled groups are, especially for Jones-Lee.

II. RELATION TO FUTURE EARNINGS

Holding in abeyance the shortcomings of the empirical studies, let us address the question of any systematic relationship between value of life and future earnings. Accordingly the average discounted present value of expected labor earnings, future earnings, is calculated for each group studied, divided into the best estimate for value of life, and the ratio of the value of life (V) to future earnings (Y) is shown in column 4 of Table 1. As with the estimates of the value of life itself, we find a rather wide range of V/Y from 1.3 to 107 and again both the minimum and maximum come from the Acton and Jones-Lee studies. The V/Y ratios tend to increase with V indicating that the differences in estimates of the value of life are much greater than differences in future earnings among the populations studied.

In contrast to the wide range of estimates of the value of life and the ratio of the value of life to future earnings is the more robust finding that for each of the studies V/Y is greater than one. Considering the various populations at risk and estimation methods used there is a strong indication that the value of life is greater than future earnings. This finding is tentative, but it should be recognized in that it can be interpreted in terms of the existing theoretical work and is at least somewhat useful for policy analysis. The finding that the value of life is greater than future earnings is, in a strict sense, consistent with the work of Conley and Usher in that it is easily shown that the implied elasticity of lifetime utility with respect to consumption is less than one. Following Linnerooth (p. 57) let $U^L = U(C)$ where lifetime utility, U^L, equals the utility of lifetime consumptions, $U(C)$. In this simple specification $E(U^L) = PU(C)$ where P is the probability of survival and the individual maximizes expected lifetime utility, $E(U^L)$. The value of life is $V = \partial C/\partial P = U(C)/U'P$ where U' is the marginal utility of lifetime consumption. If P is close to one, then we can write V in terms of the elasticity of lifetime utility with respect to lifetime consumption, α, as $V = C/\alpha$, approximately. If we assume that future consumption equals future earnings, which is reasonable in that the average age in most of the empirical studies is approximately 40 years, then $V = Y/\alpha$. The last column of Table 1 gives the elasticity implied by the various studies.

As expected the elasticity of lifetime utility with respect to lifetime consumption is less than one indicating that the value of the utility of consumption is greater than the value of the consumption. The elasticity estimates seem to be lower than anticipated, for in Conley's tables of hypothetical values (p. 55) the lowest value he gives for α is ½. (The choice of ½ as a criterion is of course arbitrary especially since Usher uses lower values.) All of the estimates of α are less than ½ except for the 0.71 from Acton's study. The low elasticities (an average of approximately 0.2) suggest that assuming the equivalence of the utility of living, U^L, with

the utility of lifetime consumption is somewhat misleading. Linnerooth criticizes Usher and Conley for equating lifetime utility with the utility of lifetime consumption. She points out the implications of defining consumption more broadly to include nonmarket commodities or what she calls neutral activities, Z. If we assume separable, additive, identical utilities, then $U^L = U(C) + U(Z)$. The value of life is $V = (C/\alpha) + U(Z)/U'$ where $P \simeq 1$, α is the elasticity of $U(C)$ with respect of C and U' is $\partial U(C)/\partial C$; this value of life is greater than without Z. The elasticity of lifetime utility with respect to C is $U'C/[U(C) + U(Z)]$ which is lower than α. If elasticity estimates less than ½ are considered low, then the empirical studies essentially support Linnerooth's contention that $U^L > U(C)$ and that V is not necessarily closely correlated with C or Y. However, the estimates are inconsistent with Conley and Ushers formulation only in that the estimates might be considered too low.[5]

III. AN ASSESSMENT

Reluctance to proceed with systematic analysis in making choices involving health and safety because of vested interests will always lead some to eschew any contributions on the value of life. However, meaningful progress is being made theoretically and empirically. Value of life based on individual willingness-to-pay is established as superior to the more-easily measured and less-theoretically founded future earnings. The consequences of making risk of death endogenous in models of individual utility maximization are understood. Empirical studies yield estimates of value of life ranging from $0.1 to $8.9 million (in 1979 dollars) with a bit smaller range, $0.3 million to $2.5 million for studies based on observable behavior. The range of values of life and the relatively low estimates of the elasticity of lifetime utility with respect to lifetime consumption (or future earnings) indicate that there is no close association of value of life with future earnings although there are alternative explanations for not finding a close association. There is a strong indication that the value of life is greater than future earnings, a result anticipated by almost all of the preceding theoretical work.

Future efforts will undoubtedly include attempts to determine which estimates of value of life are most reasonable by using different statistical

5. A discount rate of 10 percent is used to calculate future earnings on the basis of earlier work, Blomquist (1979), which finds it performs better econometrically in analysis of seat belt use than either 15 percent of 5 percent. It is only slightly better than 5 percent and naturally Y is greater the smaller is the discount rate and V/Y is smaller and α larger the greater is Y. The ratios of V/Y for the Dillingham, Thaler and Rosen, Smith, Viscusi, Blomquist, Ghosh and Lees and Seal, Acton and Jones-Lee estimates are 1.8, 3.4, 21, 21, 1.6, 5.3, 1.0 and 84 respectively and the values for α are .57, .30, .05, .05, .62, .19, .95 and .01 respectively. The average of α increases to approximately 0.3 for a 5 percent discount rate from approximately 0.2 for a 10 percent rate. Use of a discount rate lower than 5 percent would raise the elasticity estimates even further and some would even exceed 1. A countervailing thought is that since each of the estimates of value of life are considered to be lower bounds, the implication is that α will be even lower than those estimated with a 10 percent discount rate.

techniques and new estimation procedures. Perhaps even more fruitful will be efforts to identify and quantify those factors contributing to the variation of values of life across individuals, groups of people, and countries. Since it is expected that the value of life will vary inversely with the probability of survival and there are undoubtedly other factors which affect the value of life, it would be quite useful to know when if ever it is appropriate to use a value close to $50 thousand or $330 thousand and when a value closer to $2.5 or $8.9 million is more appropriate. Equally valuable will be efforts to identify and quantify the externalities associated with an improvement in an individual's health. Such work by Bailey (1979) indicates the social value of life is at least 10 percent greater than the private value. In the meantime it is clear that decisions concerning projects which improve human health by small amounts should be based on a value of life greater than future earnings in order to avoid underinvestment. It is equally clear that sensitivity analysis should include a range of values and that benefit-cost calculations should be only one part, albeit an important one, in the public decision process.

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