Lecture 16: Behavioral failure and economics

- Purpose
  - show what constitutes behavioral failure relative to the main stream economic model of behavior
  - show implications of behavioral failure on predicted agent behavior

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Outline

- Behavior - (mainly) an issue for individual decision making = agents whom we assume maximize expected utility
- Existence of a utility function (not exam stuff, but nice to be aware of)
- Expected utility theory
  - violation of EU (Allais paradox)
- Subjective probability
  - violation of SP (Ellsberg paradox)
- Behavioral implications
- Policy implications
- Experimental economics

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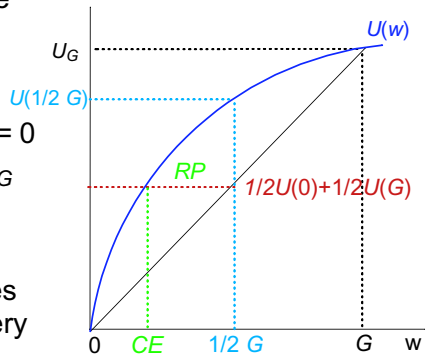
Environment and risk

- Environmental risk as a "lottery" in an EU frame
  - Utility: continuous twice differentiable fnc of wealth, $U(w)$: $U'(w) > 0$, $U''(w) < 0$
  - Bad state: $w_B = 0$, $U_B = 0$
  - Good state: $w_G = G$, U_G
  - $p_G = p_B = 1/2 = p$
  - Certainty equivalent (CE) = wealth that gives same utility as the lottery
  - Risk premium (RP) = max WTP for insurance



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Utility (1)

- Existence of a utility function:
  - When preferences are complete, reflexive, transitive, continuous, and strongly monotonic there exists a utility function $U{:}R_+^k \rightarrow R$ that represents those preferences
- Completeness: for all x and y in the choice set, either $x \succeq y$ or $y \succeq x$ or both
- Reflexiveness: for all x in the choice set, $x \succeq x$
- Transitivity: for all x, y and z in the choice set, if $x \succeq y$ and $y \succeq z$ then $x \succeq z$

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... utility (2)

- Continuity: for all y in the choice set, the sets $\{x : x \succeq y\}$ and $\{x : y \succeq x\}$ are closed sets. It follows that $\{x : x \succ y\}$ and $\{x : y \succ x\}$ are open sets.
- Monontonicity: (more is preferred to less)
  - weak form: if $x \geq y$ then $x \succeq y$
  - strong form: if $x > y$ and $x \neq y$, then $x \succ y$
- These axioms suffice in terms of having a foundation for expected utility

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Expected utility theory (1)

- Intuitive: The utility of a lottery is the expectation of the utility of its prices
  - implication: can compute the utility of a lottery by taking the utility of each outcome and multiply that utility by the probability of occurence of each outcome, and summing over outcomes

  $E[U] = \Sigma_{i=1} p_i U_i(y_i)$ where i indexes outcomes
- The existence of a Ufnc a non-issue here
- The issue is the existence of a U-fcn with the convenient property of being able to multiply utility of outcomes and probabilities and adding up

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... expected utility theory (2)

- To multiply utility of outcomes and probabilities and adding up following axioms needed:
- U1: the relationship between income, y, and utility, U, is continuous
  - unproblematic assumption
- U2: if $x \sim y$, then $px + (1\text{-}p)z \sim py + (1\text{-}p)z$
  - if the prices of two lotteries are valued the same, adding the same extra term to the two lotteries will not change the valuation of the two lotteries
  - this property is often referred to as "the independence of irrellevant alternatives"

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... expected utility theory (3)

- U3: Let there be a lottery, $\mathcal{L}$, with a best outcome, b, and a worst outcome, w. For any x in $\mathcal{L}$, it follows that $b \succeq x \succeq w$.
  - this assumption is convenient, and is usually not violated
- U4: Let there be a best outcome, b, a worst outcome, w, and let p and q be probabilities. $pb + (1\text{-}p)w$ is preferred over $qb + (1\text{-}q)w$ **if and only if** $p > q$.

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... expected utility theory (4)

- Expected utility theorem:

  If $\mathcal{L}$ and $\succeq$ satisfy axioms U1-U4, there is a utility function defined on $\mathcal{L}$ that satisfies the expected utility property

  $U[\, px + (1\text{-}p)y \,] = pU(x) + (1\text{-}p)U(y)$

- The relevance of the EU theorem: it denotes rational behavior for any agent only concerned about his/her own utility (welfare)
  - ... but possibly not a description of human behavior

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Violation of EU (1)

- The Allais paradox
  - choose between the following gambles
    - A: 100% chance of 1 million
    - B: 10% chance of 5 million
89% chance of 1 million
1% chance of 0
  - write down which gamble you prefer
- Now choose between gambles
  - C: 11% chance of 1 million, 89% chance of 0
  - D: 10% chance of 5 million, 90% chance of 0

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... violation of EU (2)

- The Allais paradox (cont.)
  - how many preferred A to B and D to C?
- $A \succ B \Rightarrow U(1) > 0.1\,U(5) + 0.89\,U(1) + 0.01\,U(0)$
  $\Rightarrow 0.11\,U(1) > 0.1\,U(5) + 0.01\,U(0)$
  $\Downarrow$ add $0.89\,U(0)$ to both sides
  $0.11\,U(1) + 0.89\,U(0) > 0.1\,U(5) + 0.90\,U(0)$
- i.e., preference reversal (inconsistent choices)
  - if you chose A in lottery 1 you should choose C in 2
  - if you chose B in lottery 1 you should choose D in 2
- Allais paradox exemplifies cognitive difficulties involved making EU hold

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Subjective probability (1)

- EU takes probabilities for given, but in "real life" probabilities on discrete choices are calculated based on some observed frequencies
  - Most interesting case: subjective probability
- Suppose we want to elicit an individual's subjective probability it will rain on a certain date. At what probability p will the individual be indifferent between the gamble

  $pb + (1-p)w$ and receive b if it rains,

  and w otherwise

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... subjective probability (2)

- Formally, let $p\,[E\,]$ denote the (subjective) probability that event E occurs

  The subjective probability that event E occurs is the number $p\,[E\,]$ that satisfies

  $p\,[E]\;b + (1\text{-}p\,[E])\;w \sim b$ if E occurs, w otherwise

- Subjective probs. obey all rules of expression transformations of ordinary probs.
  - useful implications for economic behavior (rationality in a world with subjective opinions)

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... subjective probability (3)

- Let $p\,[H\,]$ denote the (subjective) probability that a particular hypothesis is true, and that E is an event that is offered as evidence that H is true
  - How should a rational agent adjust his subjective probability about H given that E has occured?
- Let $p\,[H,E\,]$ denote the joint probability of observing E and H being true

$$p\,[H,E\,] = p\,[H\,|E\,]\;p\,[E\,] = p\,[E|H\,]\;p\,[H\,]$$

$$\Rightarrow p\,[\mathrm{H}|E\,] = \frac{p\,[E|H\,]\;p\,[H\,]}{p\,[E\,]} \quad \text{(Bayes rule)}$$

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Violation of SP (1)

- The Ellsberg paradox. An urn contains 300 balls, of which 100 balls are red, and 200 are either green or blue.

  Pick one ball, and consider the gambles
  - A: receive 1000 € if the ball is red
  - B: receive 1000 € if the ball is blue

  - write down which gamble you prefer

- Now consider the following two gambles:
  - C: receive 1000 € if the ball is not red
  - D: receive 1000 € if the ball is not blue

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... violation of SP (2)

- Common to prefer A to B and C to D, which violates SP theory

- To see this let $p(R)$ be the event "red ball" and $p(\hat{}R)$ be the event "not red ball" (same for B)
  - $p(R) = 1 - p(\hat{}R)$ and $p(B) = 1 - p(\hat{}B)$
  - for simplicity let $U(0) = 0$
  - A preferred over B $\Rightarrow$ $p(R)U(1000) - (1-p(R))\ 0 > p(B)U(1000) - (1-p(B))\ 0$ $\Rightarrow p(R) > p(B)$
  - C preferred over D $\Rightarrow$ $p(\hat{}R)U(1000) > p(\hat{}B)U(1000) \Rightarrow p(\hat{}R) > p(\hat{}B)$
  - :: Contradiction

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Observed violation of axioms

- Does this mean
  a. that EU and SP does not hold? OR
  b. that people have cognitive problems?
- What are the implications for using EU (and SP) in models of human behavior?
  - specifically "calling breach of the axioms" for "behavioral failure"
- ... or are there other reasons for individual choices?

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Behavioral implications (1)

- Experiments (Shogren) that have been conducted suggest that once people are "trained" violations of EU and SP are quite infrequent
- Other reasons why people in real life settings do not behave according to EU (and violate SP)
  - it can be fully rational for people not to maximize (what we perceive as) expected individual utility
    - one is elected as a politician (... but observed differences in voting behavior among politicians if the voting record is made public)
    - the outside observer does not fully understand the the payoffs (frequent in labor - leisure decisions)

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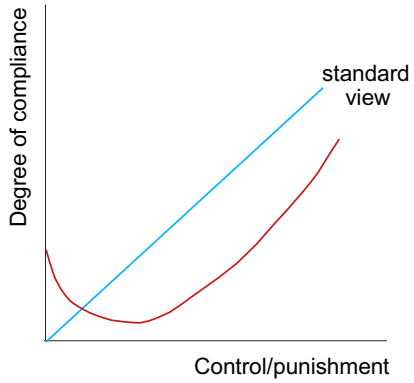
... behavioral implications (2)

- How people respond to penalties
  - EU: increasing penalty/control ⇒ increased compliance
  - frequently observed: increased penalty/control has adverse effects on compliance
    - increases from zero control/punishent ⇒ compliance ↓
    - ...before compliance increase with controls



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Rational expectations (1)

- Rational expectations (RATEX)
  - intuitive (Muth 1961): "... expectations, since they are informed predictions about future events, are essentially the same as the predictions of relevant economic theory"
  - formally, given "cost free" data:
    - expected forecast error = 0 (= unbiasedness)
    - available info. effectively utilized: minimum variance in forecast errors
- With costly data collection and analysis the economic interpretation is:

$$E[MC(info.)] = E[MU(info.)]$$

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... rational expectations (2)

- Biology: selection of species and mutants that are best fit to the environment
- Evolutionary game theory: how agents adapt (and increase/decrease their share) over time
- Economic competition and RATEX: **rational expectations equilibria** (Allen, Radner, 1980s)
  - agents with RATEX do better than agents with other expectation regimes (naive, adaptive, etc.)
  - ... thereby gaining increased weight
- ... under stable conditions: RATEX equilibria
- ... under unstable conditions: resillience

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Experimental economics (1)

- In "real life" many unobservable or non-controllable factors influence how agents act
  - problem: introduces a lot of noise when economists interpret agent responses
  - solution: conduct experiments in more controlled environments
- Many times economists would like to test responses to new issues or products
  - valuation (ECN 271)
  - experiments on a possible new policy or product

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... experimental economics (2)

- How economic experiments are conducted
  - collection of a small set of individuals who
    - receive some payment to take part (fixed)
    - receive some payment (money or in kind) based on their performance
  - training setting (to make participants familar with the mechanism or setting)
  - repeated experiments (to save money a lottery can take place to decide which experiment that will decide the performance payment
- Experiments sensitive to who takes part ⇒ repeated experiments with new participants

Summary

- EU and SP strong **normative concepts** for "rational behavior" (= not how agents behave, but ought to behave to avoid "money pumped")
  - ... but frequently violated (a difference in objectives OR just a "cognitive" problem? OR lack of knowledge of what goes into individual utility functions?)
- Create incentives that matches agents' perspectives/frames
  - I / we OR role of norms / rule of thumb
- Experimental economics
  - test new issues/products + reduce "noise"