Cost-Benefit Analysis under Uncertainty: Reply

By Daniel A. Graham*

Robert Mendelsohn and William Strang raise a number of issues which require clarification. Their misrepresentations of my results in several cases are easily corrected. The analytical flaws in their own arguments are more difficult.

Turning first to the issue of misrepresentations, they incorrectly assert that I recommended the use of the maximum expected value of alternative contingent payment schemes as the measure of project benefits. Even a cursory reading of my introduction reveals that option price, which does not maximize the expected value of revenue, is the appropriate measure of benefit in situations involving similar individuals, collective risk and certain costs. Despite their claims to the contrary, I have not suggested that option price is an "underestimate" of the true value of project benefits—option price is precisely the true value of project benefits in this case. Contradicting themselves in their first footnote, they assert that I recommend the use of option price for cases involving certain costs and collective risks, thus ignoring the crucial role of similar preferences. Other examples could be mentioned, but it is perhaps sufficient to suggest that any reader wishing to know what I actually said would do well to review my paper.

The appropriate measure of benefits is the subject of the third section of my paper. No mention is made in this general argument of expected value calculations, similar preferences, certain costs, or any of the other special cases that are considered in the fourth section of my paper. These special cases are exactly that—situations in which the general answer, because of the special circumstances, takes a relatively simple form. It is, of course, crucial not to forget the special circumstances when considering these results.

Although Mendelsohn and Strang do not mention the distinction between collective and individual risks save for a passing reference in their first footnote, this issue is central to the consideration of the appropriate measure of project benefits. While the general procedure developed in my third section is compatible with any joint distribution of individual states, option price measures the benefit to similar individuals of a project involving a collective risk when cost is certain. Expected value calculations, on the other hand, are only appropriate in situations involving individual risks. These issues were examined in detail in my fourth section.

In dealing with the special case involving individual risks, I argued that the magnitude of aggregate payments would be equal to the sum of the expected values of the individual payments with virtual certainty. This was hardly a profound observation, but it led to the result that if contingent payments are to be collected in such circumstances, one should consider those payments that have the largest expected value since all contingent payment schemes, including that associated with "expected surplus," involve the same difficulties of adverse selection, moral hazard, and so forth. Mendelsohn and Strang, in expressing the view that "...for the government to collect more revenue than the sum generated by the expected value of surplus, the government must provide an additional service" (p. 1098), fail to recognize that collecting the wrong contingent payments—those associated with the surplus point—involve the same difficulties as collecting the right contingent payments—those associated with the fair bet point.

This mistake is not eliminated by their argument that when fair insurance is available, the individual's willingness to pay locus becomes linear. The presence of such a market makes it possible for an individual to "trade" a given payment "liability" in the market for contingent claims for another,

*Professor of Economics, Duke University, Durham, NC 27706.
less onerous liability with the same expected (market) value. Such a market makes it possible for the individual to "consume" contingent claims corresponding to the fair bet point while making any contingent payments with the same expected value as the fair bet point. This would allow the individual, for example, to make sure payments while consuming contingent claims corresponding to the fair bet point, thereby eliminating the necessity for the government to collect contingent payments. This indifference to payments with the same expected value does not, however, alter the fact that the expected value of these payments is equal to the expected value of the fair bet point and not the expected value of surplus. Recall, in this regard, that "surplus" in a particular state is defined as the largest payment the individual would be willing to make for the project if that state were certain. The presence or absence of contingent claim markets is irrelevant to this definition and thus to the calculation of expected surplus. The conclusion of their Section I should, therefore, be corrected to read: a project that involves independent risks for which actuarially fair insurance markets exist, has benefits equal to the sum of the expected values of the fair bet points of the affected individuals and these expected values can be collected as sure payments.

Even the correct version of their result is of dubious interest since it ignores the question of whether existing markets can be expected to provide opportunities for insuring risks which do not currently exist and will not exist in the future unless the project is undertaken. The standard assumption is that projects involve risks that are independent of all existing risks—otherwise the measurement of project benefits would involve portfolio-type considerations regarding the contribution of the project to the joint distribution of all risks. Can existing markets provide actuarially fair opportunities for insuring risks that are independent of the risks for which these markets were created? Mendelsohn and Strang do not examine this issue.

Their proposition that projects which entail individual risks and "small" changes in the marginal utility of income across states give rise to linear WTP loci is also incorrect. Suppose, for example, that

\[ V_i(\cdot) = \log_e(M - y_i); \quad i = 1, 2, \]

where there is no risk other than the project and the marginal utility of income across states is not affected at all by the project. Supposing that states 1 and 2 are equally likely one obtains the WTP locus

\[ (M - y_1)(M - y_2) = \text{constant}, \]

which is certainly not linear. Considering first the case of individual risks confronted by 2 identical individuals, we have 3 "social states": both experience state 1; one person experiences state 1 and the other person experiences state 2; and both experience state 2. The aggregate WTP locus would then consist of triples of the form \((2y_1, y_1 + y_2, 2y_2)\) where \(y_1\) and \(y_2\) belong to the locus identified above—again not linear. Since Mendelsohn and Strang are discussing individual risks, their appeal to the Arrow-Lind result, which involves a collective risk, is incorrect. On the other hand, with \(N\) identical individuals facing a collective risk, the aggregate WTP locus would be

\[ (M - y_1/N)(M - y_2/N) = \text{constant}. \]

Although not linear, this curve becomes linear in the limit as \(N\) approaches infinity—the Arrow-Lind result. The correct conclusion in this case would read: a project that entails a collective risk for an arbitrarily large number of similar individuals gives rise to a WTP locus that is approximately linear. Whether or not the slope of this WTP locus is equal to the "fair odds" depends upon the effect of the project upon relative marginal utilities of income across states. Again, even the correct version is of limited interest given the simpler proposition for the same case presented in my earlier paper: the value of the project is \(N\) times the option price of the representative individual.

Mendelsohn and Strang correctly point out that the presence or absence of contingent claims markets has important implications for benefit measurement, but express reser-
tions with regard to the government use of contingent payment schemes. Why, they ask, if the government is able to collect contingent payments, doesn't it engage in this activity to provide insurance in the absence of the project? Insurance against what? The idea of a project with uncertain benefits, presumably, is that the provision of such a project with option price or "sure" financing would expose individuals to a new uncertainty or risk—the project will be worth more, net of this payment, in some states than others. Remove the project and you remove the purpose of the insurance.

The example I gave of a contingent payment mechanism for Yellowstone Park that involves a combination of sure taxes and visitor charges is an example of such insurance—the individual pays more in states in which the park is worth more, that is, when he visits. Even if visitor charges for a nonexistent park were conceivable, what purpose would they serve? The use of contingent payment mechanisms is not limited, moreover, to insurance for independent risks. My example of the financing of the dam, whose benefits depend upon the collective risk of whether the year is wet or dry, with a combination of sure taxes and water charges is an example of a contingent payment mechanism for a collective risk—farmers pay more in dry years when the dam is more valuable, that is, when they use more water.

A second objection to the use of contingent payment mechanisms raised by Mendelsohn and Strang concerns the difficulties associated with collecting payments contingent upon the "true state of nature." They do not take into consideration that all payment schemes involve a specification of payments to be collected in each true state of nature. The only difference between a contingent payment mechanism and a "certain" payment mechanism is that the former involves possibly different payments in different states while the latter requires the same payment in every state. The examples of contingent payments for Yellowstone Park and the dam are easier to imagine than a tax which collects the same payment from an individual no matter which state occurs. Taxes that do not depend upon the individual's income, the market value of his property, the amount of gasoline he consumes, or any other variable that is state dependent are as difficult to imagine as the proverbial "lump sum" tax. The trick, of course, is to collect the right payment in every state, but this may well be no more difficult than collecting the same payment in every state.

REFERENCES

