

Decision Making

BUS 735: Business Decision Making and Research

1

1.1 Goals and Agenda

Goals and Agenda

<u>Learning Objective</u>	<u>Active Learning Activity</u>
Learn how to make decisions with uncertainty, without using probabilities.	Lecture / Example problems.
Practice what we learn.	In-class exercise.
Learn how to make decisions with uncertainty, using probabilities.	Lecture / Example problems.
Practice what we learn.	In-class exercise.
More practice.	Read Chapter 12, Homework exercises.
Assess what we have learned	Quiz

2 Decision Making Without Probabilities

Decision Making Without Probabilities

- Suppose you have to decide on one of three choices for your business:
 1. Expand facilities.
 2. Renovate existing facilities.
 3. Do nothing.
- Each have costs (known) and benefits (unknown).

Decision	Good Economic Conditions	Bad Economic Conditions
Expand	\$150,000	-\$10,000
Renovate	\$90,000	\$10,000
Do nothing	\$70,000	\$40,000

- Suppose profits depend on economic conditions:

2.1 Maximax Decision

Maximax Decision

- Problem: probabilities of having good economic conditions or bad economic conditions are unknown.
- Maximax Decision:
 - Compute the best (maximum) outcome for each choice (very optimistic).
 - Choose the maximum of the best outcomes.
 - Choosing options given best-case scenarios.

Decision	Good Economic Conditions	Bad Economic Conditions	Maximum
Expand	\$150,000	-\$10,000	\$150,000
Renovate	\$90,000	\$10,000	\$90,000
Do nothing	\$70,000	\$40,000	\$70,000

- Maximum of maximums = \$150,000. Choice = Expand!

2.2 Maximin Decision

Maximin Decision

- Maximin Decision:
 - Compute the worst (minimum) outcome for each choice (very pessimistic).
 - Choose the maximum of the worst outcomes.
 - Choosing options given worst-case scenarios.

Decision	Good Economic Conditions	Bad Economic Conditions	Minimum
Expand	\$150,000	-\$10,000	-\$10,000
Renovate	\$90,000	\$10,000	\$10,000
Do nothing	\$70,000	\$40,000	\$40,000

- Maximum of minimums = \$40,000. Choice = Do Nothing!

2.3 Minimax Regret Decision

Minimax Regret Decision

- **Regret** is the difference between the payoff of a given decision and the best decision under a given scenario.
- Example: Suppose you chose to *do nothing* and there ended up being good economic conditions.
 - Best decision given good economic condition is to *expand*. Profit = \$150,000.
 - Profit from *doing nothing* given good economic condition is \$70,000.
 - Regret = \$150,000 - \$70,000 = \$80,000.
- Minimax Regret Decision:
 - Compute regrets for every cell in table..
 - Find the maximum regret for each decision.
 - Choose the minimum of these maximum regret values.

Minimax Regret Decision

		Decision	Good Economic Conditions	Bad Economic Conditions
• Payouts Table:	Expand		\$150,000	-\$10,000
	Renovate		\$90,000	\$10,000
	Do nothing		\$70,000	\$40,000

		Decision	Good Economic Conditions	Bad Economic Conditions	Maximum
• Regrets Table:	Expand		\$0	\$50,000	\$50,000
	Renovate		\$60,000	\$30,000	\$60,000
	Do nothing		\$80,000	\$0	\$80,000

- Minimum of maximum regrets = \$50,000. Choice = Expand!

2.4 Maximum-Weighted Decisions

Equally Likely Decision

- Suppose (for no reason whatsoever) that each outcome is equally likely.
- Compute weighted average of each decision (with equal weights).

- $P(\text{Good Economic Conditions}) = P(\text{Bad Economic Conditions}) = 0.5$.

	Decision	Good Economic Conditions	Bad Economic Conditions	“Expected” Value
• Equal Likelihood Table:	Expand	\$150,00	-\$10,000	\$70,000
	Renovate	\$90,000	\$10,000	\$50,000
	Do nothing	\$70,000	\$40,000	\$55,000

- Maximum “expected” value = \$70,000. Decision = Expand!

Hurwicz Decision

- Take a weighted average again, but choose an arbitrary weight for the best-case value.
- Coefficient of optimism, given by α , is a measure of the decision makers optimism.
- Best-case weight = α , worst-case weight = $(1 - \alpha)$.

	Decision	Good Economic Conditions	Bad Economic Conditions	“Expected” Value
• Suppose $\alpha = 0.2$ (very arbitrary).	Expand	\$150,00	-\$10,000	\$22,000
	Renovate	\$90,000	\$10,000	\$26,000
	Do nothing	\$70,000	\$40,000	\$46,000

- Maximum “expected” value = \$46,000. Decision = Do Nothing!

Dependence on Optimism

- Coefficient of optimism can be very difficult to choose.
- Optimal choice might vary a lot depending on this parameter.
- For each pair of decisions, find the cut-off value of α that leads one to switch decisions.

Summary of Results

Criterion	Decision
Maximax	Expand
Maximin	Do nothing
Minimax Regret	Expand
Equal Likelihood	Expand
Hurwicz ($\alpha = 0.2$)	Do nothing

- **Dominant decision:** when same choice is made for every criterion considered.
- **Dominated decision:** when choice is never made for every criterion considered.

3 Decision Making With Probabilities

3.1 Expected Values

[shrink]

Expected Values: Probabilities Known

- Suppose probabilities for good economic conditions and bad economic conditions are known.
- Suppose $P(\text{Good Economic Conditions}) = 0.6$, $P(\text{Bad Economic Conditions}) = 0.4$.

Decision	Good Economic Conditions	Bad Economic Conditions	Expected Value
Expand	\$150,000	-\$10,000	\$86,000
Renovate	\$90,000	\$10,000	\$58,000
Do nothing	\$70,000	\$40,000	\$58,000

- Maximum expected value = \$86,000. Decision = Expand!
- A **risk neutral** decision maker should make this decision.

Expected Opportunity Loss

- **Expected opportunity loss (EOL)** = expected value of regret for each decision.

Decision	Good Economic Conditions	Bad Economic Conditions	Expected Value
Expand	\$0	\$50,000	\$20,000
Renovate	\$60,000	\$30,000	\$48,000
Do nothing	\$80,000	\$0	\$48,000

- Minimum expected regret = \$20,000. Decision = Expand!
- Minimum expected loss decision *will always be equal to* maximum expected value decision.

Expected Value of Perfect Information

- Suppose you could purchase “perfect information” about what will happen. How much would you pay?
- If you were told good economic conditions:
 - Decision = Expand, Profit = \$150,000.
- If you were told bad economic conditions:
 - Decision = Do nothing, Profit = \$40,000.
- A priori expected profit (given you will make a perfect decision):
 - Expected Profit = $(0.6)(\$150,000) + (0.4)(\$40,000) = \$106,000$.
- Expected profit from maximizing expected value = \$86,000.
- $EVPI = \$106,000 - \$86,000 = \$20,000$.
- Not coincidentally, $EVPI = EOL$.

3.2 Bayesian Analysis

Bayesian Analysis

- **Bayesian analysis:** decision making using additional information which alter conditional probabilities.
- Suppose $P(\text{good economic conditions})$, $P(\text{bad economic conditions})$ are simply based on past history.
- Suppose your the Minneapolis Federal Reserve Bank issues an economic report (which they do) that indicates whether they have a positive economic outlook or a negative economic outlook.
- This is useful information, but not *perfect information*.
- Define the following events:
 - P: positive economic report.
 - N: negative economic report.
 - g: Good economic conditions.
 - b: Bad economic conditions.
- Of course, $P(P) = 1 - P(N)$, $P(g) = 1 - P(b)$.

Bayesian Analysis

- Suppose generally, good economic conditions occur 60% of the time, and bad economic conditions occur 40% of the time.
- Suppose past experience indicates the Federal Reserve report accurately forecasts...
 - good economic conditions 80% of the time, and
 - bad economic conditions 90% of the time.
- Probabilities:
 - $P(P|g) = 0.8$, $P(N|g) = 0.2$.
 - $P(N|b) = 0.9$, $P(P|b) = 0.1$.
 - $P(g) = 0.6$, $P(b) = 0.4$.

Bayesian Analysis

Suppose a positive report came out. We want to know $P(g|P)$:

$$\begin{aligned} P(g|P) &= \frac{P(g \cap P)}{P(P)} = \frac{P(P|g)P(g)}{P(P|g)P(g) + P(P|b)P(b)} \\ &= \frac{(0.8)(0.6)}{(0.8)(0.6) + (0.1)(0.4)} = 0.923 \end{aligned}$$

Compute Conditional Expected Values

- Now use $P(g|P)$ and $P(b|P)$ to find decision that maximizes expected value. What is the expected value?
- What would your decision be if there was a negative report? What is the expected value?

4

4.1 Next time on Business Decision Making and Research...

Next time...

- (Re)read the textbook on this topic (BWT, Chapter 12).
- Homework assignment: End of Chapter 12 problems 7,8,9,18,19.
 - Type up your answers and post them in D2L dropbox.
- Quiz on this topic.
- Next topic: Simulation (BWT, Chapter 14).