Challenges in decision making: Risk, uncertainty and time

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1. Standard risk decision model

- Choose among risky payoffs $X(s)$
- State of the world s with probability $p(s)$
- Utility function u(.)

Choose X* maximizing expected utility :

$$E_p\, u(X) = \sum_s p(s)\, U(X(s))$$

Challenge 1: right risk aversion ?

$$u(c) = \frac{c^{1-h}}{1-h}$$

$$u(c) = \ln(c) \quad \text{when} \quad \text{h} \rightarrow 1$$

Challenge 2: tails

- Value at Risk approaches:

$$\text{maximize:} \quad E_p X(s) - \quad V_p X(s)$$
$$\text{such that :} \quad p(X \leq \text{VAR}) \leq 0.05$$

Intertemporal decision

- Choose among payoffs *X*(*t*)
- Felicity function f(.), discount rate *d*

Maximize :
$$J = \sum_t (1 - d)^{-t} \, f(X(t))$$

If
$$f(c) = \frac{c^{1-i}}{1-i}$$
then SRTP = *d* + *i* *g*

Challenge 3: risk-aversion with low SRTP ?

Often we use $h = i$

$$J = \sum_{s} p(s) \sum_{t} (1 - d)^{-t} u(c(s,t))$$

When risk aversion increases, optimal abatement increases

BUT

When discounting increases, optimal abatement decreases

2. Deep uncertainty

- Forget utility function
- Choose among uncertain gambles $X(s)$
- $p(s)$ imprecisely known: $p(s) \in C$

For example, s is very unlikely

$$p(s) \leq 0.1$$

Decision criteria

$X^{\#}$ is a Bayes choice if there is p_0 in C such that

$$X^{\#} = \max_{X} E_{p_0} X$$

$$\overline{P}(X) = \max_{p(s) \in C} E_p X$$

$$\underline{P}(X) = \min_{p(s) \in C} E_p X$$

Challenge 4: Ellsberg's criteria

- Parametrize ?
- Rationality and time coherence ?

maximize

$$U(X) = aE_{p_0}X + (1-a)(b\overline{P}(X) + (1-b)\underline{P}(X))$$

Challenge 5: Bewley/Walley DM

- Expected value is an interval $\left[\underline{P}(X), \overline{P}(X)\right]$
- No total ordering of gambles
- Give X to get Y when and only when

$$\underline{P}(X - Y) \geq 0$$

- What is the reference gamble ?
- Undecidable cases ?

Challenge 6: Accepting three valued logic

- True / certain $\underline{P}(X)=1$
- False / disbelieved $\overline{P}(X)=0$
- Void priors / incertain $\underline{P}(X)=0,\ \overline{P}(X)=1$

Challenge 7: Abrupt change

Power damage functions $D = a\,(T)^b$

- Go through the roof
- Larger b, smaller initial damage

Challenge 8: Models of learning

- Bayesian learning vs. Popper
- Signal theory vs. information fusion
- Learning on the decision vs. learning on impacts
- Endogenous learning : technology vs. climate sensitivity

Conclusion

- Expected value is a range
- Value at Risk would work under uncertainty