Option Price and Option Value

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BGVW Chapter 8 "Option Price and Option Value"
Option Price (OP)

- How to estimate the benefits of a public project in monetary unit when the project involves serious uncertainty and people are risk averse?
  - Example 1: A dam project reduces the risk of flood, drought, etc. How to measure the benefits of risk reduction?
  - Example 2: A nuclear power plant has a “small” probability of a severe accident. How to evaluate a nuclear power project?

- Benefits of a policy in circumstances involving risk: Sum the ex-ante amounts people would be willing to pay to obtain it.

- Option price: The maximum amount an individual would pay for a policy prior to knowing which contingency will occur (if the probability of each contingency is known).

- The sum of the option price of all individuals equals the aggregate benefit of the policy.

- Note: Option price here is different from option price in the finance theory which is the price of an option.
Expected net benefit: \( E(NB) = \sum p_i (B_i - C_i) \)

Expected utility: \( E(U(NB)) = \sum p_i U(B_i - C_i) \)

Dam example
- Probabilities of Wet and Dry are both 1/2.
- Contingency
  - Net benefits without dam: Wet 100, Dry 50
  - Net benefits with dam: Wet 110, Dry 100
- Expected surplus
  - Without dam: \( 0.5 \times 100 + 0.5 \times 50 = 75 \)
    Dam: \( 0.5 \times 110 + 0.5 \times 100 = 105 \)
  - Increase in expected surplus: 30
- Expected utility in the without case: \( EU = 0.5U(100) + 0.5U(50) \)
- Option price: \( OP \)
  - \( 0.5U(110-OP)+0.5U(100-OP) = EU \)

Option value = Option price - Expected surplus
- Option value may be positive or negative.
Expected utility of WO

$EU = 4.26$

$OP = 34.2$

Income: dry, no dam

Income: wet, no dam and dry, dam

Income: wet, dam
Willingness to pay, Expected surplus, Option price

Figure 8-2 Risk-Reducing Project: Expected Surplus and Option Price
Expected surplus and option price: Indifference curves

- Rotate Fig.8-2 180 degrees from the Dam point
- Risk reducing project: move closer to the certainty line
The benefit of the dam project

- **Surplus point** \((Sw, Sd)\)
  - \(U(110 - Sw) = U(100) \Rightarrow Sw=10\)
  - \(U(100 - Sd) = U(50) \Rightarrow Sd=50\)

- **Expected surplus**
  - \(E(S)=0.5Sw+0.5Sd=30\)

- **WTP locus**
  - \(0.5U(110-x)+0.5U(100-y)=EU\)

- **Fair bet line**
  - \(0.5(110-x)+0.5(100-y)=0.5(100)+0.5(50)=75\)

- **Option price**: \(OP\)
  - \(0.5U(110-OP)+0.5U(100-OP)=EU\)
Option price: Conclusion

- Use option price when
  - No uncertainty about costs
  - Complete and actuarially fair insurance is unavailable
    - Complete insurance: A person can buy enough insurance to eliminate all risk
    - Actuarially fair: The price of the insurance equals the expected cost with the true probabilities of the relevant contingencies.
  - With complete and actuarially fair insurance, the larger of OP and ES is the conceptually correct measure of benefits.
Option value

- Option Value
  - Bias caused by using the expected surplus
  - $OV = OP - E(S)$
  - Option value = Option price - Expected surplus
- Option value may be positive or negative
Justification for using the expected surplus

- Benefits and costs of the project are thinly distributed over many people
  - Small changes in the real income of an individual
  - Risk neutrality is a good approximation
- Many projects are concurrently adopted and risks are pooled over those projects
  - When perfect insurance is a good approximation, the larger of OP and ES
  - ES can be used as the lower bound estimate
Collective risk and individual risk

- **Collective Risk:**
  - The same contingency will result for all individuals in society.
  - ES is not appropriate

- **Individual Risk:**
  - The contingency realized by each individual is independent of the contingency realized by any other individual.
  - The larger of OP and ES (BGVW)
    - This claim of BGVW may not be correct if perfect insurance is not available.

- **Implicit Pareto improvement**