

ECNS 432

Ch. 7

# Dealing with Uncertainty

- 3 topics relevant to CBA
  - 1.) Expected Value: a measure of reflecting risks
  - 2.) Sensitivity Analysis: a way of investigating robustness of results
  - 3.) Value of Information: A benefit category for CBA and a guide for allocating analytical effort
- Expected Value Analysis
  - Uncertainty about the future exists
  - But, it is often reasonable to characterize the future in terms of a number of distinct contingencies
    - Ex. Decide whether to take umbrella to work. Two reasonable contingencies:
      - i.) it will rain
      - ii.) it will not rain

# Dealing with Uncertainty

- We can assign probabilities of occurrence to each contingency and, thus, uncertainty about the future becomes a problem of dealing with risk
- In assessing expected values, one must first specify a tractable but representative set of contingencies
  - Requirement of the set of contingencies
    - They are exhaustive
    - They are mutually exclusive
  - Contingencies can be thought of as possible events/outcomes or states of the world such that one and only one of the relevant possibilities will actually occur

# Dealing with Uncertainty

- An important consideration is that contingencies capture the full range of likely variation in net benefits of a policy
  - Set of contingencies may be quite large
- After specifying a set of contingencies, the next step is to assign probabilities of occurrence to each of them
  - To be consistent with requirement that contingencies are exhaustive and mutually exclusive, probabilities must be nonnegative and sum exactly to 1.
- Probabilities may be based on
  - Historically observed frequencies
  - Subjective assessments
  - Theory
  - Empirical predictions

# Calculating Expected Values

- The specification of contingencies and their respective probabilities allows us to calculate the *expected* net benefits of a policy
  - First, predict net benefits under each contingency
  - Second, take weighted average of these net benefits over all contingencies, where the weights are the respective probabilities
- Expected net benefits,  $E[\text{NB}]$ , are given by

$$E[\text{NB}] = P_1(B_1 - C_1) + \dots + P_n(B_n - C_n)$$

# Calculating Expected Values

- When facing complicated risk problems, often useful to consider *games against nature*
  - Assume nature will randomly (and non-strategically) select a particular state of the world
    - Selection is non-strategic in the sense that nature does not alter the probabilities of the states of the world in response to the action selected by the analyst
- A game against nature has the following elements
  - *States of nature* and their *probabilities of occurrence*
  - *Actions* available to the decision maker facing nature
  - *Payoffs* to the decision maker under each combination of the *state of nature* and *action*

# Decision Analysis

- We can use what we call *decision analysis* to conduct CBAs with uncertainty over multiple periods
  - We will use sequential (aka extended form) games to model our decision analysis (a concept from game theory)
- Lets consider the following example of a vaccination program against a particular type of influence that involves various costs