Environment and Planning A, 1974, volume 6, pages 619-626

..... and how much for your grandmother?

J G U Adams
Department of Geography, University College, London, England
Received 1 July 1974

Abstract. Environmental planners frequently make decisions about projects which cost lives. The rational calculation of the optimal sacrifice of human life requires that such lives be made commensurate with all other factors relevant to the project under consideration. The measure most favoured by decision makers in charge of complex social problems is cash. This paper discusses the significance of recent progress toward the discovery of the correct cash value of human life.

The value of human life is a question that has always troubled decision makers. Directors of projects involving the loss of life never have known just how to calculate the optimal level of such loss. It is the great unsolved decision-making problem.

For most of recorded history, decision makers who have faced this problem have relied upon models of their projects that have been subjective, intuitive, unsystematic, and imprecise. The one notable exception was Jonathan Swift (1729). In 1729 he published a brief essay called *A Modest Proposal* in which he brought unprecedented mathematical precision to bear—he brought *reason* to bear on the question. The value of human life was, he demonstrated, simply a function of supply and demand. Further, the optimal time to end it was that at which the selling price minus the cost of production was a maximum. This time he computed to be one year and the net profit on a plump yearling child he calculated very precisely at 40p (1729 prices).

Unfortunately he was ahead of his time. The combination of his own modesty about the merits of his proposal and an unpropitious academic climate resulted in the essay's complete neglect. It was widely read as a satire and nothing more was heard of it in economics for over 200 years. [Although the method of evaluation employed by some 20th century researchers of subtracting consumption from production is remarkably similar to the Swift method of deducting production costs from selling price, I can find no acknowledgements to Swift in any of this century's literature on the subject; see for instance Dawson (1967).]

Meanwhile decision makers retained their time-confirmed habits of subjectivism, intuition, and capricious imprecision. And History went its long, suboptimal way. The industrial revolution gained momentum; roads, canals, and railways were built; dangerous rivers were bridged and mines dug; the West was won and empires subjected; wars were fought and armies sacrificed—all without a workable procedure for determining whether or not the sacrifice of human life involved was even approximately optimal [1].

And so the world might have continued but for the advent of two significant factors: democracy and the computer. The infantrymen and peasants of past ages who were sacrificed in such numbers had no voice in the councils that decided their fate. But today their modern counterparts want the decision makers who declare wars on their behalf to justify the sacrifices they ask of them. The masses are demanding to be convinced that the benefits do in fact outweigh the sacrifices they are called upon to make.

[1] Some would cite the calculations of those engaged in the Atlantic slave trade as a counter example to this historical generalization. But the criticism misses the point that we are here concerned only with the rational valuation of *human* life.

The growing scale of modern warfare has complicated the decision-maker's problems enormously, but computers have come to his aid. With machines that can perform millions of calculations in a fraction of a second, the scale of a military project need no longer affect the precision with which its benefit–cost ratio may be calculated. Not only wars but a great variety of civilian projects involve sacrifices measurable in megadeaths. Road schemes, airports, nuclear-power generators, and a great range of polluting industrial activities all confront the environmental planner with the task of reconciling the benefits expected to result from the projects with the cost of death. Such problems can now be brought within the compass of optimizing decision theory—provided one hitherto insurmountable obstacle can be overcome: the calculus of optimization requires that all costs and benefits be measured in the same units. Any units will do but convention suggests money. Thus, before the apparatus of decision theory can be brought to bear on such projects, it is imperative that we be able to place a cash value on human life.

In recent years there has been an impressive growth in the number of academic papers devoted to this most intractable of valuation problems[2], but they have all been bedevilled by the same fundamental misconception. They have as a result, and as Mishan (1971) has so scathingly demonstrated, been comic failures. They have all foundered on the difficulty that, in order to be logically consistent, they require that a man be prepared to place a cash value on his *own* life, and this, common sense tells us, is absurd.

A theoretical breakthrough

In a recent paper, entitled "Evaluation of life and limb: a theoretical approach", Mishan (1971) sweeps away all the confusion that has built up around this misconception and then lays the logical foundation necessary for a rational discussion of the issues involved. The paper is, I think it is fair to say, the *definitive* work on a *very* important subject, and as such has not received the public attention it deserves. My purpose therefore in the remainder of this paper is, in a spirit of frank admiration of Mishan's theoretical achievement, to suggest a number of practical implications of his approach and then to elaborate some additional theoretical conclusions that might be drawn from it.

But first a brief summary of the most important arguments in his paper. He begins with a broad survey of the literature on the topic and dismisses all of it as "inconsistent with the basic rationale of the economic calculus used in cost–benefit analysis", namely the potential Pareto improvement criterion. This he demonstrates simply and effectively with the help of the following formula:

$$\sum_{j=1}^{n} V_j > 0 \,. \qquad (1)$$

If V_j is the maximum sum that an individual j is prepared to pay for the benefit he will derive from a given project (or, if he will be adversely affected by the project, the minimum sum that he will accept as fair compensation) then the summation of these values for all individuals (with compensation values prefixed by a minus sign) yields the net value of the project. If the sum is greater than zero then the project will produce a potential Pareto improvement. Clearly, if a project involved the loss of a specific life, the value of V_j for the individual specified would be minus infinity, and no conceivable collection of benefits could make $\sum V_j$ positive. The project would therefore be rejected as failing to meet the Pareto criterion.

[2] See, for instance, the useful bibliographies of Fromm (1965), Klarman (1965), Dawson (1967), and Mishan (1971).

This formula, it might be mentioned in passing, applied to military decision-making problems, provides a very useful scientific criterion for distinguishing the civilized from the barbaric races of the world. It is well known that military commanders belonging to barbaric races, such as the Japanese, are prepared to sacrifice *specific* men in battle. But civilized commanders, imbued with the ideals of Pareto optimality, deny themselves the advantage of sacrificing *specific* men for the cause. Although it might be certain that a given military exercise will cost lives, every individual involved must be given a statistical possibility of surviving. Otherwise the exercise could not produce a Pareto improvement.

This military example can serve to illustrate the most important concept in Mishan's paper. While decision makers in Western democracies are forbidden, by a well-established ethical tradition, to undertake projects that will result in certain death for individuals whose identities can be known in advance, they can and do undertake projects that involve the certain loss of life. For example, in this country on an average day approximately 20 people are killed in road accidents. At the beginning of the average day the magnitude of the number of fatalities is known but the individuals comprising it are not. Similar examples could be cited for a great number of other risky ventures which have been studied by statisticians, such as mining and bridge building.

It is Mishan's discovery of this critical distinction, between the certainty of death in the aggregate and certainty in the individual case, that has removed the rock on which all previous studies in the field have foundered. It was both a logical and an emotional rock. It was a logical obstruction in the sense that a failure to grasp this distinction led to conclusions that were logically inconsistent with Pareto optimality. Mishan underlines the revolutionary importance of his discovery:

> "The basic concept introduced in this paper is not simply an alternative to, or an auxiliary to, any existing methods that have been proposed for measuring the loss or saving of life. It is the *only economically justifiable concept*. (My emphasis.) And this assertion does not rest on any novel ethical premise. It follows as a matter of consistency in the application of the Pareto principle in cost–benefit calculations".

It was an emotional obstruction in the sense that the work of all the pioneers in the field, including Swift, offended the sensibilities of people who felt that it was callous to talk cold-bloodedly about the cash value of *specific* people. The removal of the need to talk about specific lives has thus removed a serious impediment to the rational discussion of sacrifice; although our ethical tradition strongly disapproves of the taking of life in the particular, there is nothing in this tradition that particularly opposes the taking of life in the abstract, so long as the price is right.

Let us now look more closely at Mishan's achievement of logical consistency within a cost–benefit framework. The argument, he says, "which has it that a man who accepts £100000 for an assignment offering him a four-to-one chance of survival will agree to go to certain death for £500000, is implausible to say the least". The vital point here is that, while rational people refuse to accept any amount of cash compensation for certain *death*, they will accept cash compensation for undertaking certain *risks*.

There is a great wealth of subtlety and technical sophistication in the argument that Mishan builds on this point. For the sake of brevity I will set out what I take to be its essence. V_j in formula (1) is replaced by r_j and a new formula is presented:

$$\sum_{j=1}^{n} r_j \ ,$$

where r_j is the amount of compensation that an individual, j, will accept for the undertaking of a specified risk. In general this will be prefixed by a minus sign. But on occasions where j stands to benefit, perhaps from a project that threatens someone who might remember him in his will, r_j will be positive. The compensation values for all parties involved are added together and set against the benefits of the project and, if the final total is positive, then the project will produce a Pareto improvement.

The risk–compensation function

Mishan suggests that r_j will be some nonlinear function of risk. At this point I would like to present my own personal risk–compensation function. This may strike the reader as an unwarranted departure from the dispassionate detachment with which the discussion has been conducted so far. However, as Mishan observes, very little is known about the cash values that people subjectively attach to risks, and the economist will have to resort to asking them in order to find out. Thus, having given considerable thought to the way in which I rationally value risks to my own life, I offer the function described below as raw data with which to begin the filling of the empirical void.

My function I have discovered is really quite simple; it has the following form:

$$r = a(x-p)^{-b} \ ,$$

where r is compensation in pounds sterling, x is the size of the population among whom the risk of one death is distributed (that is the reciprocal of the risk of death to any individual in the population), p is the size of the population below which no amount of compensation would be a sufficient inducement to me to undertake the risk (that is the reciprocal of the maximum risk I will willingly subject myself to), and a and b are additional parameters determined empirically.

The specific values of the parameters in my function I obtained empirically by consulting myself. They are illustrated by figure 1. It can be seen by reference to this graph that I would be prepared to play Russian roulette with a 1001 cylinder revolver for £1 000 000 but will not willingly subject myself to a risk greater than 1 to 1000 for any realistic amount of money. At the other extreme I find a risk of

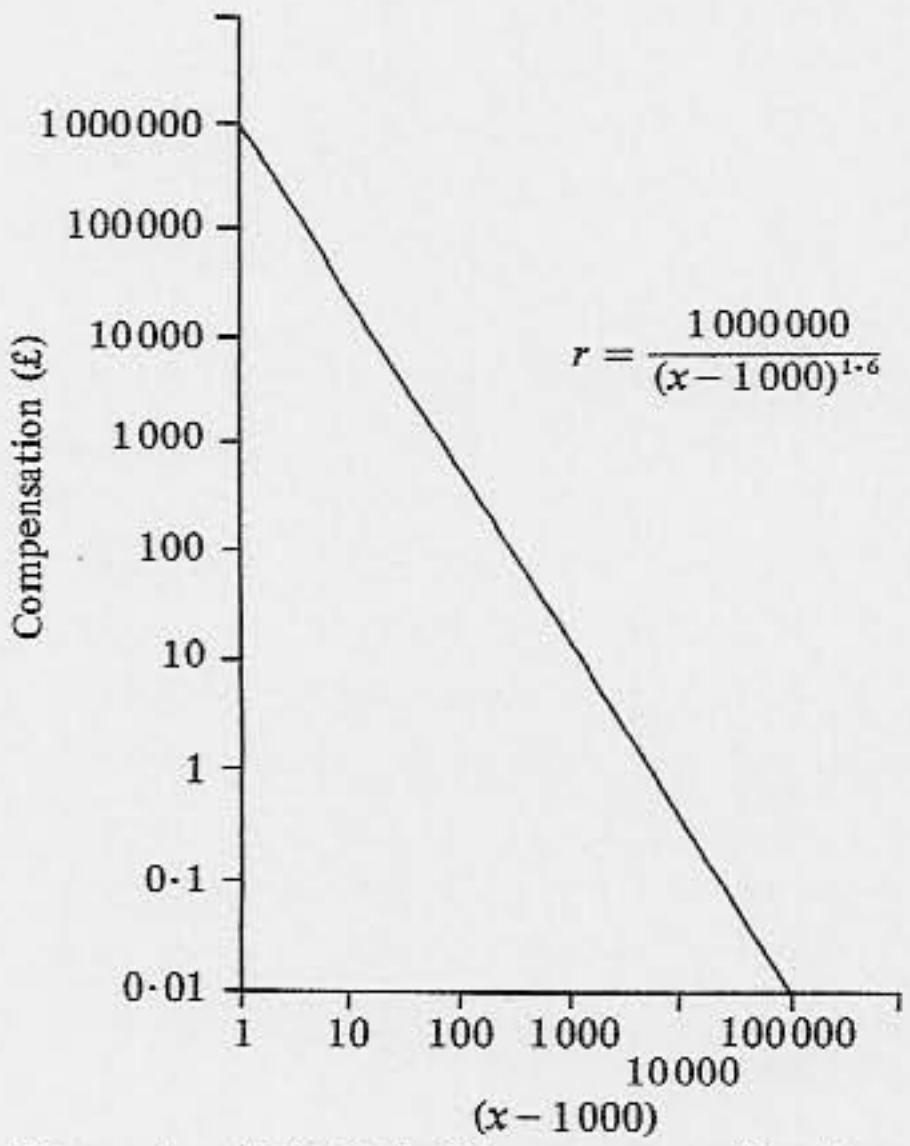

Figure 1. A typical risk–compensation function.

1 to 100000 too small to be meaningful and would demand a token 1p before subjecting myself to it. Risks even smaller than this I will subject myself to for nothing. The value of 1·6 for exponent b is greater than 1, indicating that as risk is increased, and death stares me ever more menacingly in the face, the amount of compensation I will demand increases at an even faster rate. Although Mishan does not himself attempt to define an explicit risk-compensation function, my function presented here is consistent with his speculations about the price of risk discussed above.

One can easily ascertain, by conducting a straw poll of one's associates that the values of a and p vary enormously. (The result of my poll was complicated by a very large percentage of 'don't knows'. This complication is discussed below.) a seems to be a direct function of wealth; the distribution of p appears to be U-shaped, with pessimists assigning very large values to p and optimists very low values, with a very few moderate people, such as myself, choosing an intermediate value such as 1000. But, assuming that the basic form of the function is typical of most people's reaction to risk, and assuming b to be always greater than 1, some very useful conclusions can be drawn that will be valid whatever the specific values of the parameters.

Economies of scale and economies of ignorance

An astute manipulation of their statistics will yield planners hitherto undreamed of economies of scale and ignorance. Looking first at the economies of scale it can easily be seen that the total compensation that must be paid for a given number of expected fatalities $\left(\sum_{j=1}^{n} r_j\right)$ will decrease as n is increased. In fact, if the planner can manage to spread the expected deaths over a population sufficiently large to reduce the individual risks to negligibility, no compensation will have to be paid at all. We can anticipate then that the ever-increasing scale of economic and political activity in the world and the increasingly nonselective nature of both military and civilian modes of killing will steadily reduce the *specific* probabilities of death associated with *specific* projects and drive the cost of life steadily down.

For those impatient with the slow rate at which the natural growth in the scale of society is reducing the cost of life, there remain to be exploited a large number of economies of ignorance. The more precisely the population at risk from a given project can be specified, the greater the compensation the specified population will demand. For example, if it were known that a lead smelting operation would poison only about 20 people in this country, the average level of risk would be only about 1 in 3 million, a level that most people in this country would consider negligible. But if it were known that this group of 20 would all be found among the 100 furnace tenders at the smelter, some among the 100 might place inordinately high compensation values on the risk to which they were subjected and the smelter might have to be closed.

People such as these might on occasion even place infinite compensation values on only moderate risks and thus disqualify on Pareto optimality grounds projects that would otherwise be of enormous social benefit. Short of lying or withholding information about risks there has apparently been no way of dealing with such people. If the Pareto principle were to be strictly adhered to, then fear would remain, it seems, an insurmountable barrier to progress. But, there are other, perfectly honest, ways of reducing the costs of risk compensation without actually reducing the number of deaths. Consider an illustration suggested by Mishan, a hypothetical case in which it were known that there was a very high probability that within a given period of time a sonic boom from a Concorde would trigger

fatal heart attacks in certain medical cases living beneath the flight path. Let us further hypothesize that for some flight stages no flight path could be plotted that would not have at least one of these cases. Pareto optimality considerations would demand the sacrifice of all the enormous benefits of supersonic travel for the saving of only one or two lives. But, if a *flight path randomizer* could be developed that would produce constrained random deviations from the flight path and reduce almost certain *specific* death to an acceptable level of risk, the project could be allowed to proceed.

Such economies of ignorance, however, are at the moment only theoretical possibilities for the future. Regrettably, I must conclude with an examination of some of the mundane operational problems that still stand in the way of a more optimal future.

The research frontier

Although the conceptual foundations laid by Mishan for the valuation of the loss of life are very strong, before such valuations become a practical possibility for general use in cost–benefit studies some rather intractable measurement problems must be overcome. I have reserved the discussion of the difficulties for the end, but the problems raised must not be taken as an excuse for defeatism. Rather they should be viewed by all economists as a challenge that defines an important research frontier. I repeat the caveat of Mishan: "The problem of measurement must not be allowed to obscure the validity of the concept".

It is generally argued that the valuation of life which is to be fed into cost–benefit studies and used for policy decisions must be that of society as a whole and not just the valuation of a few experts. But eliciting such a value from society is no easy matter. Firstly, not a single figure, but a finely graded tariff is required. Society values old people, who are going to die in the near future anyway, less highly than people who are in their middle years. People in their middle years are also valued more highly than new-born infants because society has made a larger economic and emotional investment in them. The problems of questionnaire design are formidable. Because, as we have noted above, lives in the abstract tend to be valued less than specific lives, the questionnaire must be very specific: "How much for your best friend, neighbour, greengrocer ... spouse, child, uncle ... and grandmother?" are questions of the sort that will have to be answered if reliable estimates are to be obtained. Even then problems will remain. For example, cultural weightings will have to be devised to compensate for the fact that some cultures value the extended family more highly than others; key words will have to be tested for emotional bias; time discount rates will have to be estimated for lingering death situations; answers will have to be standardised for age, sex, and education; equity problems will have to be resolved .... The list is a long one.

However, even after all the work on the problems of questionnaire design and administration is completed, serious problems of questionnaire interpretation will remain. The difficulty with asking people questions such as "How much for your grandmother?" is that they do not generally give honest answers. If they think that reporting a high value might influence the government to spend more money on the welfare of their grandmother, and they want their grandmother better cared for, they will answer accordingly. But if they think such an answer might result in higher taxes for the possessors of grandmothers then they will report very low values. However, this may not be the insuperable problem it seems at first glance. A positivist economist will not generally know in advance what use will be made of the answers to the questionnaire since his job is only to present the alternatives and advise on optimal strategies for somebody else's value judgments. So, making a

virtue of necessity, a new school of thought has arisen to argue that we should also make a virtue of ignorance[3]. If we genuinely cannot tell people what use will be made of their answers then they will not be able to cheat. So long as we remain ignorant of even the probabilities of future policy decisions there is no possibility of self-interested bias creeping into the answers.

This solution to the cheating problem does, however, add to another problem, the last that I wish to discuss. This is the problem of what to do with the 'don't knows', a category that plagues the lives of all practising opinion pollsters. If a man with a fixed income has a number of hypothetical questions about expenditure to answer simultaneously (as is commonly the case in reality) then things get computationally somewhat complex. But even when very simple valuation questions were put, well over 95% of those questioned in my straw poll fell into the 'don't know' category. This very widespread inability to perform the calculations necessary to convert lives into money is a very worrying reflection of the unworldly nature of the education system in this country. But it also raises an interesting epistemological question: namely, where does the question 'What is the value of a human life?' come from? Mishan suggests that it emerges from political debate; the people want to know and ask the economist, who is society's acknowledged expert on the cash value of things. But because the answer is subjective and locked up inside people's heads the only way the economist can get at it is by asking the people. The problem Mishan acknowledges, is 'somewhat circular'. This circularity is a serious problem, but, fortunately, not an insurmountable one. Philosophers who have had long experience with such subtle issues are reassuring. As one has noted (Bertrand Ryle), "If a dog turns in circles quickly enough he usually succeeds in catching his own tail".

The difficulties, then, are many but the potential rewards are great. Cost–benefit analysts on the research frontier must become multidisciplinary men embodying the skills of not only the economist but the philosopher, sociologist, psychologist, doctor, and natural scientist as well. We must not relent. Mishan reminds us of the importance of the task upon which we are embarked: "As cost–benefit studies grow in popularity, it is increasingly important to make proper allowance for losses or gains arising from changes in the incidence of death, disablement, or disease caused by the operation of new projects or developments". We must not be deterred by the softhearted among us who prefer not to think of death and disablement in terms of money. Rationality and efficiency demand that we reduce everything to cash. If we refuse, we throw away all the inestimable benefits of the cost–benefit calculus.

References

Bohm, P., 1971, "An approach to the problem of estimating demand for public goods", in *The Economics of Environment*, Eds P. Bohm, A. Kneese (Macmillan, London).
Dawson, R. F. F., 1967, "Costs of road accidents", *Road Research Laboratory Report LR 79*, 1–64, Road Research Laboratory, Crowthorne, Berks., England.
Fromm, G., 1965, "Civil aviation expenditures", in *Measuring Benefits of Government Expenditure*, Ed. R. Dorfman (Brookings Institution, Washington, DC).
Klarman, H., 1965, "Syphilis control programs", in *Measuring Benefits of Government Expenditure*, Ed. R. Dorfman (Brookings Institution, Washington, DC).

[3] This is a theme pursued by Bohm (1971). In *A Theory of Justice* philosopher John Rawls (1972) suggests that the construction of a just social framework can only be achieved if the builders are kept in ignorance about the consequences of the framework they are building. This recent rediscovery of the value of ignorance appears likely to open up a large number of exciting prospects in the social sciences.

Mishan, E. J., 1971, "Evaluation of life and limb: a theoretical approach", *Journal of Political Economy*, **79**, 687-705; also reprinted in Mishan, E. J., *Cost Benefit Analysis* (Unwin University Books, London), chapters 22 and 23.
Rawls, J., 1972, *A Theory of Justice* (Clarendon Press, Oxford).
Ryle, Bertrand, *Tautologies I Have Known* (Reason Press, Oxford).
Swift, J., 1729, *A Modest Proposal,* reprinted in *Jonathan Swift,* 1968 (Random House, New York).