Introduction to Prospect Theory

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Introduction to Prospect Theory

- Social scientists look for parsimonious models that predict human behavior
- Prospect Theory (KT, 1979) is a descriptive model
- One of the most widely cited and influential social science papers ever published

Overview

- Today:
  - Features of PT
  - Motivate/examine evidence
  - Begin modeling approach
- Tuesday:
  - Modeling reference-dependent preferences
  - Examples
  - Calibrating risk attitudes
  - Weaknesses

Features of Prospect Theory

- Reference-dependent preferences: $u(c_t|r_t)$, not $u(c_t)$; r_t is some reference level. (For now: status quo ante)
  - Loss aversion
  - Diminishing sensitivity
- Non-linear probability weighting
  - EU: probabilities enter linearly
  - PT: enter as "decision weights" via weighting function π

Loss Aversion: Losses & Gains Matter

Summary of evidence

- Endowment effects
- Surveys/experiments on risk
- $DMU(w)$ cannot explain risk aversion

Loss Aversion

Endowment effect: KKT

- Distribute mugs $\longrightarrow$ owners & non-owners
- Immediately elicit buying/selling/choosing prices
- Buying (+ choosing) price $\approx$ \$3.50
- Selling price $\approx$ \$7.00

Loss Aversion

Endowment effect: Knetsch (1995)

randomly given	offered to exchange for	% kept	% kept
Mug	Pen+$.05	88%	12%
Pen	Mug+$.05	90%	10%

Loss Aversion

Would you accept a 50/50 lose \$500 or gain \$700 bet?

- Aversion to modest scale risk cannot come from $DMU(w)$.
- The strongest such aversion arises for risks that involve gains and losses to the status quo.

Diminishing Sensitivity

- Choose between

  1. A 45% chance of winning \$6000
  2. A 90% chance of winning \$3000

  ⇒ 14% choose option 1, i.e. exhibit risk aversion

- Replace “winning” with “losing” ⟹ 92% choose 1.

In the Gains domain, people are risk averse, but not in the Losses domain.

Diminishing Sensitivity

Imagine that the US is preparing for the outbreak of an unusual Asian disease which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows:

A: 200 people will be saved

B: $(1/3, 600 \text{ saved}; 2/3, 0 \text{ saved})$

Which of the two programs would you favor?

Diminishing Sensitivity

Imagine that the US is preparing for the outbreak of an unusual Asian disease which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows:

A: 200 people will be saved (72%)

B: $(1/3, 600 \text{ saved}; 2/3, 0 \text{ saved})$ (28%)

Which of the two programs would you favor?

Diminishing Sensitivity

Imagine that the US is preparing for the outbreak of an unusual Asian disease which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows:

C: 400 people will die

D: $(1/3, 0 \text{ die}; 2/3, 600 \text{ die})$

Which of the two programs would you favor?

Losses and gains depend upon the framing of the question.

Diminishing Sensitivity

Imagine that the US is preparing for the outbreak of an unusual Asian disease which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the exact scientific estimates of the consequences of the programs are as follows:

C: 400 people will die (22%)

D: $(1/3, 0 \text{ die}; 2/3, 600 \text{ die})$ (78%)

Which of the two programs would you favor?

Losses and gains depend upon the framing of the question.

Diminishing Sensitivity

- In addition to whatever you own, you have been given $1000. You are now asked to choose between:

  A: 50% chance of gaining $1000
  B: a certain gain of $500

Diminishing Sensitivity

- In addition to whatever you own, you have been given $1000. You are now asked to choose between:

  A: 50% chance of gaining $1000 (16%)
  B: a certain gain of $500 (84%)

Diminishing Sensitivity

- In addition to whatever you own, you have been given $1000. You are now asked to choose between:

  A: 50% chance of gaining $1000 (16%)
  B: a certain gain of $500 (84%)

- In addition to whatever you own, you have been given $2000. You are now asked to choose between:

  A: 50% chance of losing $1000
  B: a certain loss of $500

Diminishing Sensitivity

- In addition to whatever you own, you have been given \$1000. You are now asked to choose between:

  A: 50% chance of gaining \$1000 (16%)
  B: a certain gain of \$500 (84%)

- In addition to whatever you own, you have been given \$2000. You are now asked to choose between:

  A: 50% chance of losing \$1000 (69%)
  B: a certain loss of \$500 (31%)

Diminishing Sensitivity

Which feels like a bigger difference?

gaining $100 vs $101		gaining $0 vs $1
losing $101 vs $100		losing $2 vs $1
101' away vs 100' away		1' away vs 0' away
saving $10 on a $1000 item	vs.	saving $10 on a $20 item
carrying suitcase 21 blocks vs 20		carrying suitcase 2 vs 1 block

Across domains, we tend to perceive, judge and choose based upon proportional thinking.

Non-linear Probability Weighting

Certainty Effect:

- Choose one of the following two lotteries:

  A: 80% chance of winning $4000
  B: 100% chance of winning $3000

Non-linear Probability Weighting

Certainty Effect:

- Choose one of the following two lotteries:

  A: 80% chance of winning $4000 (28%)
  B: 100% chance of winning $3000 (72%)

Non-linear Probability Weighting

Certainty Effect:

- Choose one of the following two lotteries:

  A: 80% chance of winning $4000 (28%)
  B: 100% chance of winning $3000 (72%)

- Choose one of the following two lotteries:

  A: 20% chance of winning $4000
  B: 25% chance of winning $3000

Non-linear Probability Weighting

Certainty Effect:

- Choose one of the following two lotteries:

  A: 80% chance of winning $4000 (28%)
  B: 100% chance of winning $3000 (72%)

- Choose one of the following two lotteries:

  A: 20% chance of winning $4000 (59%)
  B: 25% chance of winning $3000 (41%)

Non-linear Probability Weighting

More evidence of certainty effect:

- Russian Roulette: 4 to 3 bullets vs. 1 to 0
- Non-monetary evidence: vacation preference survey

Prospect Theory

Prospect theory accommodates all these anomalies

- Value function carries
  - Risk aversion
  - Loss aversion
  - Diminishing sensitivity
- Probability-weighting function
  - Overweights small probabilities
  - Features certainty premium

Prospect Theory

How does it do this? Summary:

- Editing phase
  - Bracketing: Organize options into relevant values, reference points, probabilities
- Evaluation phase
  - Map real probabilities of bracketed prospect to subjective decision weights vis π
  - Map objective values into value function defined over gains/losses w.r.t. reference point
  - Choose prospect of highest value

Prospect Theory

- Let L be a lottery: $(y, p; z, 1-p)$
- Utility of prospect L: $\pi(p)v(y-r) + \pi(1-p)v(z-r)$
- Utility defined over departures from reference point, r

Prospect Theory

Graphical Illustration of Value Function and Probability-weighting function.