# Option Price and Option Value

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BGVW Chapter 8 "Option Price and Option Value"

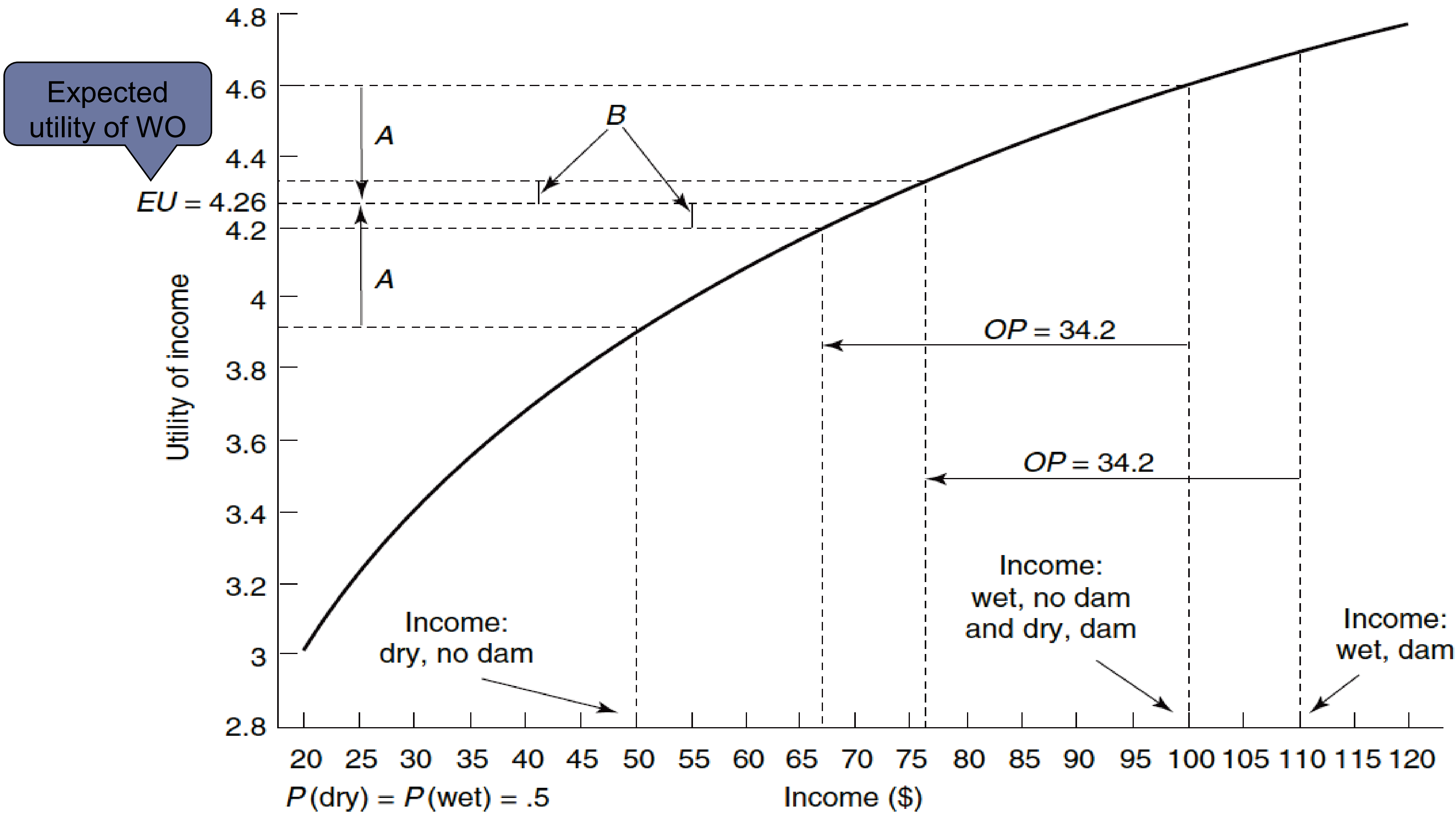
# Option Price (OP)

- 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

# Option Price, Expected Surplus, and Option Value

- 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 x 100 + 0.5 x 50 = 75<br>Dam: 0.5 x 110 + 0.5 x 100 = 105
    - Increase in expected surplus: 30
  - Expected utility in the without case: EU
    - EU = 0.5*U*(100) + 0.5*U*(50)
  - Option price: OP
    - 0.5*U*(110-OP)+0.5*U*(100-OP) = EU
- Option value = Option price - Expected surplus
  - Option value may be positive or negative.

# Dam Project: Utility function and option price



# Willingness to pay, Expected surplus, Option price

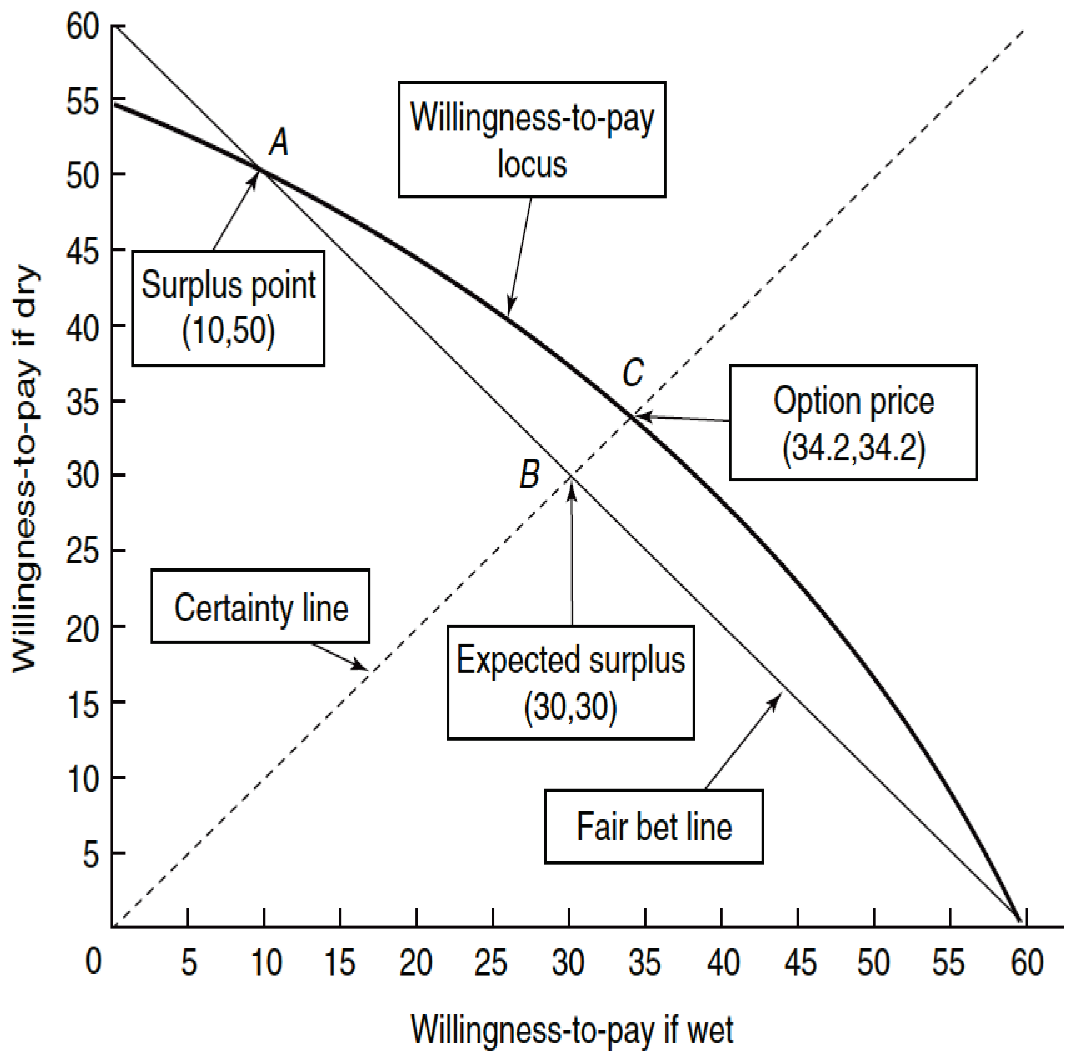
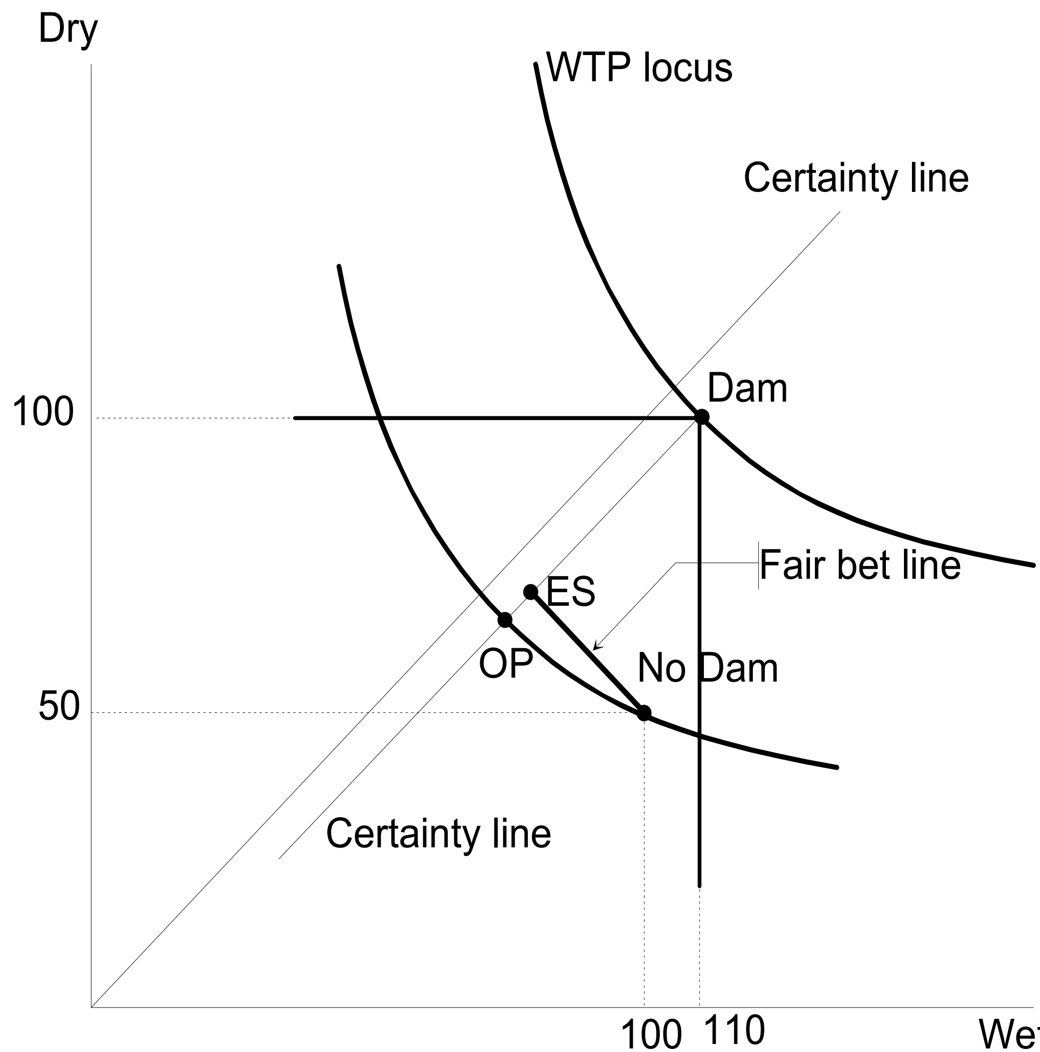



Figure 8-2 Risk-Reducing Project: Expected Surplus and Option Price

# 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
    - D.A. Graham, Cost-Benefit Analysis under Uncertainty, AER, 1981.