Choice and Risk

ADEC781001: Empirical Behavioral Economics

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Outline

St Petersburg Paradox

- Bernoulli (1738): Peter proposes a game to Paul
  - Peter flips a coin until it lands heads
  - Paul gets 2^k ducats if heads is observed on the k_{th} toss
- How much should Peter sell this game for?
  - expected payoffs to Paul: $\mathbb{E}[\pi] = \frac{1}{2}2 + \frac{1}{4}4 + \cdots + \frac{1}{8}8 + \cdots = \sum_{k=1} \frac{1}{2^k}2^k = \infty$
  - Bernoulli: Peter realistically does not require ∞ ducats to sell
  - Insight: diminishing marginal utility of money
    - people care about expected utility of an outcome, not the expected outcome

Expected Utility

Prospects

- Prospect: set of outcomes and their probabilities
  - $A = (p_1, x_1; p_2, x_2; \ldots; p_n, x_n)$

Table 3.1 The possible consequences of Alan buying insurance

	Car is stolen	*Car is in an accident*	*Stopped by police*	*No theft, accident, or police.*
Probability	0.05	0.05	0.10	0.80
Final wealth if buys full insurance	\$61	\$61	\$61	\$61
Insurance against theft	\$64	\$14	\$64	\$64
No insurance	\$20	\$20	\$30	\$70

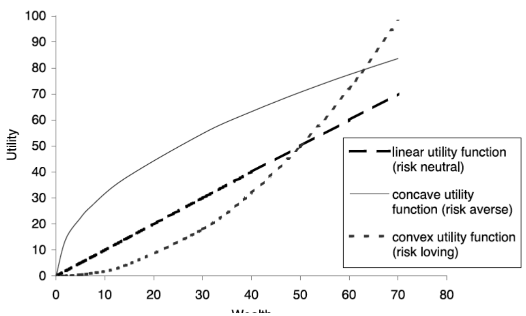
Excepted value vs expected utility

- Expected value is just the sum of the outcomes weighted by their probabilities
  - $\mathbb{E}[A_j] = \sum_{i=1}^{n} p_{ji} x_{ji}$
  - e.g. $\mathbb{E}[A_3] = (0.05)(20) + (0.05)(20) + (0.10)(30) + (0.80)(70) = 61$
- Expected utility is the sum of the *utility* of the outcomes weighted by their probabilities
  - $\mathbb{E}[A_j] = \sum_{i=1}^{n} p_{ji} u(x_{ji})$
  - The *curvature* of $u(x)$ is going to matter

Curvature of the utility function

Table 3.2 Alan's expected utility depends on his utility function

Utility function	*Expected utility if chose*			*Predicted choice*
	full insurance	*insurance for theft*	*no insurance*	
Linear: u(x) = x	61.0	61.5	61.0	insurance for theft
Concave: u(x) = $10\sqrt{x}$	78.1	77.9	76.9	full insurance
Convex: u(x) = $x^2/50$	74.4	78.0	81.0	no insurance



People vs expected utility

- In the standard model we assume people are risk neutral
  - Implication: their *expected utility* over a prospect is the same as the *expected value*
  - The only information that matters is the probability distribution
- Loads of evidence that people are in fact risk averse (concave utility function)
  - e.g. people tend to put too much money in savings accounts (low but guaranteed interest) rather than investments (risky interest)
  - e.g. people who believe vaccines cause autism (they don't)
  - other examples?

The Allais Paradox

Table 3.4 The Allais Paradox. Many people prefer B to A and C to D

Prospect	*Amount with probability of outcome*		
A	\$2,500 with probability 0.33	\$2,400 prob. 0.66	\$0 prob. 0.01
B	\$2,400 for sure.		
C	\$2,500 with probability 0.33		\$0 with probability 0.67
D	\$2,400 with probability 0.34		\$0 with probability 0.66

The Allais Paradox

- If people prefer B to A this implies $u(2400) > 0.33u(2500) + 0.66u(2400)$
- Note that $C \equiv A - 0.66u(2400)$ and $D \equiv B - 0.66u(2400)$
  - Implication: we should see choices such that $D > C$
  - Instead we see $C > D$
- What is going on?
  - certainty effect: changing a sure thing to a risk matters more than changing a risk to a risk
  - D went from sure thing to risky
  - Another example where context matters
  - What information *might* people take from this?

Consequences of Allais Paradox

- The standard model assumes preferences are transitive and independent
  - Consider three prospects X, Y, Z
  - **Transitive**: if $X \geq Y$ and $Y \geq Z$ then $X \geq Z$
  - **Independent**: if $X \geq Y$ then $(p, X; 1-p, Z) \geq (p, Y; 1-p, Z)$, $p \in [0, 1]$
    - Meaning: if X is preferred to Y, then a new prospect that mixes X and Z must be preferred to another new prospect that mixes Y and Z.
- Allais Paradox example where *independence* is not satisfied
  - Certainty effect a consequence of fanning out: people are more risk averse the closer they get to being guaranteed \$2,400 or more
  - Bigger picture: people perceive the same probabilities differently depending on context

Prospect Theory

Rank dependent expected utility

- How people perceive probabilities matters
  - People tend to overweight small probabilities
  - People tend to underweight large probabilities
- Need to a function that weights probabilities accordingly
  - $\pi(p) = \frac{p^\gamma}{p^\gamma + (1-p)^{\frac{1}{\gamma}}}, \gamma \in [0,1]$
    - $\gamma = 1$: no weighting of p
    - $\gamma < 1$: overweight small probabilities, underweight large probabilities
- rank dependent expected utility: rank outcomes from best to worst
  - then $U(X) = \sum_{i=1}^n w_i u(x_i)$ where $w_i = \pi(p_i + \cdots + p_n) - \pi(p_{i+1} + \cdots + p_n)$
    - $\pi(p_i + \cdots + p_n)$: weighted probability of getting outcome equal to or better than i
    - $\pi(p_{i+1} + \cdots + p_n)$: weighted probability of getting an outcome better than i

Prospect theory

- The work of KT and others on choice under risk became know as prospect theory
  - organizes findings on loss aversion and probability perception into one framework
  - extends rank dependent utility
- Two main components
  1. a value function that kinks at a reference point (status quo wealth)
  2. a function that weights probabilities

Prospect theory
Value function

$$u(x) = \begin{cases} u_+(x) = (x-r)^\alpha & \text{if } x \geq r \\ u_-(x) = -\lambda(r-x)^\beta & \text{if } x < r \end{cases}$$

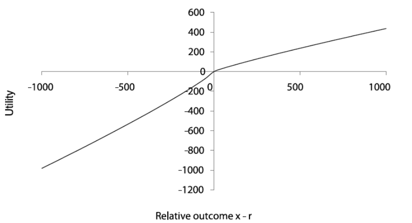
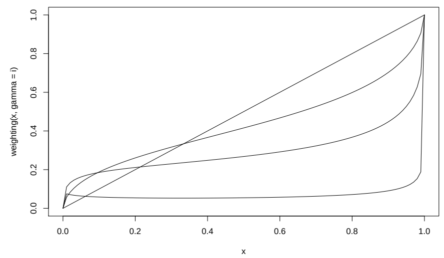


Figure 3.10 A prospect theory utility function for money with parameters $\lambda = 2.25$, α, $\beta = 0.88$, $\gamma = 0.61$ and $\delta = 0.69$.

- Diminishing sensitivity: differences harder to distinguish as you move away from reference point
  - implies risk aversion over prospects where all outcomes are in the gain domain
  - implies risk-seeking over prospects where all outcomes are in the loss domain
  - loss aversion only relevant when considering prospects with outcomes in both domains

Prospect theory
Weighting function

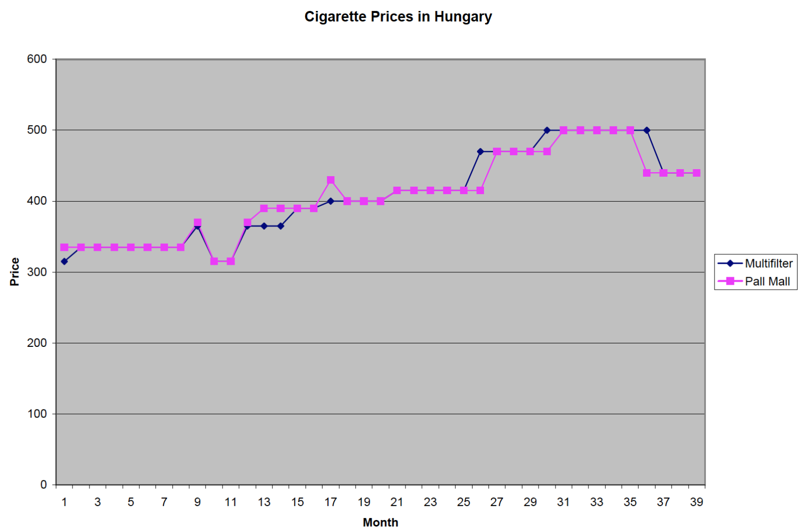
- $\pi^G(p) = \frac{p^\gamma}{p^\gamma + (1-p)^{\frac{1}{\gamma}}}$
- $\pi^L(p) = \frac{p^\delta}{p^\delta + (1-p)^{\frac{1}{\delta}}}$
- KT (1992): $\gamma = 0.61, \delta = 0.69$



Application: Aversion to small/medium risk

- Kahneman and Tversky (1979) find subjects can in fact be *risk-loving* (or *risk-seeking*) in the loss domain (i.e. when all outcomes involve losses)
- Many people are averse to small risks relative to lifetime wealth/liquidity constraints (i.e. the reference point is current/future income)
- Consider the following lottery: 50-50 chance at winning \$550 or losing \$500
  - Would you like to play?
  - Barberis, Huang and Thaler (2006): 71% of MBA students, financial analysts and very rich investors say no.
    - "People should be less risk averse over prospects for small amounts of money if they are already exposed to risk."
- Sydnor (2010): calculates how homeowners choosing lower deductibles would have done with a \$1,000 deductible.
  - people tradeoff premiums (paid each month) and deductibles (paid when a claim is made)
  - why do people pay more in premiums to lower their deductibles?
  - "no loss in buying": buying something is perceived as a foregone gain rather than a loss (means spending extra on insurance is not a perceived as a loss)
  - $\gamma = 0.61$: 4 percent claim rate perceived as 12 percent (overestimating the probability of making a claim)

Application: Firm pricing
Heidhues and Koszegi (2008)



Application: Firm pricing
Heidhues and Koszegi (2008)

- Prices in imperfectly competitive markets change less than we expect from the standard model (i.e. prices are sticky)
- Prices are also focal: firms set same price as competitor
- Explanation: consumers are loss averse
  - "Because consumers are especially averse to paying a price when it exceeds their expectation of the purchase price, the price responsiveness of demand - and hence the intensity of competition - is greater at higher than at lower market prices, reducing or eliminating price variation."

Application: Disposition effect
Odean (1998)

- Data on 10,000 customer accounts at a nationwide discount brokerage house
- Constructs a measure of how often investors realize losses and gains relative to their opportunities to do so
  - on any sale date count the number of "loser" and "winner stocks"
  - of these, count the "realized losses" and "realized gains"
    - Proportion of losers realized: # of realized losses / # of total losers
    - Proportion of gains realized: # of realized gains / # of total winners
- Disposition effect: investors tend to hold on to losers and sell winners
  - investor's valuation of stock is reference-dependent (reference point: purchase price)
  - pleasant to sell a winner and unpleasant to sell a loser
  - and due to diminishing sensitivity, individuals are willing to take more risks with losing stocks than with winning stocks

Reference points

Candidates for reference points

- **Status quo** (i.e. the endowment), common assumption in prospect theory
  - extension: *lagged* consumption or endowment
- **Social preferences**: compare other people's outcomes to yours
- **Goals or aspirations**: less tangible but could also serve as reference points (though less evidence of this)
- New idea: **expectations**

Expectations

Abeler et al (2011)

- Experiment: students perform a boring task for piecerate, working as long as they want
- When they stop they flip a coin:
  - Heads: receive what they earned
  - Tails: receive a fixed wage €3 or €7
- Prediction: should work as much as possible in hopes of earning above fixed wage
- Finding: most subjects stop working once they reach fixed wage
- Interpretation: the fixed wage becomes their reference point since it forms their expectation about how much they will get paid
  - so reference point is not status quo
  - if earnings were determined by piecerate, and reference point is fixed wage, then earnings below fixed wage feel like a loss

Expectations

Endowment Effect revisited

- List (2003): experienced traders show less endowment effect than inexperienced traders
- Apicella et al. (2014): hunter-gatherer tribes exposed to markets less likely to show endowment effect
- Plott and Zeiler (2004,2007): inexperienced traders more likely to trade if they are repeatedly told they can trade their endowment object
- Interpretation: experience traders *expect* to trade acquired or endowed goods, while inexperienced traders *expect* to trade if they primed to trade

Expectations
Taxi drivers revisited

- Evidence of income targeting, but also countervailing evidence
  - Oettinger (1999): stadium vendors are more likely to go to work for games that attract many fans
  - Farber (2005,2008): weak evidence for income targeting, strong evidence for effort targeting
- Expectations:
  - if wage increase expected, worker sets higher income target and thus works longer (so labor supply positively responds to wage increase)
  - if target is already set and there is a surprise wage increase, worker reaches target faster (so labor supply negatively responds to wage increase)

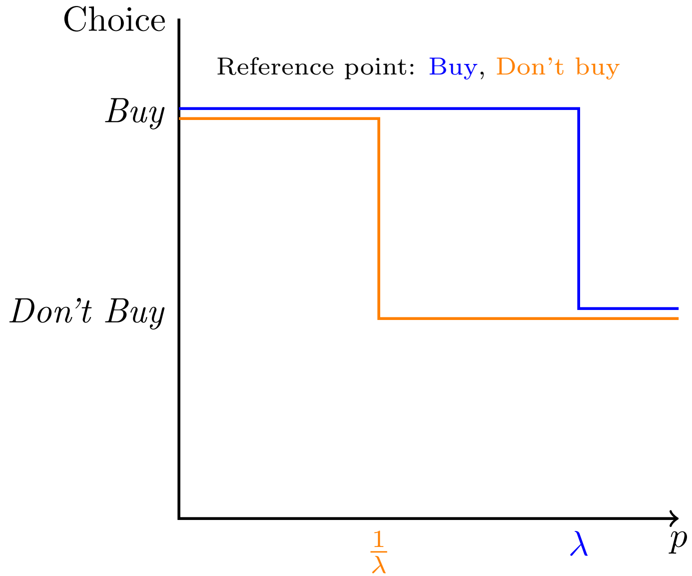
Expectations
Koszegi and Rabin (2006,2007,2009)

- Where do expectations come from?
- Koszegi and Rabin: recent expectations are the reference points for evaluating outcomes
  - scope for status quo (expectations may not change dramatically over time) and social preferences
- Assume expectations are consistent with rationality
  - Feedback loop: beliefs → preferences → behavior → beliefs
  - Leads to Preferred Personal Equilibrium: optional choice depends on what agent *expected* to choose

Expectations
Example of personal equilibrium

- Suppose you have linear utility with loss aversion
  - utility of gains is x
  - utility of losses is $-\lambda x, \lambda > 1$
- Suppose there is some good x for price p such that $u(x) = 1$
- Suppose reference point is a) buy x or b) don't buy x
  - **1.** buy x:
    - utility from buying: 0 (because you expect to buy it - you *already have* x and $u(x) = 1$)
    - utility from not buying: $p - \lambda x$
    - buy if $p - \lambda x < 0 \implies p < \lambda$
  - **2.** don't buy x
    - utility from not buying: 0
    - utility from buying: $1 - p\lambda x$
    - buy if $1 - p\lambda < 0 \implies p < \frac{1}{\lambda}$

Expectations
Example of personal equilibrium illustrated



Expectations and Risk
Koszegi and Rabin (2007)

- Recall KT (1979) find subjects are risk-loving in the loss domain
- Disposition effect another example of risk-loving in loss domain
- Buy consumers very risk averse in loss domain when buying small-scale insurance or choosing low deductibles on existing insurance
- How can expectations resolve this?
  - if a possible loss is a surprise, the reference point is above possible outcomes, and loss aversion does not play a role in evaluating the risk
  - If the possibility is expected, the reference point is lower, and loss aversion dominates the evaluation of the risk

Extensions: narrow versus broad bracketing (framing)

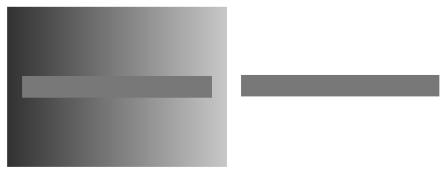
- Endowment effect: WTA > WTP
- Suppose you offer the the owner of a mug two choices: a) sell the mug for $6, then b) buy an identical mug for $4
  - narrow framing: she considers each offer separately (likely to reject)
  - broad framing: considers offers jointly (likely to accept, since it amounts to her keeping the mug and earning $2)
  - implication: how broad or narrow you bracket matters if you have reference-dependent utility
    - when mental accounting it is important to “think outside the account” (e.g. considering new risks in light of existing risks)
    - Prospect Theory originally had two stages: evaluation and editing. In editing, agent organizes prospects in a way that makes sense to them and codes outcomes as gains or losses.
    - Implication: how you present prospects to an individual will influence how they edit and evaluate them (could explain why we sometimes see preference reversals)
- Another example of bracketing: equity premium puzzle (bracketing: short versus long evaluation period)
- Webb and Shu (2017): broad bracketing leads to better risk preferences among subjects

Extensions: true loss aversion or mistake?

- Projection bias: project current preferences onto your future self
  - Read and van Leeuwen (1998): people project their current appetite onto their future appetite (if I’m hungry now, I’ll be hungry later)
- We may under-appreciate how changes in reference points impact our utility and thus temporarily overreact to gains and losses
  - if you currently have a mug, giving it up will feel like a loss - but you get over it quickly
  - projection bias means you under-appreciate how fast this loss will dissipate

Reference dependence: final remarks

- Contrast is a key part of human cognition, and contrast requires a reference point



- We have seen that both outcomes and utility of outcomes in economic decisions are sensitive to reference points
- Can reference points be manipulated? How can this be exploited in policy design?