Econ 211

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Prospect Theory

An Overview of Prospect Theory

- Prospect theory originally laid out by Kahneman and Tversky (1979)
  1. Reference dependence: decision value determined by reference point
  2. Loss aversion: losses loom larger than gains
  3. Diminishing sensitivity: risk averse over gains, risk seeking over losses
  4. Non-linear probability weighting
- We will talk about the first three pieces of the theory
- Probably the most well-known, well-cited contribution from behavioral economics

Motivating Example

- Consider the following two decision problems:
  - Problem 1: Win \$900 for certain OR 90% chance of winning \$1000
    - Which would you choose?
  - Problem 2: Lose \$900 for certain OR 90% chance of losing \$1000
    - Which would you choose?
- Most people:
  - Problem 1: (only gains are possible): choose the certain option
  - Problem 2: (only losses are possible) choose the risky option
- If you are risk-averse, what should you do?
  - Choose certain option in both problems

Motivating Example, cont

- Another pairing:
  - Problem 3: You have been given $1000. You are now asked to choose between these two options:
    - Option A: 50% chance of winning another $1000, 50% chance of no additional winnings
    - Option B: winning addition $500 for certain
  - Problem 4: You have been given $2000. You are now asked to choose between these two options:
    - Option A: 50% chance of losing $1000, 50% chance of losing nothing
    - Option B: losing $500 for certain
- Most people:
  - choose certain option in Problem 3
  - choose risky option in Problem 4
- According to expected utility theory, what should you choose?
  - According to EU, these are *exactly the same problem*
  - In both cases, total winnings are either $1500 for certain or coin flip for $1000 vs $2000
  - Key difference not captured by expected utility: your starting point of wealth before the gamble ($1000 vs $2000)

What is Reference Dependence?

- Reference dependence: when people evaluate alternatives by comparing them to a *reference point*
- Where could reference point come from?
  - Current wealth level
  - Aspirational wealth level
  - Expected outcome
  - Social comparison
- So which one is reference point?
  - Depends on context
  - Theory is still weak here: determination of reference point gives and extra *degree of freedom* to the model

Biological Roots of Reference Dependence

"Our perceptual apparatus is attuned to the evaluation of changes or differences rather than the the evaluation of absolute magnitudes... The past and present context of experience defines an adaptation level, or reference point, and stimuli are perceived in relation to this reference point." – Kahneman and Tversky (1979)

- Many perceptual systems in the brain evaluate *differences* rather than absolute values
  - For example, the visual system
  - Weber-Fechner law: The just-noticeable difference between two stimuli is proportional to the stimulus magnitude
  - Retinal cells respond to differences in light intensity

Reference-Dependent Utility

- Suppose consumption is evaluated relative to some reference point c^r
- Then utility of consumption c depends on c^r as well
- One useful formulation: utility depends on the *difference* between current consumption and reference level

$$u(c|c^r) = v(c - c^r)$$

- In general, more complex formulations are possible

Loss Aversion: Motivation

- Our motivating examples from earlier had another feature: "A salient characteristic of attitudes to changes in welfare is that **losses loom larger than gains**. The aggravation that one experiences in losing a sum of money appears to be greater than the pleasure associated with gaining the same amount." – Kahneman and Tversky (1979)
- People attach more of a utility change to an decrease in consumption relative to the reference point than to an increase in consumption of the same magnitude
- Biological basis: Different brain regions are used to value losses and gains

Loss Aversion is Not Risk Aversion

- *Thinking Fast and Slow* is a bit imprecise about this point
- Turning down a positive expected value lottery is completely consistent with having *risk*-averse expected utility preferences
  - Eg prefer not to take coin flip for +\$150 or -\$100
- What is *not* consistent with classic expected utility is for the *framing* of the problem (and hence the reference point) to affect the apparent risk aversion

Loss Aversion: Field Evidence

- Suppose you are a cab driver in New York City
- It is an extremely cold day, so you make more per hour because demand for cabs is very high
- Should you work longer or shorter hours than you usually do?
  - Classic economic theory says work longer hours
  - The price of your leisure time has gone up, so you should consume less leisure (ie work more)
- Data: cab drivers' hours are negatively correlated with hourly wages
  - That is, work long days when wages are low and go home early when wages are high
- One explanation:
  - Cab drivers have reference or target income for the day
  - Losses (ie not reaching income target) are very painful, so work longer on slow days to avoid missing target

Source: Camerer et al (1999)

Incorporating Loss Aversion into the Theory

- We want losses to hurt more than gains of the same magnitude feel good
- One way to get this feature
  - Recall $u(c|c^r) = v(c - c^r)$
  - Let $v(-x) = -\lambda v(x)$ for some $\lambda > 1$
  - So then

$$u(c|c^r) = \begin{cases} v(|c - c^r|) & c - c^r > 0 \\ -\lambda v(|c - c^r|) & c - c^r < 0 \end{cases}$$

Diminishing Sensitivity: Motivation

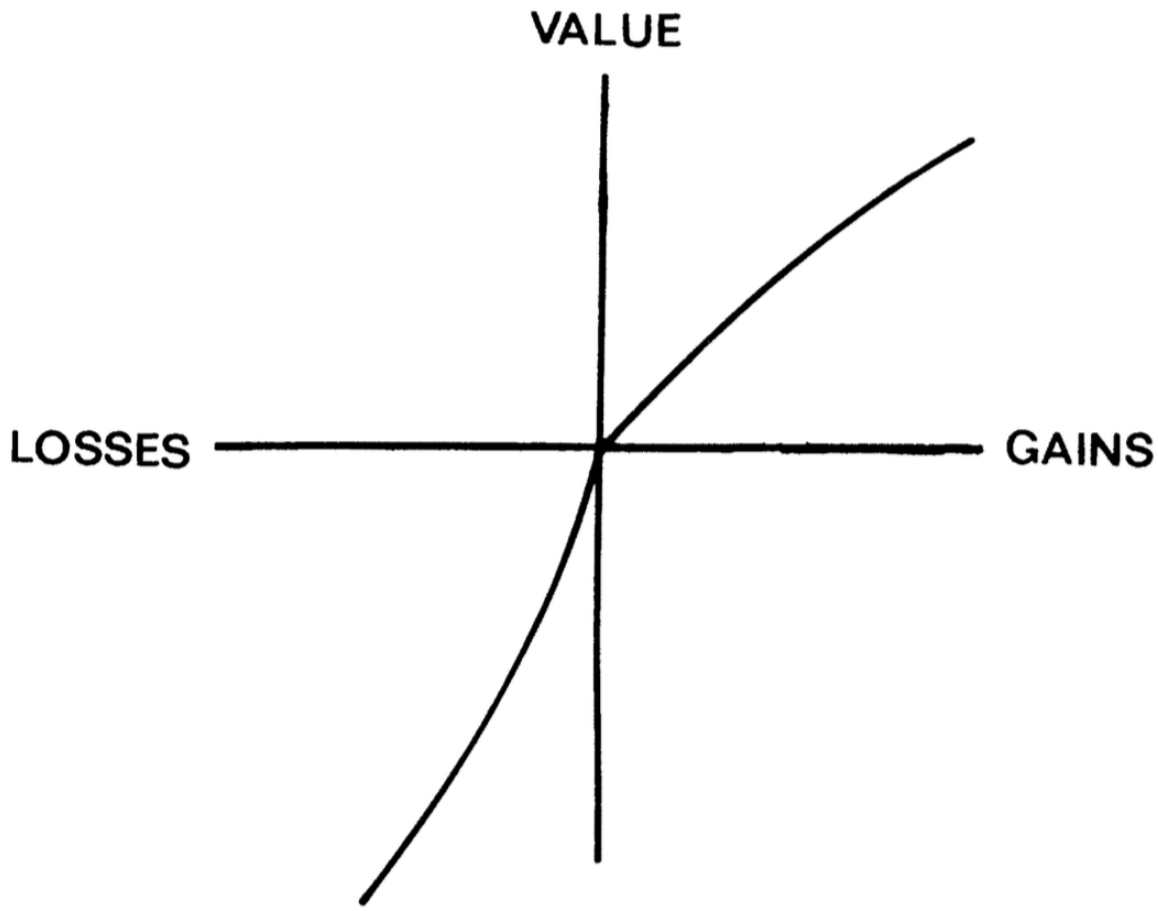
- In our examples of problem 1 and problem 2 earlier, we saw that people appear to be risk-seeking when they are in the loss domain (below the reference point)
- Psychological motivation: people become risk averse in loss domain to increase likelihood of getting back to reference point
- However, tend to be risk-averse when gains are involved
- We call the combination of these features *diminishing sensitivity* because the decreasing marginal impact of increasing a gain or loss farther from reference point
- Biological basis: Weber-Fechner law: The just-noticeable difference between two stimuli is proportional to the stimulus magnitude

Incorporating this into the Theory

- Recall that risk-averse preferences require $v(x)$ to be concave
  - Eg, $v(x) = x^{\alpha}$ for $\alpha \in [0, 1]$ when $x > 0$
- Conversely, risk-seeking preferences require $v(x)$ to be convex
  - Eg, $v(x) = x^{\alpha}$ for $\alpha > 1$ when $x > 0$
  - But when $x < 0$ we get convexity by $\alpha \in [0, 1]$
- Utility is then

$$u(c|c^r) = \begin{cases} (|c - c^r|)^{\alpha} & \text{if } c - c^r > 0 \\ -\lambda(|c - c^r|)^{\alpha} & \text{if } c - c^r < 0 \end{cases}$$

Prospect Theory in One Picture



Source: Kahneman and Tversky (1979)

Calcuation Example

- Calculate PT value like EU, but with new $u()$ function
- Consider problems 3 and 4 from earlier
- Let $\alpha = \frac{1}{2}$, $\lambda = 2$
- Problem 3:
  - Option A:

$$PT_A = \frac{1}{2}\sqrt{|2000 - 1000|} + \frac{1}{2}\sqrt{|1000 - 1000|} = 15.8$$

  - Option B:

$$PT_B = \sqrt{|1500 - 1000|} = 22.4$$

  - So will choose option B (certain option)

Calcuation Example, cont

- Problem 4:
  - Option A:

$$PT_A = \frac{1}{2}\sqrt{|2000 - 2000|} + \frac{1}{2}(-2)\sqrt{|1000 - 2000|} = -31.6$$

  - Option B:

$$PT_B = -2\sqrt{|1500 - 2000|} = -44.7$$

  - So will choose option A (risky option)

The Endowment Effect

Motivating Example

- Professor A likes to collect wine
- He will not pay more than $35 for a bottle
- Once he gets a bottle, he will not sell it for less than $100
- So, for a price between $35 and $100, will neither sell nor buy
- What is going on?
  - Once he obtains the bottle, its value goes up
  - This phenomenon is the *endowment effect*: owning an item changes its apparent value to the owner
  - Explanation: prospect theory
    - Before owning the bottle, reference point is not having it
    - Once he owns the bottle, having it becomes the reference point
    - Because of loss aversion, losing a bottle hurts more than gaining one feels good

The Classic Experiment

- Undergraduates participate sequentially in 11 markets for goods like pens and mugs
- Half of subjects randomly endowed with item
- Value of item for buyer and sellers gathered through price lists
  - Buyers express *willingness to pay* (WTP) for items
  - Sellers express *willingness to accept* (WTA) to give up items
- Items transacted at market prices (not random price as we did)

Source: Kahneman, Knetsch, and Thaler (1991)

Results

- What relationship should we expect between WTP and WTA?
  - Items were distributed randomly, ie independent of student's actual value of item
  - So average value among sellers should be same as average value among buyers in expectation
  - That is, we expect WTP=WTA
- Results
  - Median WTA (seller stated price) 2-3 times higher than median WTP (buyer stated price)
  - Interpretation: Sellers' stated price is higher because they are endowed with the items, and this increases their value
  - We call this the *willingness to pay vs willingness to accept gap*

Source: Kahneman, Knetsch, and Thaler (1991)

When Does the Endowment Effect Occur?

- List (2003): Traders
  - Inexperienced traders demonstrate endowment effect
  - Experienced traders do not, even with goods they don't trade regularly
- Bertrain, Mullainathan, and Shafir (2004): The poor
  - Poor individuals are essentially always below their reference point
  - Thus, even though they have prospect theory preferences, they never demonstrate loss aversion because they are always in the loss domain