Experimental Economics

Week 5
Prospect Theory

- Risk aversion and seeking in both gain and loss context discussed on board.

Risk Attitude

Risk averse action: A person chooses a sure-thing X over a gamble G where X is less than the expected value of G.

–A risk averse person prefers
a sure win of $500
over
a 50-50 gamble for $1,010 or $0.
(Note: Expected value of gamble = $505)

Risk seeking action: A person chooses a gamble G over a sure thing X where the expected value of G is less than X.

–A risk seeking person prefers
a 50-50 gamble for $1000 or $0
over
a sure win of $505.
(Note: Expected value of gamble = +$500)

Examples of Risk Aversion & Risk Seeking

- Whenever you buy insurance, you are acting in a risk averse way.
  - The cost of car insurance is a sure loss that is a bigger loss than the expected value of the gamble of driving an uninsured car.
- Whenever you play a gamble with a professional casino or state lottery, you are acting in a risk seeking way.
  - The cost of the lottery ticket is greater than the expected value of the lottery ticket.

Is It Normative* to be Risk Averse?

- (Outcome of economy or public policies) **ought to be**. ⇔ positive economic (what is)
- There is no normative requirement to be risk averse. I.e., it is equally rational to be generally risk averse or generally risk seeking.
  - It is also rational to be risk seeking for some money quantities, e.g., small amounts of money, and risk averse for other money quantities, e.g., large amounts of money.
  - It is also rational to be risk averse in some domains, e.g., gambles for the health of your children, and risk seeking in other domains, e.g., gambles for business profit and loss.

- Before the work of Kahneman & Tversky, many theorists thought that people were generally risk averse.

Allais's Paradox

	Urn i	Urn ii
A	61 % chance to win $520,000	63 % chance to win $500,000
B	98 % chance to win $520,000	100 % chance to win $500,000

What's the problem with this preference???

Imagine: 100 marbles in an urn. If you draw a red marble, you win.

	Urn i	Urn ii
A	61 red marbles $520,000	63 red marbles $500,000
B	98 red marbles $520,000	100 red marbles $500,000

Now, add 37 red marbles to A's Urns.

	Urn i	Urn ii
A	61+37 =98 red marbles $520,000	63+37=100 red marbles $500,000
B	98 red marbles $520,000	100 red marbles $500,000

- What is going on here???

Prospect Theory

Daniel Kahneman and Amos Tversky

"*Prospect Theory: An Analysis of Decision under Risk*"

Econometrica, Vol. 47, Issue 2 (Mar., 1979), 263-292.

Prospect Theory

- Proposed in 1979 by Daniel Kahneman & Amos Tversky.
- Attempts to explain patterns of human preference under risk that are not explained by expected utility (EU) theory.
- Kahneman received the Nobel Prize in Economics in 2001. Prospect theory was a major part of the work for which the Nobel was awarded.

Key features

1. Gains / Losses from a reference point (not final assets/wealth)

2. Value Function
   - Convex for losses and concave for gains
   - Initially steeper for losses than gains (Loss Aversion)
   - Weighting function (Decision weight)

3. Loss Aversion

4. Endowment Effect

(details will be explained on board)

Two Phases in Choice Process

1. Editing phase

2. Evaluation phase => through π (decision weight) and v (a function assigns x a number v(x)).

Editing Phase

1. Coding
   – coded as gains/losses w.r.t. reference point.
2. Combination
   – Prospects are simplified by combining same probabilities
   e.g. (200,0.25; 200,0.25) =>(200,0.5)
3. Segregation
   – Riskless component is segregated from risky components
   e.g. (300,0.8; 200,0.2) => (200, 1) + (100, 0.8)
   (-400, 0.4; -100, 0.6) => (-100,0.6) + (-300,0.4)

4. Cancellation
   – Discarding same components
   e.g. (200,0.2; 100,0.5;-50,0.3)
   vs.
   (200,0.2; 150,0.5;-100,0.3)

   => (100,0.5;-50,0.3) vs. (150,0.5; -100,0.3)

5. Simplification
   – Rounding probabilities or outcomes
   e.g. (101, 0.49) -> coded as (100, 0.5)

6. Detection of Dominance
   – Detect dominated alternatives and stop further investigation.,
   e.g. (500, 0.2; 101, 0.49) vs. (500, 0.15; 99,0.51)

<= Many anomalies come from editing process

Now back to Allais' Paradox.

	Urn i	Urn ii
A	61 red marbles $520,000	63 red marbles $500,000
B	98 red marbles $520,000	100 red marbles $500,000

Now, add 37 red marbles to A's Urns.

	Urn i	Urn ii
A	61+37 =98 red marbles $520,000	63+37=100 red marbles $500,000
B	98 red marbles $520,000	100 red marbles $500,000

- What is going on here???

=> Simplification of Gamble A
61 marbles $520,000
63 marbles $500,000
are simplified to "about 60 marbles" $520,000
"about 60 marbles" $500,000
<= One of the possible explanations.

=> Certainty Premium

Kahneman & Tversky's Insights into Risk Attitude

- Important Idea #1:
  People tend to risk averse for gains and risk seeking for losses.
- Even More Important Idea #2:
  These concepts, risk aversion and risk seeking, apply to gains and losses, not to states of wealth.

Reflection Effect - Example

Choice 1: Which would you prefer?
Option A: .80 chance to win $4,000.
Option B: 1.0 chance to win $3,000. ← *typical*

Choice 2: Which would you prefer?
Option A': .80 chance to lose $4,000. ← *typical*
Option B': 1.0 chance to lose $3,000.

Gambling for Gains

Gambling for Losses

Expected value of Choice 1, Option A = +$3,200
Expected value of Choice 2, Option A' = –$3,200

- This pattern of responses shows that people are risk averse for gains and risk seeking for losses.
  (This statement is generally true, but there are exceptions to it, to be discussed later.)

Reflection Effect – The Simple (Slightly False) Version

Reflection Effect: People are generally risk averse for gains and risk seeking for losses. (Not quite correct, but will be corrected shortly)

- Risk Averse for Gains: If all outcomes are zero or positive, people prefer sure things over gambles that have a slightly higher expected value.
  - Example: People prefer $3,000 for sure to an 80% chance of $4,000, otherwise $0.
- Risk Seeking for Losses: If all outcomes are zero or negative, people prefer a gamble over a sure loss that is somewhat higher than the expected value of the gamble.
  - Example: People prefer an 80% chance of -$4,000, otherwise $0, to -$3,000 for sure.

- Do you agree???

Reflection Effect (More Accurate Version) : the Fourfold Pattern

	Small Probabilities	Medium to Large Probabilities
Gains	Risk-Seeking	Risk Averse
Losses	Risk-Averse	Risk-Seeking

- Definition: The reflection effect is the finding that preferences switch from risk averse to risk seeking if we change the outcomes from gains or losses.
  - The direction of the change, from risk averse to risk seeking or from risk seeking to risk averse, depends on the size of the probabilities.

	Small Probabilities	Medium to Large Probabilities
Gains	Risk-Seeking (buy lottery tickets)	Risk Averse (playing gambles for gains)
Losses	Risk-Averse (buy insurance)	Risk-Seeking (playing gambles for losses)

Examples:

- People are risk seeking when they buy lottery tickets (small probability of large gain).
- People are risk averse when they buy car insurance (small probability of large loss).
- People are risk averse w.r.t. gambles with large probability. (Prefer $5,000 for sure over 50-50 chance of $10,010 or $0)
- People are risk seeking w.r.t. gambles with large probability. (Prefer 75% chance of –$1,000, otherwise $0 over lose –$700)

Example of small probabilities

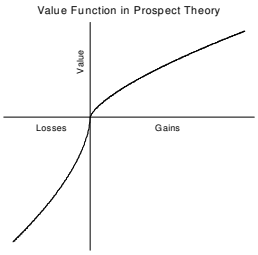
A: 0.1% chance to win $5,000 or 100% chance to win $5

Risk Seeking (lottery)

B: 0.1% chance to lose $5,000 or 100% chance to lose $5

Risk Averse (car insurance)

	Small Probabilities	Medium to Large Probabilities
Gains	Risk-Seeking	Risk Averse
Losses	Risk-Averse	Risk-Seeking

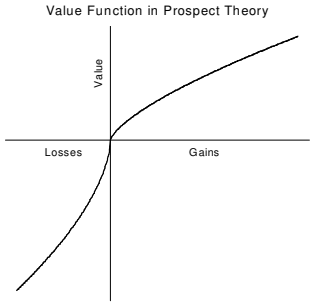


Loss Aversion

- people's tendency to strongly prefer avoiding losses to acquiring gains
- Endowment effect

=> How is this incorporated into the value function of Prospect Theory?

Loss Aversion



Results of Outcome Framing & Reflection Effect

Asian Disease Problem: 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.

Gain Frame (N = 152)	**Loss Frame** (N = 155)
If Program A is adopted, 200 people will be saved. 72%	If Program C is adopted 400 people will die. 22%
If Program B is adopted, there is 1/3 probability that 600 people will be saved, and 2/3 probability that no people will be saved. 28%	If Program D is adopted there is 1/3 probability that nobody will die, and 2/3 probability that 600 people will die. 78%
Which of the two programs would you favor?	Which of the two programs would you favor?

Framing Effects Due To Reflection & Gain/Loss Framing

- Prospect theory (PT) predicts that framing effects can occur when we change the problem description from gains to losses (without changing the objective problem) because ...

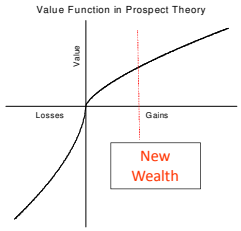
1) … people are risk averse for gains and risk seeking for losses.
2) … the psychological objects of values are changes with respect to a reference level rather than the objective outcomes.

- EU theory denies (2). Many EU theorists would also deny (1).

- What "reference level" is, really?

Adjustment of Reference Level – Redefinition of Gains & Losses

- What happens when you get richer?
  E.g., you finish school and get a job?
- Do you start becoming risk averse for small losses?
  - Example: Hopefully, 5 years from now you will be substantially richer. Will your risk attitude be determined by a shift to the right along the X-axis of the graph?



Updated Reference Point and Framing Effect

Assume yourself richer by $300 than you are today.
Now choose between (a) and (b):

- (a) A sure gain of $100. ← 72% prefer (a) in K&T experiment
- (b) A 50% chance to gain $200 and a 50% chance to gain nothing.

U(a) = U(current wealth + 300 + 100)
= **U(current wealth + 400)**

U(b) = (1/2)U(current wealth + 300 + 200) + (1/2)U(current wealth + 300 + 0)
= **(1/2)U(current wealth + 500) + (1/2)U(current wealth + 300)**

Assume yourself richer by $500 than you are today.
Now choose between (a') and (b'):

- (a') A sure loss of $100.
- (b') A 50% chance to lose nothing and a 50% chance to lose $200. ← 64% prefer (b') in K&T experiment

U(a') = U(current wealth + 500 – 100)
= **U(current wealth + 400)**

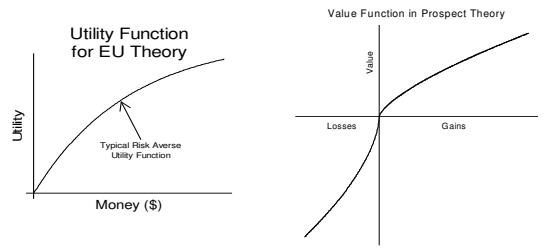
U(b') = (1/2)U(current wealth + 500 – 0) + (1/2)U(current wealth + 500 – 200)
= **(1/2)U(current wealth + 500) + (1/2)U(current wealth + 300)**

- U(a) = U(current wealth + 300 + 100)
  = **U(current wealth + 400)**
- U(b) = (1/2)U(current wealth + 300 + 200) + (1/2)U(current wealth + 300 + 0)
  = **(1/2)U(current wealth + 500) + (1/2)U(current wealth + 300)**

- U(a') = U(current wealth + 500 – 100)
  = **U(current wealth + 400)**
- U(b') = (1/2)U(current wealth + 500 – 0) + (1/2)U(current wealth + 500 – 200)
  = **(1/2)U(current wealth + 500) + (1/2)U(current wealth + 300)**

What Does the Preceding Example Show?

- Changing the initial wealth level from +$300 to +$500 changes the gamble outcomes from gains to apparent losses.
- We can rapidly adjust our reference level, so that what used to be gains are now losses.
- We tend to be risk averse for gambles that *look like gains*, and risk seeking for gambles that *look like losses*.



- EU theory – utility function does not identify the current (status quo) position.
- Prospect theory – status quo determines shift in shape of value function.

How Prospect Theory (PT) Differs From Expected Utility (EU) Theory

Expected Utility Theory	Prospect Theory
The basic objects of preference are states of wealth (including non-monetary resources like health).	The basic objects of preference are changes from a neutral reference point (gains and losses).
The utility function is risk averse (concave) everywhere. (Most theorists)	The value function is concave for gains, convex for losses.
Loss aversion cannot be defined (EU theory does not identify a reference point.)	The value function implies loss aversion.
People evaluate probabilities linearly.	People evaluate probabilities nonlinearly.
Problem description should have no effect as long as the problem is logically the same.	Problem description can change the reference level; hence the definition of gains & losses can change.
All outcomes are evaluated with respect to one big account.	People evaluate gains and losses with respect to mental accounts.

Some Questions

- What is “endowment effect”?
- What is a “reference point”?

[start here]Endowment Effect

- (Well-known) Experiments (among others)

1. Jack L. Knetsch “The Endowment Effect and Evidence of Nonreversible Indifference Curves” The American Economic Review, Vol. 79, No. 5 (1989)
2. Daniel Kahneman, Jack L. Knetsch, Richard H. Thaler “Experimental Tests of the Endowment Effect and the Coase Theorem”. Journal of Political Economy, Vol 98, No.6, pp. 1325-1348 (1990)
3. John A. List “Nonclassical Theory versus Prospect Theory: Evidence from the Marketplace” Econometrica, Vol 72, No.2 (2004)

Knetsch (1989)

- Group 1: endowed with **a coffee mug** => asked if he/she wants to trade the mug for a 400-gram Swiss chocolate bar.
- Group 2: endowed with **a 400-gram Swiss chocolate bar** => asked if he/she wants to trade the chocolate for a coffee mug
- Group 3: simply asked a choice between receiving a coffee mug or a chocolate. (Baseline preference)

Expectation?

1. Neoclassical theory suggests that the trading rate for the three cases will be almost close to each other. (Two goods are selected so).
2. If there is "Endowment Effect", then many of those who are endowed with a mug will keep the mug, many of those who are endowed with a chocolate bar will keep the mug. Group 3 will reveal the trading rate (preference) over the items.

Result

Group	Proportion Favoring (In Percent)		
	Mug Over Candy	Candy Over Mug	*N*
1. Give up mug to obtain candy	89	11	76
2. Give up candy to obtain mug	10	90	87
3. No initial entitlement	56	44	55

An evidence of "Endowment Effect".

Willingness to pay (WTP) vs. Willingness to accept (WTA)

- WTP is the maximum payment for acquiring the good.
- WTA is the minimum payment to be received for giving up the good.

Experiment 2 (WTP ⇔ WTA discrepancy)

Group 1: Endowed with two $1 bills. Asked the minimum number of candy bars they would require to give up their two dollars. (WTP)

=> How much do you value a candy bar?

Is one candy bar worth $2 for you? ($2 per bar)

Are two candy bars worth $2 for you? ($1 per bar)

Are two candy bars worth less than $2? (less than $1 per bar)

Group 2: Endowed with 2 candy bars. Asked the smallest number of dollars he/she would accept to give up the two candy bars. (WTA)

- The offer price will be determined by a random draw of one of the six cards with $0, $1, $2, $3, $4 and $5. If WTA ≤ Offer, you can sell, if WTA ≥ Offer, keep the candy bars.

e.g. WTA = $3 (you want at least $3 to be paid in order to give up the candy bars)

Offer = $4 => Trade candy bars for money

Offer = $2 => Will not trade.

- Expectations?
- Neoclassical theory suggests WTP = WTA

<= The % of group 1 participants who value $1 per candy bar and the % of group 2 participants who value $1 per candy bar are close to each other

- Endowment Effect suggest that those who endowed with candy bars will value the bars higher than those who endowed with money.

Group	Less than $1	Proportion of Individuals Valuing Candy Bar Equal to or More than: (In Percent) $1	$2
1. Give up Money to Get Candy Bars ($N = 39$)	77%	33	8
2. Give Up Candy Bars to Get Money ($N = 41$)	5%	95	37

- Group 1 (endowed with money) valued on average $0.90 for two candy bars.
- Group 2 (endowed with candy bars) valued on average $1.83 for two candy bars

WTP/WTA discrepancy

- Neoclassical theory suggests: differences between an individuals' maximum WTP for a good and minimum compensation demanded for the same entitlement (WTA) should be negligible.

⇒Indifference curves have no reference point to current endowments.

⇒Coase theorem: the allocation of resources will be *independent of the assignment of property rights* when costless trades are possible.

- Observed WTP ≠ WTA suggests the impact of reference point on preferences.

<= due to endowment effect (?)

- Endowment of a good shifts a reference point instantaneously.

⇒Connected to loss aversion

Kahneman, Knetsch and Thaler (1990)

On WTP/WTA discrepancies

Existing Evidences for WTP/WTP Discrepancies

SUMMARY OF PAST TESTS OF EVALUATION DISPARITY

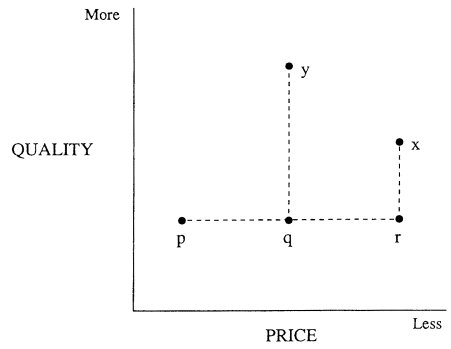
STUDY AND ENTITLEMENT	MEANS WTP	WTA	Ratio
Hypothetical surveys:			
Hammack and Brown (1974): marshes	$247	$1,044	4.2
Sinclair (1978): fishing			
Banford et al. (1979):			
Fishing pier	43	120	2.8
Postal service	22	93	4.2
Bishop and Heberlein (1979): goose hunting permits	21	101	4.8
Rowe et al. (1980): visibility	1.33	3.49	2.6
Brookshire et al. (1980): elk hunting*	54	143	2.6
Heberlein and Bishop (1985): deer hunting	31	513	16.5
Real exchange experiments:			
Knetsch and Sinden (1984): lottery tickets	1.28	5.18	4.0
Heberlein and Bishop (1985): deer hunting	25	172	6.9
Coursey et al. (1987): taste of sucrose octa-acetate†	3.45	4.71	1.4
Brookshire and Coursey (1987): park trees†‡	10.12	56.60	5.6

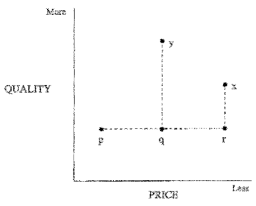
Reference-Dependence

Amos Tversky and Daniel Kahneman

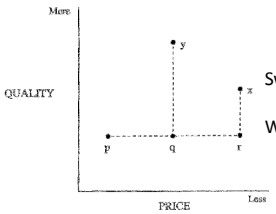
"Loss aversion in riskless choice: A reference-dependent model"

The Quarterly Journal of Economics, (1991)





- Suppose: from q (reference point), x and y are indifferent.
- y: same price, much better quality than q
- r: lower price, better quality than q (but less than y)
- In other words, price difference (q – r) is evaluated equivalently as the differences in quality.



Switch the reference point to "r".

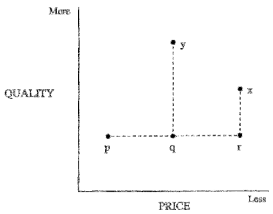
Which one, x or y is preferred???

=> From r to x, gain in quality

=> From r to y, loss in price advantage (increase in price), much more gain in quality

The loss (increase in price by r – q) is evaluated greater than the differences in quality, therefore x is preferred.

=> A shift of reference point can turn gains into losses and vice versa, it can give rise to reversals of preference.



Switch the reference point from "q" to "p"

Which one, x or y is preferred???

- The difference in the choice from q and p are the price increase (p – q). Because of **diminishing sensitivity of price**, advantage in price (decrease in price from p to r) is less valued compared to the differences in the quantity.
- y is preferred to x.

Reference point & Elasticity

Putler (1988)

- Analysis of demand incorporating an asymmetric effect of price increases and decreases.
- Estimation of demand elasticities of price increase and decrease (eggs).

=> expectation?

- Estimated price elasticity of demand
- - 1.10 for price increases
- -0.45 for price decreases

=> Price increases have a significantly greater impact on consumer decisions. (The effects are not symmetric!)

Reference Point

- What is a "reference point"?

(Gains and Losses from which point???)

- Status Quo?
- Expectations?
- Beliefs?

Botond Koszegi and Matthew Rabin (2006)
"A model of reference-dependent preferences"
The Quarterly Journal of Economics
121(4): 1133-65

- The reference point people use to compute gains and losses is <u>their expectations, or "beliefs…held in the recent past about outcomes.</u>"

Expectation about

1. Endowment in near future
2. Price (WTP, actual purchasing price, fluctuations of price)

could shift reference point.