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Ag Econ 514/Econ 514/MAP 514

Evaluation of Benefits of Projects that Reduce Risks (Freeman)

I. Reducing the magnitude of an adverse event (e.g., public shelters to protect against natural disasters).

Individual utility is represented as U = U (y, A), where y = income and A = adverse event; A can have two values, A* or 0. Assume that

$$\frac{\partial U}{\partial y} > 0, \quad \frac{\partial U}{\partial A} < 0, \quad \text{and} \quad y = g(A).$$

The consumer would like to maximize expected utility,

$$E(U) = \pi U(y, A^*) + (1 - \pi)\, U(y, 0)$$

where π = probability of the adverse event, and $(1 - \pi)$ = probability that the adverse event does not occur.

To estimate the value of a reduction in the magnitude of an adverse event, we would like to measure willingness-to-pay, holding utility constant at its initial level. This measure is the compensating variation. So,

$$dU = 0 = \pi\left[\frac{\partial U}{\partial y^A}\, dy + \frac{\partial U}{\partial A}\, dA\right] + (1 - \pi)\frac{\partial U}{\partial y^0}\, dy. \qquad (1)$$

Rearranging terms in equation (1),

$$-\pi\frac{\partial U}{\partial y^A}\, dy - (1 - \pi)\frac{\partial U}{\partial y^0}\, dy = \pi\frac{\partial U}{\partial A}\, dA \qquad (2)$$

or

$$dy = \frac{-\pi \left(\partial U / \partial A\right)}{\left[\pi \frac{\partial U}{\partial y^A} + (1-\pi)\frac{\partial U}{\partial y^0}\right]} dA. \quad (3)$$

The denominator is the probability-weighted average of the marginal utility of income, measured at the alternative income levels.

The WTP measured in (3) is interpreted as the probability of the adverse event, times the disutility of the adverse event (converted to a money value by the average marginal utility of income), times the change in the adverse effect (dA).

II. Reducing the probability of an adverse event.

As before, we wish to measure WTP.

$$dU = 0 = \pi\left[\frac{\partial U}{\partial y^A}\, dy\right] + d\pi\,\left[U(y, A^*)\right] + (1-\pi)\left[\frac{\partial U}{\partial y^0}\, dy\right]$$

$$+ d(1-\pi)\,\left[U(y, 0)\right]. \quad (4)$$

A reduction in the probability of the adverse event means in increase in the probability of non-adversity, so

$$d(1-\pi) = -d\pi.$$

Substituting for $(1-\pi)$ in equation (4) gives

$$0 = d\pi\left[U(y,0) - U(y,A^*)\right] + dy\left[\pi\frac{\partial U}{\partial y^A} + (1-\pi)\frac{\partial U}{\partial y^0}\right]. \quad (5)$$

Rearranging terms,

$$dy = \frac{\left[U(y,A^*) - U(y,0)\right]}{\left[\pi \frac{\partial U}{\partial y^A} + (1-\pi)\frac{\partial U}{\partial y^0}\right]} d\pi. \quad (6)$$

Expression (6) states that the WTP is measured as the difference between utilities in the two states, converted to a money measure by the average marginal utility of income, times the change in the probability.