UC Berkeley
Haas School of Business
Economic Analysis for Business Decisions
(EWMBA 201A)
Fall 2021

Block I
The consumers

Decision-making under certainty (PR 3.1-3.4) and uncertainty (PR 5.1-5.3 and 5.5)

Objectives

[1] Explain what economists mean by *rationality*, because that term is often misunderstood.

[2] Show that the techniques of economic analysis may be brought to bear on modeling and predicting behavior in many situations.

[3] The economic theory of the consumer can help managers to think *systematically* through their product decisions.

Prologue

Many people think that economists view people as being super-rational and find the material to be highly theoretical and not very "realistic".

... theories do not have to be realistic to be useful...

Even though the assumptions are pretty unrealistic, the theory predicts behavior well and is quite useful.

A theory can be *useful* in three ways:

A. descriptive (how people actually choose)

B. prescriptive (as a practical aid to choice)

C. normative (how people ought to choose)

Decision making under certainty and uncertainty

The "standard" theory of the economic agent (consumer, manager, policy maker) is best understood as follows:

$$\begin{tikzcd}
\text{Preferences} \arrow[dr] & & \text{Constraints} \arrow[dl] \\
& \text{Choice} & \\
\text{Information} \arrow[ur] & & \text{Beliefs} \arrow[ul]
\end{tikzcd}$$

Behavioral economics incorporate more “realistic” assumptions about decision making based on findings in psychology and related fields:

$$\begin{array}{ccccc} \text{Preferences} & & \longleftrightarrow & & \text{Constraints} \\ & \searrow & & \swarrow & \\ \updownarrow & & \text{Choice} & & \updownarrow \\ & \nearrow & & \nwarrow & \\ \text{Information} & & \longleftrightarrow & & \text{Beliefs} \end{array}$$

Consumer preferences (PR 3.1)

Consider some (finite) set of alternatives or consumption bundles or baskets $(x, y, z, ...)$.

– For our purposes it is convenient to consider only the case of two goods, since we can then depict the consumer's choice behavior graphically.

– We denote a bundle by a single symbol like x, where x is simply an abbreviation for a list of two numbers (x_1, x_2).

Bear in mind: the two-good assumption is more general than you might think it first. Why?!

Formally, we represent the consumer's preferences by a binary relation $\succsim$ defined on the set of consumption bundles.

For any pair of bundles x and y, if the consumer says that x is at least as good as y, we write

$$x \succsim y$$

and say that x is *weakly preferred* to y.

<u>Bear in mind</u>: economic theory often seeks to convince you with simple examples and then gets you to extrapolate. This simple construction works in wider (and wilder circumstances).

From the weak preference relation $\succsim$ we derive two other relations on the set of alternatives:

– Strict performance relation

$$x \succ y \text{ if and only if } x \succsim y \text{ and not } y \succsim x.$$

The phrase $x \succ y$ is read x is *strictly preferred* to y.

– Indifference relation

$$x \sim y \text{ if and only if } x \succsim y \text{ and } y \succsim x.$$

The phrase $x \sim y$ is read x is *indifferent* to y.

The basic assumptions about preferences

The theory begins with three assumptions about preferences. These assumptions are so fundamental that we can refer to them as "axioms" of decision theory.

[1] Completeness

$$x \succsim y \text{ or } y \succsim x$$

for any pair of bundles x and y.

[2] Transitivity

$$\text{if } x \succsim y \text{ and } y \succsim z \text{ then } x \succsim z$$

for any three bundles x, y and z.

Together, completeness and transitivity constitute the formal definition of *rationality* as the term is used in economics. Rational economic agents are ones who

> have the ability to make choices [1], and whose choices display a logical consistency [2].

(Only) the preferences of a rational agent can be represented, or summarized, by a *utility function* (more later).

The third axiom about consumer's preferences for one bundle versus another is that "more is better" (goods are desirable).

[3] Monotonicity

$$\text{if } x_1 \geq y_1 \text{ and } x_2 \geq y_2 \text{ then } x \succsim y$$

for any pair of bundles x and y.

Indifference curves

We next represent a consumer's preferences graphically with the use of *indifference curves*.

The consumer is indifferent among all consumption bundles represented by the points graphed on the curve.

The set of indifference curves for *all* consumption bundles is called the *indifference map*.

– PR Figures 3.1-3.4 here –

The marginal rate of substitution (MRS)

The maximum amount of a good that a consumer is willing to give up in order to obtain one additional unit of another good.

The MRS at any point is equal to the *slope* of the indifference curve at the point.

If indifference curves are "convex" (bowed inwards), then the MRS falls as we move down the indifference curve, that is it diminishes along the curve.

– PR Figures 3.5-3.6 here –

Utility

A numerical score representing the satisfaction (or happiness?) that a consumer has from a given bundle.

An <u>ordinal</u> utility function replicates the consumer's <u>ranking</u> of bundles – from most to least preferred.

$$x \succsim y \text{ if and only if } u(x_1, x_2) \geq u(y_1, y_2).$$

The Cobb-Douglas utility function (and production function) is widely used to represent preferences

$$u(x) = x_1^{\alpha} x_2^{\beta}$$

where $\alpha, \beta > 0$. (Can you draw the Cobb-Douglas indifference curves?)

Paul Douglas (1892-1976) – a University of Chicago economist and a Democratic U.S. Senator from Illinois who earned two Purple Heart medals in WWII (at the age of 50).

Budget sets (PR 3.2)

The *budget set* includes all bundles on which the total amount of money spent given the market prices p_1 and p_2 is less or equal to income I

$$p_1x_1 + p_2x_2 \le I.$$

Rearranging,

$$x_2 \le \frac{I}{p_2} - \frac{p_1}{p_2}x_1.$$

The slope of the budget line $-p_1/p_2$ is the negative of the ratio of the two prices.

– PR Figures 3.10-3.12 here –

Consumer choice (PR 3.3)

The *optimal* consumption bundle is at the point where an indifference curve is *tangent* to the budget line, that is

$$MRS = \frac{p_1}{p_2}.$$

Bot maximization is sometimes achieved at a so-called corner solution in which the equality above does not hold.

This is an important result that helps us understand and predict (using econometric tools) consumers' purchasing decisions.

– PR Figures 3.13 and 3.15 here –

Foundations of Economic Analysis (1947)

Paul A. Samuelson (1915-2009) – the first American Nobel laureate in economics and the foremost (academic) economist of the 20th century (and the uncle of Larry Summers…).

Revealed preferences (PR 3.4)

Economists test for consistency with maximization using *revealed preference* axioms.

Revealed preference techniques can be used to "recover" the underlying preferences and to forecast behavior in new situations.

The revealed preference barouche was first suggested by Paul Samuelson in his remarkable *Foundations of Economic Analysis* (1947).

– PR Figures 3.18-3.19 here –

Takeaways

- We explained what economists mean by rationality, because that term is often misunderstood.

- The techniques of economic analysis may be brought to bear on modeling and predicting behavior in many situations.

- Consumer theory can help managers to think *systematically* through their product decisions.

Decision making under uncertainty

- Uncertainty is a fact of life so people's attitudes towards risk enter every realm of economic decision-making.

- We *must* study individual behavior with respect to choice involving uncertainty.

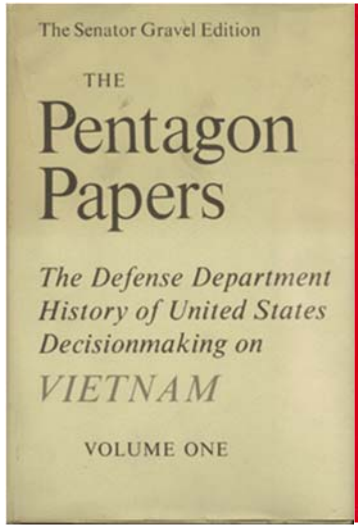
- Models of decision making under uncertainty play a key role in every field of economics.

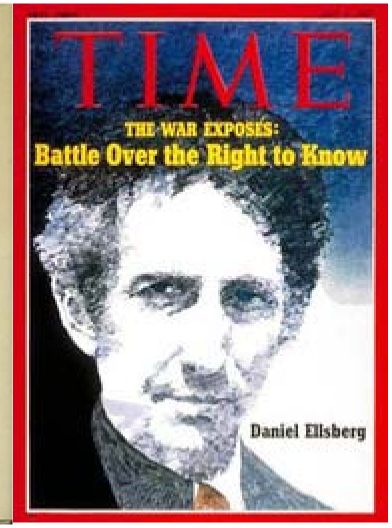
Objectives

- Illustrate that agents (consumers and managers) frequently make decisions with uncertain consequences.

- Facing uncertain choices, maximizing the Expected Utility is how agents ought to choose.

- Individual behavior is often contrary to the assumptions of Expected Utility Theory.






The Washington Post

FINAL

Documents Reveal U.S. Effort In '54 to Delay Viet Election

Times Lists But Retains Viet Papers

Times' Stand Wins Wide Hill Support

FBI Seeking Ex-Pentagon Aide in Leak

End-War Bid Fails; Draw Gain in House

Prosecutor Links Bobby Baker To Ring Accused in NW Thefts

- I have an urn with 1000 balls in it. Some of the balls are red and some are blue. All the balls are the same size and weight, and they are not distinguishable in any way except in color.

- I will let you reach into this urn without looking and drew out one of these balls. I want to know your preferences between investments (gambles) based on the outcome of this random event.

[1] There are precisely 500 red balls in the urn. Would you rather (fill the blank)

(a) get $_____ for sure

(b) get $100,000 if the ball drawn from the urn is red and $0 if it is blue.

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(a) lose $____ for sure
(b) lose $100,000 if the ball drawn from the urn is red and $0 if it is blue.

[3] The number of red balls in the urn is unknown. Would you rather (fill the blank)

(a) get $____ for sure
(b) get $100,000 if the ball drawn from the urn is red and $0 if it is blue.

Life is full of lotteries :-(

$$x := \begin{array}{ll} \overset{p}{\nearrow} & \$A \\ & \\ \underset{1-p}{\searrow} & \$B \end{array} \qquad\qquad y := \begin{array}{ll} \overset{p}{\nearrow} & \$A \\ \xrightarrow{q} & \$B \\ \underset{1-p-q}{\searrow} & \$C \end{array}$$

A risky lottery (left) and an ambiguous lottery (right)

$$x := \begin{array}{cc} \overset{1/2}{\nearrow} & \$A \\ & \\ \underset{1/2}{\searrow} & \$B \end{array} \qquad\qquad y := \begin{array}{cc} \overset{?}{\nearrow} & \$A \\ & \\ \underset{1-?}{\searrow} & \$B \end{array}$$

A compounded lottery

$$
x := \begin{array}{ccl}
 & & \overset{q}{\nearrow} \quad \$A \\
 & \overset{p}{\nearrow} & \\
 & & \underset{1-q}{\searrow} \quad \$B \\
 & & \overset{l}{\nearrow} \quad \$C \\
 & \underset{1-p}{\searrow} & \\
 & & \underset{1-l}{\searrow} \quad \$D
\end{array}
$$

The reduction of a compounded lottery

$$
x := \begin{array}{ccccc|c}
 & & & \overset{q}{\nearrow} & \$A & pq \\
 & \overset{p}{\nearrow} & & \underset{1-q}{\searrow} & \$B & p(1-q) \\
 & & & & & \\
 & \underset{1-p}{\searrow} & & \overset{l}{\nearrow} & \$C & (1-p)l \\
 & & & \underset{1-l}{\searrow} & \$D & (1-p)(1-l)
\end{array}
$$

Risk (known probabilities) (PR 5.1)

Probability is the likelihood that a given outcome will occur. If there are two possible outcomes having payoffs x_1 and x_2 and the probabilities of these outcomes are π_1 and π_2, then the *expected value* is

$$E(x) = \pi_1 x_1 + \pi_2 x_2$$

where $\pi_1 + \pi_2 = 1$ (a probability distribution). More generally, when there are n outcomes the *expected value* is

$$E(x) = \pi_1 x_1 + \pi_2 x_2 + \cdots + \pi_n x_n$$

where $\pi_1 + \pi_2 + \cdots + \pi_n = 1$.

When there are two outcomes x_1 and x_2 occurring with probabilities π_1 and π_2 the *variance* is given by

$$\sigma^2 = \pi_1[x_1 - E(x)]^2 + \pi_2[x_2 - E(x)]^2,$$

and when there are n outcomes $x_1, x_2, ..., x_n$ occurring with probabilities π_1, $\pi_2, ...\pi_n$ the variance is given by

$$\sigma^2 = \pi_1[x_1 - E(x)]^2 + \pi_2[x_2 - E(x)]^2 + \cdots + \pi_n[x_n - E(x)]^2.$$

The *standard deviation* is the square root of the variance σ and it is a standard measure of variability.

An example (PR Tables 5.1-5.3)

	Outcome 1		Outcome 2		
	p_1	x_1	p_2	x_2	$E(x)$
Job 1	.5	2000	.5	1000	1500
Job 2	.99	1510	.01	510	1500

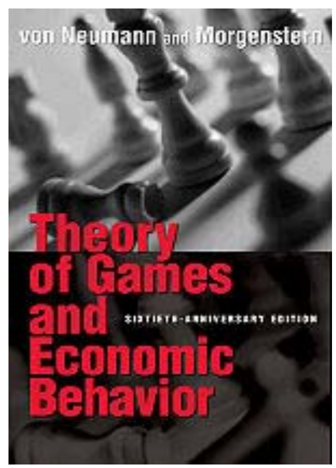
	Outcome 1		Outcome 2		
	x_1	$[x_1 - E(x)]^2$	x_2	$[x_2 - E(x)]^2$	σ
Job 1	2000	$250,000$	1000	$250,000$	500
Job 2	1510	100	510	$9,900$	14

A modified example (PR Table 5.4)

	Outcome 1		Outcome 2		
	p_1	x_1	p_2	x_2	$E(x)$
Job 1	.5	2100	.5	1100	1600
Job 2	.99	1510	.01	510	1500

	Outcome 1		Outcome 2		
	x_1	$[x_1 - E(x)]^2$	x_2	$[x_2 - E(x)]^2$	σ
Job 1	2000	$250,000$	1000	$250,000$	500
Job 2	1510	100	510	$9,900$	14

The paternity of decision theory and game theory (1944)



Preferences toward risk (PR 5.2)

The standard model of decisions under risk (known probabilities) is based on von Neumann and Morgenstern Expected Utility Theory.

Consider a set of *lotteries*, or gambles, (outcomes and probabilities). A fundamental axiom about preferences toward risk is *independence*:

For any lotteries x, y, z and $0 < \alpha < 1$

$$x \succ y \text{ implies } \alpha x + (1-\alpha)z \succ \alpha y + (1-\alpha)z.$$

$$x := \begin{array}{c} \overset{p_x}{\nearrow} \\ \\ \underset{1-p_x}{\searrow} \end{array} \begin{array}{c} \$A \\ \\ \$B \end{array} \quad \succ \quad y := \begin{array}{c} \overset{p_y}{\nearrow} \\ \\ \underset{1-p_y}{\searrow} \end{array} \begin{array}{c} \$C \\ \\ \$D \end{array}$$

$$
x+z := \begin{array}{ll}
\overset{p}{\nearrow} & \begin{array}{ll} \overset{p_x}{\nearrow} & \$A \\ \underset{1-p_x}{\searrow} & \$B \end{array} \\[2em]
\underset{1-p}{\searrow} & \begin{array}{ll} \overset{p_z}{\nearrow} & \$E \\ \underset{1-p_z}{\searrow} & \$F \end{array}
\end{array}
\qquad \succ \qquad
y+z := \begin{array}{ll}
\overset{p}{\nearrow} & \begin{array}{ll} \overset{p_y}{\nearrow} & \$C \\ \underset{1-p_y}{\searrow} & \$D \end{array} \\[2em]
\underset{1-p}{\searrow} & \begin{array}{ll} \overset{p_z}{\nearrow} & \$E \\ \underset{1-p_z}{\searrow} & \$F \end{array}
\end{array}
$$

Expected Utility Theory has some very convenient properties for analyzing choice under uncertainty.

To clarify, we will consider the *utility* that a consumer gets from her or his income.

More precisely, from the consumption bundle that the consumer's income can buy.

Expected utility is the sum of utilities associated with all possible outcomes, weighted by the probability that each outcome will occur.

In the job example above the expected utility from job 1 is given by

$$E(u) = .5u(\$2000) + .5u(\$1000),$$

and the expected utility from job 1 is given by

$$E(u) = .99u(\$1510) + .01u(\$510).$$

– PR Figures 5.3-5.4 here –

Behavioral economics (PR 5.5)

Allais (1953) I

– Choose between the two gambles:

$$x := \begin{array}{l} \nearrow^{.33} \ \$25,000 \\ \xrightarrow{.66} \ \$24,000 \\ \searrow_{.01} \ \$0 \end{array} \qquad y := \xrightarrow{1} \$24,000$$

Allais (1953) II

– Choose between the two gambles:

$$z := \begin{array}{ll} & \$25,000 \\ \overset{.33}{\nearrow} & \\ & \\ \underset{.67}{\searrow} & \\ & \$0 \end{array} \qquad\qquad w := \begin{array}{ll} & \$24,000 \\ \overset{.34}{\nearrow} & \\ & \\ \underset{.66}{\searrow} & \\ & \$0 \end{array}$$

Ambiguity (unknown probabilities)

Ellsberg (1961)

An urn contains 300 marbles; 100 of the marbles are red, and 200 are some mixture of blue and green. We will reach into this urn and select a marble at random:

– You receive $\$25,000$ if the marble selected is of a specified color. Would you rather the color be red or blue?

– You receive $\$25,000$ if the marble selected is *not* of a specified color. Would you rather the color be red or blue?

Takeaways

- Consumers and managers frequently make decisions with uncertain consequences.

- Facing uncertain choices, Expected Utility consumers maximize the average expected utility associated with each outcome.

- Individual behavior is often contrary to the assumptions of Expected Utility Theory (an important frontier of choice theory).