Psychology and Economics

14.13 Lectures 7 and 8: Risk Preferences[1]

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[1] Some slides are based on notes by Tomasz Strzalecki. I would like to thank him, without implicating him in any way, for sharing his materials with me.

Some logistics

- Pset 2 will be posted later this week.
  - Reminder: late submissions will NOT be accepted!
- Will post previous psets, midterms, and finals for you to practice
- Ask (and answer!) questions on the forum.

Plan

(1) Risk aversion

(2) Expected utility

(3) Absurd implications

(4) Small vs. large-scale risk aversion

What kinds of decisions involve risk/uncertainty?

- Many decisions involve options with varying amounts of risk and uncertainty
  - Going to college
  - Health decisions
  - Financial investments
  - Studying for exams
  - Dating
  - Riding a bicycle
  - ...

- Some choices and decisions can reduce and mitigate risk
  - Buying insurance
  - Wearing a helmet
  - Avoiding dangerous areas
  - ...

Risk aversion

- What is risk aversion?
  - Reluctance of a person to accept an option with an uncertain payoff rather than another option with a more certain, possibly lower expected payoff.
- Why are people risk-averse?
  - Risk makes contingent planning harder.
  - People are worried and stressed about risk und uncertainty.
  - People feel regret over missed opportunities.
  - People are disappointed if they don't achieve expectations.
  - **Diminishing marginal utility of wealth**
  - ...

Stylized fact 1: People are risk-averse.

- People buy insurance.
  - Insurance industry exists to help people reduce (or diversify) risk.
- Social security
- Various other institutions
  - Extended families
  - Sharecropping
  - Informal insurance
  - ...

Stylized fact 2: Risk reduction has its price.

- People are willing to take on risks if the return is high enough.
  - Not everybody buys the safest car in the world.
  - Restaurants face significant risk, yet people keep opening then.
  - People put money into index funds or even riskier assets.
- One role of the finance industry: risk intermediation
  - Offload some risk from businesses to investors
  - Investors accept some risk for a good return.
- People often face trade-offs between risk and (expected) reward

Stylized fact 3: People are also willing to take on some risks.

- People are not risk-averse in all situations.
  - People play lotteries.
  - Casino gambling
  - Sports betting

Expected monetary value (EMV) vs. expected utility (EU)

- Expected utility theory: Workhorse model for studying behavior under risk
    - Helps us understand many important real-world economic choices
    - Risk aversion is modeled via diminishing marginal utility
- Consider a gamble G over two states of the world.
    - State 1 occurs with probability p and yields (monetary) payoff x.
    - State 2 occurs with probability $1 - p$ and yields (monetary) payoff y.
- What is the **expected monetary value (EMV)** of this gamble?
    - $\text{EMV}(\mathbf{p}, \mathbf{x}) = \sum_i^N p_i x_i = px + (1 - p)y$
    - A fair gamble is one with a price equal to its expected (monetary) value.
- What is the **expected utility (EU)** of this gamble?
    - $\text{EU}(\mathbf{p}, \mathbf{x}) = \sum_i^N p_i u(x_i) = pu(x) + (1 - p)u(y)$
    - Evaluating gambles using EU gives the same answer as using EMV if $u(\cdot)$ is linear.

Expected monetary value (EMV) and risk aversion

- EMV: first model of how rational people *should* behave.
  - $U(G) = \text{EMV}(G)$ is not descriptively accurate.
  - People are risk-averse in most situations

- We now use $\text{EMV}(G)$ to define risk neutrality.
  - A decision-maker is **risk-neutral** if, for any lottery G she is indifferent between G and getting the $\text{EMV}(G)$ for sure.
  - The decision-maker is risk-neutral if $u(\cdot)$ is linear.

- Risk aversion
  - A decision-maker is **risk-averse** if, for any lottery G, she prefers getting $\text{EMV}(G)$ for sure, rather than taking G.
  - A decision-maker is **risk-loving** if, for any lottery G, she prefers it to getting the $\text{EMV}(G)$ for sure.

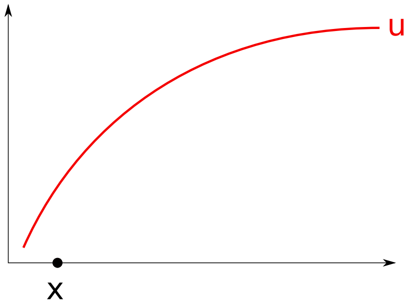
Expected utility theory: example

- A person with wealth \$10,000 is offered a gamble:
  - Gain \$500 with 50% chance, lose \$400 with 50% chance
  - Will she accept the gamble?

- Expected monetary value (EMV):
  - $\text{EMV(accept lottery)} = 0.5 \cdot 9,600 + 0.5 \cdot 10,500 = 10,050$
  - $\text{EMV(reject lottery)} = 10,000$
  - A risk-neutral decision-maker will accept the gamble (irrespective of initial wealth).

- Expected utility (EU):
  - $\text{EU(accept lottery)} = 0.5 \cdot u(9,600) + 0.5 \cdot u(10,500)$
  - $\text{EU(reject lottery)} = u(10,000)$
  - Will an expected-utility maximizer accept the gamble? Depends on concavity of $u(\cdot)$

Concavity of $u(\cdot)$

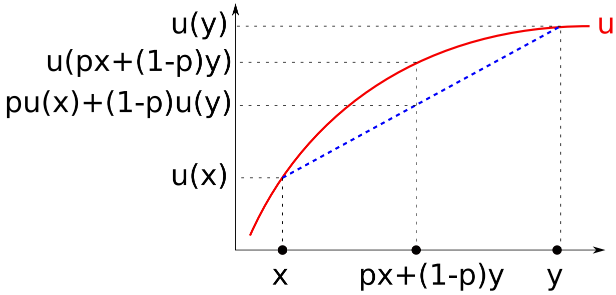


- $u(\cdot)$ is concave. For any x, y, and any $p \in (0,1)$,

$$u(px + (1-p)y) \geq pu(x) + (1-p)u(y).$$

- Implies $u''(\cdot) < 0$ if $u(\cdot)$ twice differentiable.

Concavity of $u(\cdot)$



- $u(\cdot)$ is concave. For any x, y, and any $p \in (0, 1)$,

$$u(px + (1-p)y) \geq pu(x) + (1-p)u(y).$$

- Implies $u''(\cdot) < 0$ if $u(\cdot)$ twice differentiable.

- x is associated with utility $u(x)$.
  y is associated with utility $u(y)$.
- $px + (1-p)y$ is a convex combination of x and y.
- $u(px + (1-p)y$ is the utility associated with this convex combination.
- $pu(x) + (1-p)u(y)$ is the weighted average of utilities associated with x and y.
- The utility of the average is higher than the average of the utilities.

Do only final outcomes matter?

Due to copyright restrictions, OCW cannot include the video "Why most people refuse to sell their lottery tickets for twice what they paid." *Business Insider*. You can view the video here.

Expected utility theory: summary

- Many important economic choices involve risk.
- People are risk-averse in many contexts.
- Expected utility theory
  - Main workhorse economic model for studying risk
  - Weighted average of utilities from final outcomes matters.
  - Risk aversion due to concavity of utility function

How do we measure risk aversion? Two main measures

- Absolute risk aversion: $r = -\frac{u''(x)}{u'(x)}$
    - Why do we divide by $u'(x)$?
    - What happens to r if we multiply $u(x)$ by a constant a?
- Relative risk aversion: $\gamma = -\frac{xu''(x)}{u'(x)}$
    - $\gamma = x \cdot r$
    - γ is the elasticity of the slope of $u(x)$: $\gamma = \frac{\partial u'(x)}{\partial x}\frac{x}{u'(x)}$
    - People with constant relative risk aversion invest a constant share of their wealth in risky assets, regardless of their level of wealth.

Commonly used utility functions in economics

- Constant absolute risk aversion (CARA)

$$u(x) = -\frac{e^{-rx}}{r}$$

where r is the coefficient of absolute risk aversion: $r = -\frac{u''(x)}{u'(x)}$

- Constant relative risk aversion (CRRA)

$$u(x) = \frac{x^{1-\gamma}}{1-\gamma}$$

where γ is the coefficient of relative risk aversion: $\gamma = -\frac{xu''(x)}{u'(x)}$

- We will focus on CRRA functions, which are most commonly used in economics.

How can we estimate γ?

- Suppose you have a CRRA utility function:

$$u(x) = \begin{cases} \frac{x^{1-\gamma}}{1-\gamma} & \text{for } \gamma \neq 1, \\ \ln x & \text{for } \gamma = 1 \end{cases}$$

- Three approaches to estimate γ:
  (1) Certainty equivalents
  (2) Choices from gambles
  (3) Insurance choices

Estimating γ using choices from using certainty equivalents

- Thought experiment
  - Suppose your wealth equals either \$50,000 or \$100,000 each with probability 50%.
  - Your expected wealth is $\mathbb{E}[W] = \$75,000$.
  - What guaranteed amount (certainty equivalent) W_{CE} do you find equally desirable?
- Backing out γ for different values of W_{CE}:

$$\begin{aligned} u(W_{CE}) &= \frac{1}{2} \cdot u(50,000) + \frac{1}{2} \cdot u(100,000) \\ \Rightarrow \frac{W_{CE}^{1-\gamma}}{1-\gamma} &= \frac{1}{2} \cdot \frac{50,000^{1-\gamma}}{1-\gamma} + \frac{1}{2} \cdot \frac{100,000^{1-\gamma}}{1-\gamma} \end{aligned}$$

Implied values offor dierent values of W

Value of γ	1	2	5	10	30
Value of W_{CE}	70,711	66,667	58,566	53,991	51,209

- What kinds of insurance purchases do large values of γ imply?
  - If $\gamma = 30$, you would probably not even leave your house!
  - Economists often assume $\gamma \in (0, 2)$ in many applications, based on observed behavior involving large-scale choices, e.g. Chetty (2006).
- Broader lesson: Choices involving large-scale risks suggest that γ can't be 'too large'.

How can we estimate γ?

- Suppose you have a CRRA utility function:

$$u(x) = \begin{cases} \frac{x^{1-\gamma}}{1-\gamma} & \text{for } \gamma \neq 1, \\ \ln x & \text{for } \gamma = 1 \end{cases}$$

- Three approaches to estimate γ:
  (1) Certainty equivalents
  (2) Choices from gambles
  (3) Insurance choices

Estimating γ using choices from small-scale gambles

- Who would accept a 50-50 bet to win \$11 vs. lose \$10? What about a bet to win \$110 vs. lose \$100?
  - If you turned down the bet, what can we learn about your γ?
  - What else do we need to know? Your utility function and your wealth level w.

- Suppose you have wealth of \$20,000, and you turn down a 50-50 bet to win \$110 vs. lose \$100. What can we learn about your γ?

$$u(20,000) > \frac{1}{2} \cdot u(20,000 + 110) + \frac{1}{2} \cdot u(20,000 - 100)$$
$$\Rightarrow \frac{(20,000)^{1-\gamma}}{1-\gamma} > \frac{1}{2} \frac{(20,110)^{1-\gamma}}{1-\gamma} + \frac{1}{2} \frac{(19,900)^{1-\gamma}}{1-\gamma}$$

  - Can show that rejecting the bet implies $\gamma > 18.2$.
  - Implies ridiculous behavior for larger-scale gambles.

Rabin (2000): absurd implications

- Main line of argument
  - People often turn down small-scale gambles with positive expected value.
  - The expected utility model explains such behavior with curvature (concavity) of the utility function.
  - Curvature over small stakes implies implausible risk aversion at large stakes.
  - Reason: Marginal utility of money must decrease extremely rapidly.
- Argument requires no assumption about utility function except concavity
- Rabin and Thaler (2001) describe simplified version of this reasoning.

Rabin (2000): example

- Johnny is a 'risk-averse' EU maximizer, i.e. assume $u''(\cdot) \leq 0$.
- He turns down a 50-50 gamble of losing \$10 or gaining \$11 for any level of wealth.
- What is the biggest Y such that we *know* Johnny will turn down a 50-50 lose \$100/win \$$Y$ bet?
  (a) \$110
  (b) \$221
  (c) $\$2,000$
  (d) $\$20,242$
  (e) \$1.1 million
  (f) \$2.5 billion
  (g) Johnny will reject the bet no matter what Y is.
  (h) Johnny will reject the bet no matter what Y is. Whoa!!!
  (i) We can't say without knowing more about $u(\cdot)$.

What is going on?

- Johnny's choice implies:

$$0.5u(w+11)+0.5u(w-10)<u(w)$$
$$\Rightarrow u(w+11)-u(w)<u(w)-u(w-10)$$

- On average, Johnny values each dollar between w and $w+11$ by at most $\frac{10}{11}$ as much as the dollars between $w-10$ and w.
- Diminishing marginal utility (concavity) implies that the marginal dollar at $w-10$ is at least as valuable as the marginal dollar at w.
- Similarly, the marginal dollar at w is at least as valuable as the marginal dollar at $w+11$
- Taken together, this implies that Johnny values the dollar $w+11$ by at most $\frac{10}{11}$ as much as he values the dollar $w-10$.

What is going on? (cont'd)

- Johnny makes the same choice when he is \$21 richer:

$$0.5u(w+21+11)+0.5u(w+21-10)<u(w+21)$$
$$\Rightarrow u(w+32)-u(w+21)<u(w+21)-u(w+11)$$

- On average, he values each dollar between $w+21$ and $w+32$ by at most $\frac{10}{11}$ as much as the dollars between $w+11$ and $w+21$.

- Concavity implies that Johnny value the dollar $w+32$ by at most $\frac{10}{11}$ as much as he values the dollar $w+11$.

- Hence he values the dollar $w+32$ by at most $(\frac{10}{11})^2 \approx \frac{5}{6}$ as much as he values the dollar $w-10$.

Iterating this forward gives absurd implications!

- Rejecting the 50-50 lose \$10/gain \$11 gamble implies a 10 percent decline in marginal utility for each \$21 in additional lifetime wealth.
  - \$42 richer: $(10/11)^2 \approx 5/6$
  - \$420 richer: $(10/11)^{20} \approx 3/20$
  - \$840 richer: $(10/11)^{80} \approx 2/100$
  - ...
- Marginal utility plummets for substantial changes in lifetime wealth.
- You care less than 2% as about an additional dollar when you are \$900 wealthier than you are now.

Absurd implications!

Table 1

The Necessary, Implausible Consequences of Risk Aversion at Low Levels of Wealth

If an Expected Utility Maximizer Always Turns Down the 50/50 bet . . .	*Then She Always Turns Down the 50/50 Bet . . .*
lose \$10/gain \$10.10	lose \$1,000/gain \$∞
lose \$10/gain \$11	lose \$100/gain \$∞
lose \$100/gain \$101	lose \$10,000/gain \$∞
lose \$100/gain \$105	lose \$2,000/gain \$∞
lose \$100/gain \$110	lose \$1,000/gain \$∞
lose \$1,000/gain \$1,010	lose \$100,000/gain \$∞
lose \$1,000/gain \$1,050	lose \$20,000/gain \$∞
lose \$1,000/gain \$1,100	lose \$10,000/gain \$∞
lose \$1,000/gain \$1,250	lose \$6,000/gain \$∞
lose \$10,000/gain \$11,000	lose \$100,000/gain \$∞
lose \$10,000/gain \$12,500	lose \$60,000/gain \$∞

Measuring risk aversion: preliminary summary

- Expected utility is the workhorse model for studying economic behavior under risk.
  - Many important phenomena can be explained using this model.
  - Example 1: investment behavior (finance)
  - Example 2: criminal behavior and risk of getting caught
- Coefficient of (relative) risk aversion γ is a key parameter of this model.
- Depending on the size of the gamble, we get very different answers for γ!
  - Small-scale gambles: people are *very* risk-averse.
  - Large-scale risk: people are moderately risk-averse.
  - The expected utility model can't match both behaviors with only one parameter
- Rabin (2000) formalizes this issue. Recitation will discuss it a bit more.

How can we estimate γ?

- Suppose you have a CRRA utility function:

$$u(x) = \begin{cases} \frac{x^{1-\gamma}}{1-\gamma} & \text{for } \gamma \neq 1, \\ \ln x & \text{for } \gamma = 1 \end{cases}$$

- Three approaches to estimate γ:
  (1) Certainty equivalents
  (2) Choices from gambles
  (3) Insurance choices

Estimating γ using insurance choices (Sydnor, 2010)

- Some doubts about validity of choices in lab games
  - Would like to have real-world choices
- Sydnor (2010): data from large home insurance provider
  - Random sample of 50,000 standard policies
  - Policy parameters and claims filed over a one-year period
  - Old and new customers
- What is a deductible?
  - Expenses paid out of pocket before insurer pays any expenses
  - Used to deter large number of claims

Sample data

Policyholder 1: Home was built in 1966 and had an insured value of $181,700. The menu available to this policyholder in the sample year was:

Deductible	Premium	Relative to $1,000 policy	Chosen
$1,000	$504	0	
$500	$588	+84	
$250	$661	+157	x
$100	$773	+269	

Policyholder 2: Home was built in 1992 and had an insured value of $266,100. The menu available to this policyholder in the sample year was:

Deductible	Premium	Relative to $1,000 policy	Chosen
$1,000	$757	0	x
$500	$885	+128	
$250	$999	+242	
$100	$1,171	+414	

Policyholder 2 had a higher premium for the $1,000 deductible contract than Policyholder 1, largely because Policyholder 2 had a higher insured home value. Policyholder 2, then, also faced a greater increase in cost for the alternative of a

- Choice over a menu of four deductibles
  - $1,000
  - $500
  - $250
  - $100
- Observe individuals' choice sets *and* their preferred option

Choosing a deductible

- What do these choices tell us about risk aversion?
  - Losses to the customer are capped at the deductible.
  - Choosing a lower deductible represents modest increase in insurance.
  - Choice of low deductible thus reveals high risk aversion.
- What info do we need to learn about risk aversion?
  - Available deductibles
  - Premium for each option
  - Claim probabilities
  - Wealth levels

Claim rates are low: about 4 percent per year

TABLE 1—SUMMARY STATISTICS

Variable	Full sample	Chosen deductible $1,000	$500	$250	$100
Panel A. Selected policy variables					
Insured home value	206,917	266,461	205,026	180,895	164,485
	(91,178)	(127,773)	(81,834)	(65,089)	(53,808)
Year home was built	1970	1972	1973	1966	1962
	(20.1)	(22.9)	(20.3)	(17.6)	(15.2)
Number of years insured by the company	8.4	5.1	5.8	13.5	13.2
	(7.1)	(5.6)	(5.2)	(7.0)	(6.7)
Average age of household (H.H.) members	54.3	50.8	51.1	60.4	66.9
	(15.6)	(14.3)	(14.9)	(15.7)	(15.0)
Number of paid claims in sample year (claim rate)	0.042	0.025	0.043	0.049	0.047
	(0.22)	(0.17)	(0.22)	(0.23)	(0.21)
Company payout per claim above deductible level	5,571.53	6,880.77	6,227.63	4,496.38	2,679.50
	(21,022.20)	(15,583.12)	(25,234.58)	(16,298.04)	(4,584.58)
Yearly premium paid	719.79	798.63	715.63	687.19	709.78
	(312.76)	(405.78)	(300.39)	(267.82)	(269.34)
Observations	49,992	8,525	23,782	17,536	149
Percent of sample	100	17.05	47.57	35.08	0.30

Notes: Means with standard deviations are in parentheses. The average age measure was calculated by the insurance company based on information they have about household members. This variable is not used in rating. Insured home value is the coverage limit on the insurance policy. For the claim rate and payout by the company per claim, only claims that resulted in positive payouts by the company were counted.

Reducing the deductible is expensive.

Available deductible	Full sample	Chosen deductible $1,000	$500	$250	$100
Panel B. Deductible-premium menu					
$1,000	$615.82 (292.59)	$798.63 (405.78)	$615.78 (262.78)	$528.26 (214.40)	$467.38 (191.51)
$500	+99.91 (45.82)	+130.89 (64.85)	+99.85 (40.65)	+85.14 (31.71)	+75.75 (25.80)
$250	+86.59 (39.71)	+113.44 (56.20)	+86.54 (35.23)	+73.79 (27.48)	+65.65 (22.36)
$100	+133.22 (61.09)	+174.53 (86.47)	+133.14 (54.20)	+113.52 (42.28)	+101.00 (82.57)

- The average insurance price with a deductible of $1,000 is $615.82.
- On average, reducing the deductible from $1,000 to $500 costs $99.91.
- On average, reducing the deductible from $250 to $100 costs $133.22!

Yet the majority chooses small deductibles.

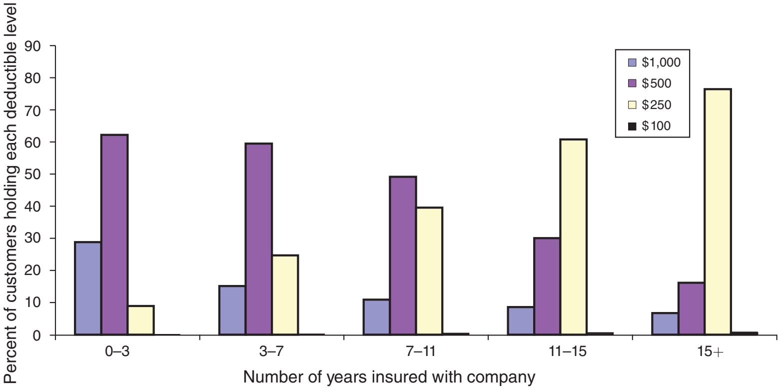


FIGURE 1. DEDUCTIBLE CHOICE BY YEARS INSURED WITH COMPANY

Notes: This chart gives the fraction of customers holding each deductible level by groups of tenure with the company. The percent of the sample that falls into each category is as follows: 0–3 years (34.16 percent), 3–7 years (22.97 percent), 7–11 years (12.95 percent), 11–15 years (10.48 percent), 15+ years (19.44 percent).

Choosing a deductible

- Choice between one-year insurance contracts with yearly premium P and deductible D
- Assumptions
  - No other risk to lifetime wealth
  - At most one loss during the year, with probability π
  - Accurate subjective beliefs about the likelihood of a loss
- Individuals maximize expected (indirect) utility-of-wealth function:

$$V(w, P, D, \pi) = \underbrace{\pi}_{\text{prob(loss)}} \cdot \underbrace{u(w - P - D)}_{\text{utility(loss)}} + \underbrace{(1 - \pi)}_{\text{prob(no loss)}} \cdot \underbrace{u(w - P)}_{\text{utility(no loss)}} \tag{1}$$

Backing out implied risk aversion from choices

- Choose contract j that maximizes expected (indirect) utility:

$$\max_j \ \pi \cdot u(w - P_j - D_j) + (1 - \pi) \cdot u(w - P_j). \tag{2}$$

- Choices imply upper and lower bounds on risk aversion
  - Upper bound for those who choose the \$1,000 deductible
  - Upper & lower bound for those who choose \$500 or \$250 deductible
  - Lower bound for those who choose \$100 deductible

Example: Individual chooses \$100 deductible

- The person prefers a \$100 deductible over choosing a \$250 deductible:

$$
\begin{aligned}
V(w, P_{100}, 100, \pi) &= \pi \cdot \frac{(w - P_{100} - 100)^{1-}}{1 -} + (1-\pi) \cdot \frac{(w - P_{100})^{1-}}{1 -} \\
\geq V(w, P_{250}, 250, \pi) &= \pi \cdot \frac{(w - P_{250} - 250)^{1-}}{1 -} + (1-\pi) \cdot \frac{(w - P_{250})^{1-}}{1 -}
\end{aligned}
$$

- Solving this equation yields lower bound for γ (for given P_{100}, P_{250}, w, and π).
  - Choosing a \$100 deductible maximizes the available insurance.
  - This choice reveals very high risk aversion in the expected utility framework.
  - There are no options with even lower deductibles available, so we don't know what she would have chosen for such deductibles.
  - We thus don't have an upper bound for γ for this person.

Implied values of γ are enormous!

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TABLE 3—BOUNDS ON COEFFICIENT OF RELATIVE RISK AVERSION

Model	\$1,000 (n = 2,474) LB	\$1,000 (n = 2,474) UB	\$500 (n = 3,424) LB	\$500 (n = 3,424) UB	\$250 (n = 367) LB	\$250 (n = 367) UB	Reject *any* 50/50 gamble with potential loss of \$1,000
Panel A. Bounds at the fiftieth percentile							
1 CRRA; \$1 mil; deductible average	—	2,823	1,839	5,064	4,337	14,032	100.0%
2 CRRA; \$1mil; individual estimate	—	2,979	2,013	5,406	4,621	14,650	99.9%
3 CRRA; \$500k; individual estimate	—	1,488	1,005	2,700	2,308	7,319	99.9%
4 CRRA; IHV; individual estimate	—	690	353	947	711	2,244	99.8%
5 CRRA; \$100k; individual estimate	—	294	199	535	458	1,452	99.9%
6 CRRA; \$50k; individual estimate	—	145	98	265	226	718	99.8%
7 CRRA; \$5k; individual estimate	—	7	6	21	18	58	92.9%
8 CARA; \$1mil; individual estimate	—	2,983	2,015	5,411	4,626	14,661	99.9%
Mode wealth class	\$1,000 (n = 2,474) LB	\$1,000 (n = 2,474) UB	\$500 (n = 3,424) LB	\$500 (n = 3,424) UB	\$250 (n = 367) LB	\$250 (n = 367) UB	Reject *any* 50/50 gamble with potential loss of \$1,000
Panel B. Bounds at the twenty-fifth and seventy-fifth percentile							
1 CRRA; \$1 mil; deductible average	—	3,173	1,614	5,582	3,898	15,283	100.0%

- Table shows lower and upper bounds at the 50th percentile.
- Different rows show estimates for different assumption on utility function and wealth.
- Example: for $w = \$50k$ and CRRA utility, almost all estimates yield $\gamma > 100$!

Why do people choose small deductibles? Neoclassical explanations

- Sydnor (2010) discusses several potential explanations in Section IV of the paper.
    - High risk aversion: implies implausibly high values of γ (see above).
    - High objective probability of claims: but actual claim rates are low (around 4%).
    - Borrowing constraints: unlikely given that people have fairly expensive homes.

- None of these explanations plausibly explains the patterns in the data.

Why do people choose small deductibles? Behavioral explanations

- Sydnor (2010) also argues that several behavioral explanations are unlikely.
  - Risk misperception: requires people to vastly overestimate risk, including many who have been insured for over 15 years with this company.
  - Marketing, social pressure: possible but company is not a low-cost provider, so sales agents often suggest high deductibles to lower policy costs.
  - Menu effects (people avoid extreme options): possible but does not explain why people choose $250 rather than $500 deductibles.
- Preferred explanation: reference-dependent preferences/loss aversion (next)

Summary from risk preferences

- Choices involving small-scale and large-scale risks yield contradicting answers.
  (1) Individuals are risk-averse for small-scale risks.
    - Such choices imply enormous risk aversion for large-scale risks.
    - But individuals do not avoid large-scale risks at all costs.

  (2) Individuals are moderately risk-averse for large-scale risks.
    - Such choices imply that individuals should be nearly risk-neutral for small-scale risks.
    - But individuals exhibit risk aversion for small-scale risks!

- Kahneman and Tversky (1979)
  - Even more evidence against the expected utility model
  - Proposed alternative model, **reference-dependent utility (loss aversion)**, can explain individuals' risk attitudes for *both* small-scale and large-scale risks.

Kahneman and Tversky (1979)

- Survey responses by Israeli students and university faculty
    - ‘Essentially identical’ results in Stockholm and Michigan
- Series of hypothetical, large-stake choices such as this one:

Which of the following would you prefer?

A: 50% chance to win 1,000, 50% chance to win nothing;

B: 450 for sure.

Gains and losses

- Expected utility theory: people only care about final outcomes (and their associated probabilities).
- Kahneman and Tversky (1979): striking evidence contradicting this prediction

TABLE I

PREFERENCES BETWEEN POSITIVE AND NEGATIVE PROSPECTS

Positive prospects					Negative prospects				
Problem 3:	(4,000, .80)	<	(3,000).		Problem 3′:	(−4,000, .80)	>	(−3,000).	
$N = 95$	[20]		[80]*		$N = 95$	[92]*		[8]	
Problem 4:	(4,000, .20)	>	(3,000, .25).		Problem 4′:	(−4,000, .20)	<	(−3,000, .25).	
$N = 95$	[65]*		[35]		$N = 95$	[42]		[58]	
Problem 7:	(3,000, .90)	>	(6,000, .45).		Problem 7′:	(−3,000, .90)	<	(−6,000, .45).	
$N = 66$	[86]*		[14]		$N = 66$	[8]		[92]*	
Problem 8:	(3,000, .002)	<	(6,000, .001).		Problem 8′:	(−3,000, .002)	>	(−6,000, .001).	
$N = 66$	[27]		[73]*		$N = 66$	[70]*		[30]	

Gains and losses (cont'd)

- The usual assumption in expected utility theory is that $u(x)$ is (weakly) concave, i.e. individuals are risk-averse (or risk-neutral).
- KT 1979 evidence contradicts this assumption:
  (1) Individuals are risk-averse for gains (Problem 3): Most individuals choose safe amount (3,000) that yields lower EMV than lottery (for which $EMV = 3,200$).
  (2) But individuals are risk-seeking for losses (Problem $3'$): Most individuals choose lottery that yields lower EMV (-3,200) than fixed amount (-3,000).
- Taken together, a large fraction of people appears to be *simultaneously* risk-averse (for gains) and risk-loving (for losses).
- Expected utility theory cannot explain these patterns.

Framing and reference points matter.

PROBLEM 11: In addition to whatever you own, you have been given 1,000. You are now asked to choose between

A: (1,000, .50), and B: (500).

$N = 70$ [16] [84]*

PROBLEM 12: In addition to whatever you own, you have been given 2,000. You are now asked to choose between

C: (−1,000, .50), and D: (−500).

$N = 68$ [69*] [31]

Framing matters. (cont'd)

- Subjects don't integrate initial payment with risky options.
- When viewed in terms of final states, the choice problems are identical:

$$A = (2,000, .50; 1,000, .50) = C, \quad \text{and} \quad B = (1,500) = D.$$

- But individuals evaluate these choices differently.
  - They consider choices A and B as gains (and are risk-averse).
  - They consider choices C and D as losses (and are risk-loving).

Most important points in Kahneman and Tversky (1979)

(1) **Changes rather than levels.** Utility seems better described by *changes* in consumption rather than by *levels* of consumption.

> *... the carriers of value are changes in wealth or welfare, rather than final states. This assumption is compatible with basic principles of perception and judgment.*

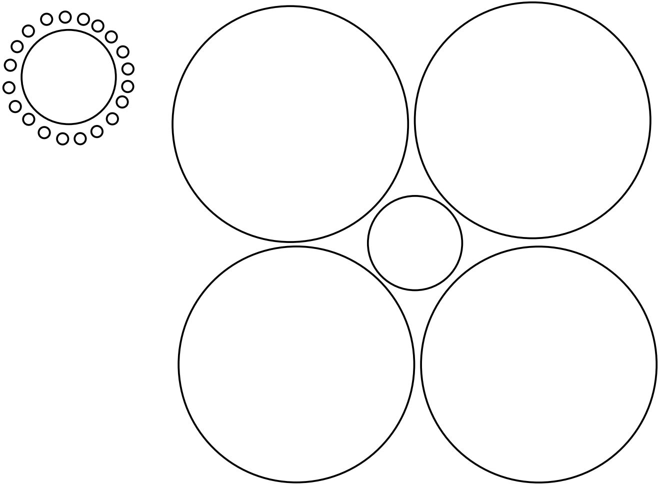
(2) **Loss aversion.** Losses loom larger than gains.

> *The aggravation that one experiences in losing a sum of money appears to be greater than the pleasure associated with gaining the same amount.*

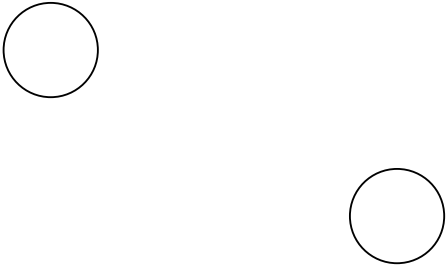
Reference dependence

- Utility seems better described by *changes* in consumption (relative to a reference point) rather than by *levels* of consumption
- What are real-world examples of reference dependence?

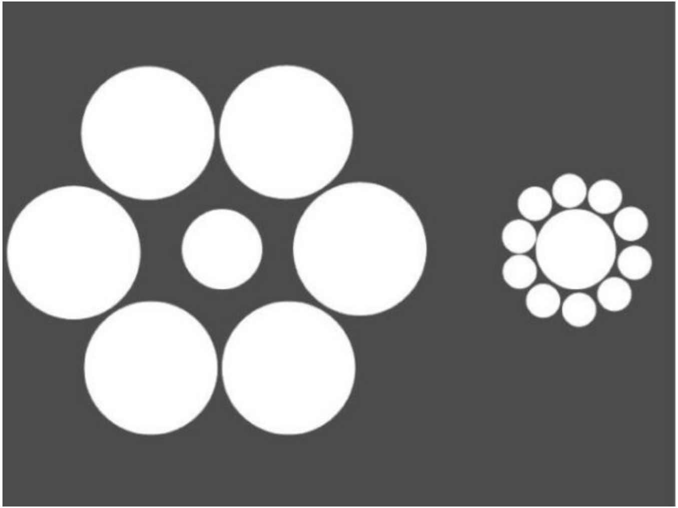
The size-contrast illusion



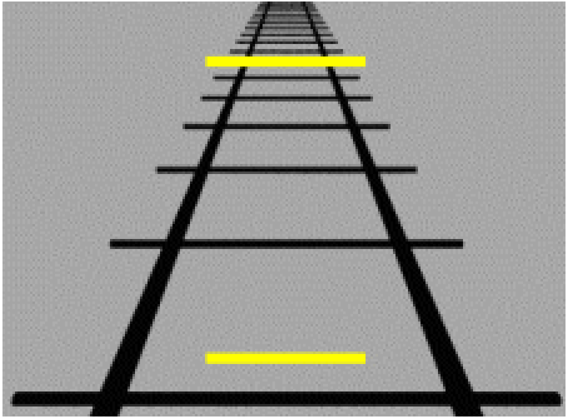
The size-contrast illusion



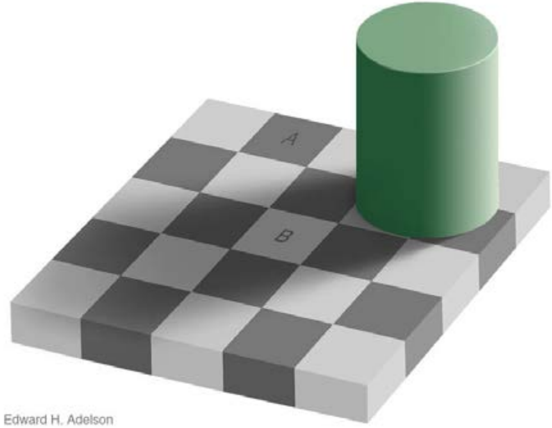
Yes, really, those circles are also the same size.



Which bar is longer?

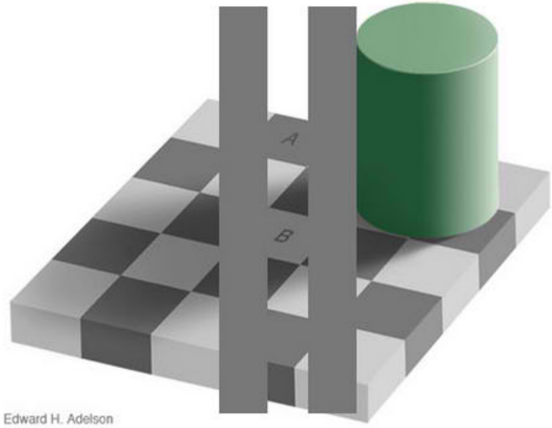


Which field is darker?



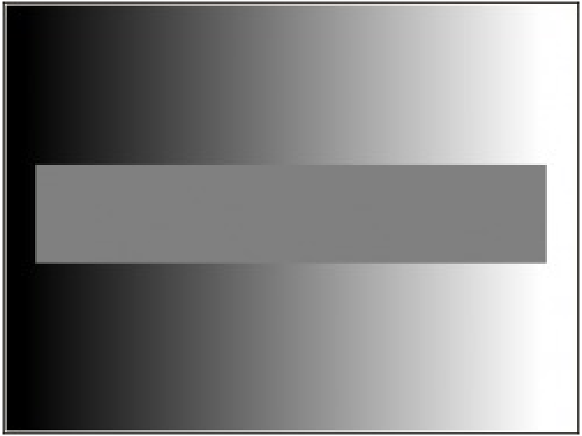
Courtesy of Professor Edward H. Adelson. Used with permission.

Yes, the colors are the same.



- If you're still not convinced, watch this video.

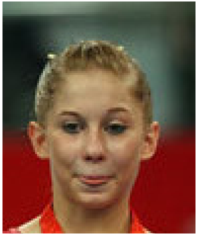
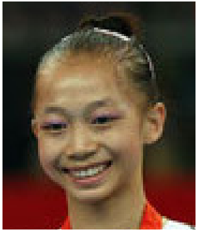
Shades of grey



Who is happier?

- There are plenty of examples of reference-dependence for vision.
  - These examples do tell us something about how the brain works.
  - But are those relevant for utility as well?

- One of these women won silver medal, one won bronze medal:

Who is happier? (cont'd)

- Psychology study (Medvec et al., 1995): olympic bronze medalists look on average happier than silver medalists.
- Silver medalists are thinking about having missed the gold, while bronze medalists are happy to be on the podium.
- Their evaluation of the result is relative. Read more about this here.

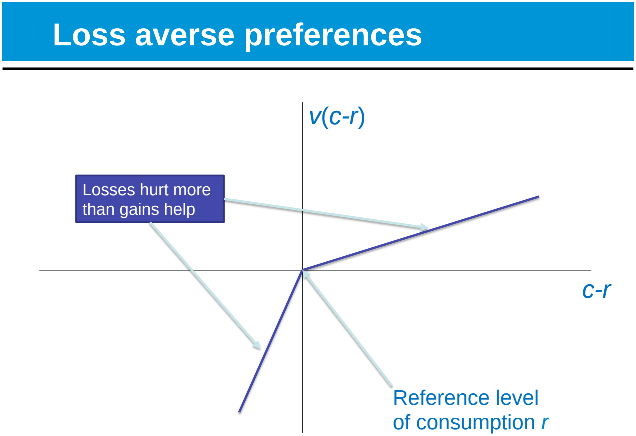
Comparative perceptions

- How do humans evaluate stimuli?
  - Not only absolute levels matter for perceptions, feelings, judgments, etc.
  - People compare stimuli to reference levels.
- Comparative judgments much easier than absolute judgments.
- Examples?
  - It's easy to tell which of two buckets of water is warmer.
  - It's hard to tell their absolute temperature.

Reference-dependent preferences

- The same is true for evaluations of economic outcomes.
    - It's easy to compare your income to your friend's.
    - It's hard to judge what will be enough to lead a nice life, or how much an extra \$1,000 per year would improve things.
- Reference-dependent utility
    - Utility from an outcome depends on comparisons to relevant 'reference levels' or 'reference points'.

Loss aversion



- Kahneman and Tversky (1979) argue that utility is reference-dependent.
- Outcomes (c) are evaluated relative to a reference point (r).
- Loss aversion: the utility function is steeper if $c < r$ than if $c > r$.

Empirical evidence of loss aversion

- People dislike losses relative to a reference point more than they like same-sized gains
- Two kinds of early experimental evidence of loss aversion
  (1) Preferences over risky gambles involving losses
  (2) (Un)willingness to trade one's current position for an alternative

Preferences over risky gambles involving losses

- Remember experiments from small-scale gambles:
  - Many people reject 50/50 gain \$11/lose \$10 gambles.
  - Do people just not take these small-scale gambles seriously?
- Would you accept a 50/50 gain \$550/lose \$500 gamble?
  - Barberis, Huang, and Thaler (2006) offered gamble for real (!) to MBA students, financial analysts, and rich investors (financial wealth of \$10 million).
  - Most, including 71% of the investors, turn down the gamble.

Endowment effect

- Endowing someone with a good almost instantaneously makes her value it more.
- Difference between buying and selling prices
  - If people (randomly) own an item, they want more money for it than they are willing to pay for it if they do not own the item.
  - Many experiments with mugs
  - Many other settings, e.g. Carmon and Ariely (2000)

(Not) trading mugs and pens

- Knetsch (1995) found a mug and a pen such that, when asked straight, about half the students prefer one and half the other.
- Gave randomly chosen half the students mugs and half pens. Then offered exchange.
- Vast majority of students preferred to keep the good that they were endowed with.

Start with	offered	% kept	% exchanged
Mug	Pen + \$.05	88%	12%
Pen	Mug + \$.05	90%	10%

Loss aversion over mugs and pens

- Reference point of mug owners: to have a mug and no pen.
- A trade is evaluated as a loss of a mug and a gain of a pen.
- Subjects hate loss more than they like gain, so stick with mug.
- Similarly for pen owners.

Loss aversion over pain

- Law-school students asked to assess compensation for pain and suffering damages
  - Expected to last about three years and be quite unpleasant
  - No impact on earnings capacity
  - Example: extreme stiffness in upper back and neck
- Some students led to imagine being injured
  - What amount of compensation would make them whole again?
  - Average amount: $151,448
- Another group of students led to imagine being uninjured
  - How much would need to be paid to accept the injury?
  - Average amount: $331,042

The High Price of Ownership (Carmon and Ariely, 2000)

Due to copyright restrictions, we aren't able to include the video, "The High Price of Ownership." You can view it on YouTube at: https://bit.ly/3toeYCU

A third important point in KT

(3) **Diminishing sensitivity.** People are risk-averse in the gain region, but risk-loving in the loss region.

> *Many sensory and perceptual dimensions share the property that the psychological response is a concave function of the magnitude of physical change. For example, it is easier to discriminate between a change of 3 degrees and a change of 6 degrees in room temperate, than it is to discriminate between a change of 13 degrees and a change of 16 degrees.*

Diminishing sensitivity

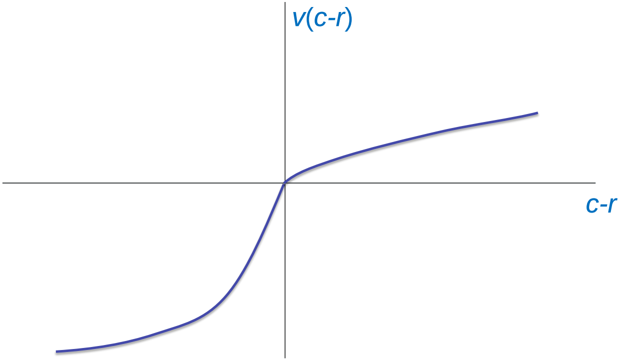
- People's sensitivity to *further* changes in consumption is smaller for consumption levels that are further away from the reference point.
  - A change from getting \$0 to getting \$10 feels greater than a change from getting \$1,000 to getting \$1,010.
  - Risk-taking in losses and risk aversion in gains is consistent with diminishing sensitivity.

- Much like reference dependence, diminishing sensitivity is a general feature of human perception:

Distance	101 ft. vs. 100 ft.	1 ft. vs. 0 ft.
Time	101 days from now vs. 100 days	1 day vs. 0 days
Chance	19% vs. 18%	1% vs. 0%

Proposed alternative utility function

Loss aversion – diminishing sensitivity



- Loss aversion: kink at zero
- Diminishing sensitivity: diminishing returns on both sides of the reference point
- Concavity in gains, convexity in losses

Many applications of reference-dependent utility

- Endowment effect: Kahneman et al. (1990), Plott and Zeiler (2005)
- Labor supply, employment, and effort: Mas (2006); Camerer et al. (1997) and and many other taxi driver papers
- Marathon running: Allen et al. (2014)
- Disposition effect in finance (Odean, 1998) and housing (Genesove and Mayer, 2001)
- Insurance: Sydnor (2010)
- Domestic violence: Card and Dahl (2011)
- ...

What's next?

- Monday: many applications of reference-dependent utility
  - Read Kahneman and Tversky (1979) pages 263 to 269.
- Wednesday: social preferences
  - Games in class! No readings.

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