3. Choice Anomalies

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Economics 176
• **Individual choice experiments**
  - Test assumptions about Homo Economicus

• **Strategic interaction experiments**
  - Test game theory

• **Market experiments**
  - Test classical notions of competitive equilibrium
Suppose a person faces a gamble (call it a lottery):

The **expected value** (EV) is the sum of the possible outcomes, each weighted by their probability of occurring:

- \( EV(L1) = p_A A + (1 - p_A) B \)
- \( EV(L1) = 0.5 \times 30 + 0.5 \times 50 \)
- \( EV(L1) = 15 + 25 \)
- \( EV(L1) = 40 \)
Another example

- \( EV(L2) = q_A A + (1 - q_A) B \)
- \( EV(L2) = 0.4 \times 10 + 0.6 \times 70 \)
- \( EV(L2) = 4 + 42 \)
- \( EV(L2) = 46 \)
Expected Value

What if you had to choose between these two gambles?

Which would a “rational” person choose?

L1

A

B

$30

$50

0.5

0.5

L2

A

B

$10

$70

0.4

0.6
The dominant theory in economics is **Expected Utility Theory**.

- People have utility function $U$ and choose lotteries that maximize **expected utility** (instead of expected value):
  
  $$EU(L_i) = p_A U(A) + (1 - p_A) U(B)$$

So a person with utility function $U$ chooses $L_1$ if $EU(L_1) \geq EU(L_2)$

- $0.5 \ U(30) + 0.5 \ U(50) \geq 0.4 \ U(10) + 0.6 \ U(70)$

and $L_2$ otherwise.
Special case: utility function, $U$ is linear:

L1

L2
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Expected Utility

Independence

Symmetry

Prospect Theory

Subjective Expected Utility

Expected Utility

Special case: utility function, $U$ is linear:
Special case: utility function, $U$ is linear:
As a result, risk doesn’t matter – only expected value!

We call linear utility “risk neutral.”
What if utility is curved?

L1

L2

Utility
Value

0 1 2 3 4
0 10 20 30 40 50 60 70

Expected Utility

Value
Utility

0 1 2 3 4
0 10 20 30 40 50 60 70
3. Choice Anomalies

Expected Utility

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Subjective Expected Utility

**What if utility is curved?**

![Graph L1](image1.png)

![Graph L2](image2.png)
Notice, expected utility is below the utility of the expected value!

Means you would be happier avoiding risk (“risk averse” preferences).
3. Choice Anomalies

Expected Utility

Which lottery is chosen?

L1

L2

Value

Utility

Expected Utility
You actually choose the lower expected value lottery to avoid risk!
The theory of expected utility is deeply ingrained in economics.

We can ask a bunch of important empirical questions about the nature and validity of expected utility in the laboratory:

- What sort of curvature is implied by subjects’ choices (how risk averse are subjects)?
- Expected utility rests on a number of axioms (behavioral assumptions). Are these assumptions true?
- Expected utility theory has a number of distinctive predictions. Do these assumptions bear out in reality?
Holt-Laury Procedure

One of the most popular ways of measuring risk aversion (curvature of utility) is the Holt-Laury price list.

Choose between two lotteries (Safe and Risky) and decide when to switch.

Under the null hypothesis of risk neutrality, should switch when expected value of lottery 2 exceeds that of lottery 1!
Holt-Laury Procedure

We can graphically show what a risk neutral population of subjects would look like:
Independence Axiom

A central assumption on which expected utility theory rests is the **independence axiom**.

Adding an additional lottery to each lottery shouldn’t influence choice.
A central assumption on which expected utility theory rests is the independence axiom.

Adding an additional lottery to each lottery shouldn't influence choice.

\[
\text{If } L_1 > L_2 \text{ Then } L_3 \cdot p + (1-p) \cdot L_1 \geq L_2 \cdot (1-p) + p \cdot L_3
\]
**Allais Paradox**

**Idea:** Create a task that will tell you if behavior is consistent with independence axiom, *without observing utility function.*

### Game 1

<table>
<thead>
<tr>
<th>L1</th>
<th>L2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0$</td>
<td>$0$</td>
</tr>
<tr>
<td>$\frac{1}{2}$</td>
<td>$\frac{1}{2}$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0$</td>
<td>$3k$</td>
</tr>
</tbody>
</table>

### Game 2

<table>
<thead>
<tr>
<th>L1</th>
<th>L2</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0$</td>
<td>$0$</td>
</tr>
<tr>
<td>$0.75$</td>
<td>$0.25$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0$</td>
<td>$3k$</td>
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</table>

Subjective Expected Utility

Independence

Symmetry

Prospect Theory
You guys did this!

<table>
<thead>
<tr>
<th>Decision</th>
<th>Left Choice</th>
<th>Right Choice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision 0</td>
<td>$6.00 if throw of die is 0-99</td>
<td>$8.00 if throw of die is 0-79</td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0.00 if throw of die is 80-99</td>
</tr>
<tr>
<td>Decision 2</td>
<td>$6.00 if throw of die is 0-24</td>
<td>$8.00 if throw of die is 0-19</td>
</tr>
<tr>
<td></td>
<td>$0.00 if throw of die is 25-99</td>
<td>$0.00 if throw of die is 20-99</td>
</tr>
</tbody>
</table>

What is a typical choice for each decision?
Allais Paradox

Typically subjects play different actions in each game!

**Game 1**
Most play L1

**Game 2**
Most play L2
Allais Paradox

This pattern of play (L1 in Game 1 and L2 in Game 2) is **inconsistent** with the independence axiom *regardless of people’s utility functions!*

If the independence axiom holds for you, you *must* make the same choice in each game. Why?

Suppose you have utility function $U$ and choose L1 in Game 1

- Then $1 \times U(3000) > 0.8 \times U(4000)$

Now suppose I tell you that there is only a 25% chance I’ll actually pay you anything for the experiment.

- I’ve essentially added a lottery to each decision (a 75% chance you earn nothing). Given your utility above:
  - $0.25 \times U(3000) > 0.2 \times U(4000)$

But this is just Game 2 where most people choose the reverse! Evidence against the Independence Axiom!
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Gain/Loss Symmetry

A key component of EU:

- People have a **single** utility function regardless of how much they have.
- The size and direction in which wealth changes don’t affect utility or decisions – only the final level of wealth!
- People treat anticipated gains and anticipated losses exactly the same!

Example: Suppose you have 100k and had to choose between

- a low risk lottery that would cause you to lose an expected 10k
- a high risk lottery that would cause you to lose an expected 10k (but might involve you losing nothing at all).

To expected utility theory this is no different than having nothing and choosing between

- a low risk lottery that would cause you to gain an expected 90k.
- a high risk lottery that would cause you to gain an expected 90k (but might give you significantly more).

According to EU, your starting point doesn't matter at all!
Reflection Effect

Idea: Create a task that will tell you if behavior is consistent with gain/loss symmetry, again, *without observing utility function*.

Game 1

Game 2
Reflection Effect

Once again, you guys did this!

<table>
<thead>
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<th>Decision</th>
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<td>Decision 0</td>
<td>$6.00 if throw of die is 0-99</td>
<td>$8.00 if throw of die is 0-79 $0.00 if throw of die is 80-99</td>
</tr>
<tr>
<td>Decision 5</td>
<td>-$6.00 if throw of die is 0-99</td>
<td>-$8.00 if throw of die is 0-79 $0.00 if throw of die is 80-99</td>
</tr>
</tbody>
</table>

What is a typical choice for each decision?
Subjects usually switch from Game 1 to Game 2!

**Game 1**
Most play L1

**Game 2**
Most play L2
Gain/Loss Asymmetry

Results show something that can’t be true of standard EU

- Risk aversion in **gains** but
- Risk seeking in **losses**

In EU, your risk preferences should not depend locally on the direction of change in your utility!

Related findings:

- **Loss Aversion:** People dislike losses perhaps twice as much as they like gains!
- **Endowment Effect:** People are typically willing to pay less to acquire something that they would be willing to accept to sell it.
  - Coffee mug experiments
Estimation Errors

Misperception

• Some experimental evidence suggests people treat small probability events as more likely than they are
• and large probability events as less likely than they are!

Law of Small Numbers

• Evidence suggest people infer too much from small samples
• and underestimate the precision (reliability) of large samples.
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Prospect Theory

These predictive failures call EU into question.

Kahneman and Tversky created prospect theory as an alternative to EU.
### Expected Utility Theory

1. Total wealth matters
2. Always risk averse or risk seeking
3. Smooth utility function
4. Accurate probability assessments

### Prospect Theory

1. Changes to wealth matter
2. Risk averse in gains, risk seeking in losses
3. “Kink” in utility functions so losses have more effect on utility
4. Decision weights on probabilities.
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Subjective Expected Utility

People often don’t know the probabilities they are responding to when making decisions.

Risk vs. Uncertainty

- Risk: Known probabilities
- Uncertainty: Unknown probabilities

**Subjective Expected Utility**: People form probabilistic beliefs in the absence of known probabilities, transforming uncertainty into risk.

- People treat uncertainty just as they would treat risk.
- Only difference is that probabilities attached to events are subjective rather than objective.

Is this true?
Daniel Ellsberg proposed an experimental test:

- Draw a ball from a jar containing 90 total balls
- 30 balls are red for sure
- The rest are some unknown combination of black and green.

**Game 1**

1. $100 if red
2. $100 if black

**Game 2**

1. $100 if red or green
2. $100 if black green
Ellsberg Paradox

Once again, you guys did this!

<table>
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<tr>
<th>Decision</th>
<th>Option A</th>
<th>Option B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decision 1</td>
<td>If the card drawn is spades</td>
<td>If the card drawn is clubs</td>
</tr>
<tr>
<td></td>
<td>you receive $5.00 and zero otherwise</td>
<td>you receive $5.00 and zero otherwise</td>
</tr>
<tr>
<td>Decision 2</td>
<td>If the card drawn is spades or diamonds,</td>
<td>If the card drawn is clubs or diamonds,</td>
</tr>
<tr>
<td></td>
<td>you receive $5.00, and zero otherwise</td>
<td>you receive $5.00, and zero otherwise</td>
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What do people typically choose?
Ellsberg Paradox

Once again, you guys did this!

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</tr>
<tr>
<td>Decision 2</td>
<td>If the card drawn is spades or diamonds, you receive $5.00 and zero otherwise</td>
<td>If the card drawn is clubs or diamonds you receive $5.00 and zero otherwise</td>
</tr>
</tbody>
</table>

What do people typically choose?

Choice 1 in Game 1 and Choice 2 in Game 2.
Ellsberg Paradox

This typical pattern is inconsistent with SEU!

SEU predicts the same decision in each game. Why?

Suppose you assign a probability $p$ to a draw being black and $q$ to a draw being green (and a 0.333 that draw will be red).

- If you choose (1) in the Game 1 then
  - $p \times U(100) < 0.333 \times U(100)$
  - $p < 0.333$

- If you choose (2) in the Game 2 then
  - $0.333 \times U(100) + q \times U(100) < p \times U(100) + q \times U(100)$
  - $0.333 < p$

Note that this is a contradiction! People seem to avoid bets they don’t know the risk of

- We call this ambiguity aversion