Risk Concepts and Management

Managerial Economics

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IT'S CALLED RISK MANAGEMENT
MAYBE YOU'VE HEARD OF IT

Introduction

Up until now we have assumed that decision makers face no uncertainty

- They know prices with certainty
- They know about all input and output relationships with certainty

We will now allow for the possibility of uncertainty in specific ways, still imposing some structure on the uncertainty

$\rightarrow$ What does this mean?

Overview

- Describing Outcome Distributions
- Risk Attitudes and Choice Criteria
- Probabilistic Budgeting
- Managing Risk

Risk and Uncertainty

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What is risk?

Risk: uncertainty about deviation from expected earnings or expected outcome

Describing Outcome Distributions

- We will allow for uncertainty: we do not know exactly what the payoff of specific actions will be
- However, we will assume that we know the distribution of possible outcomes (what are outcomes?)
- In other words: we know all the possibilities and how likely each one of them is
- Analogy: throwing dice (board)

Payoff Matrices

A payoff matrix is a way of describing the distribution of outcomes for a risky choice

- Alternative Actions
- Probabilities for each state of nature
- States of nature
- Payoffs for each alternative in each state

State of Nature	Job A	Job B	Job C	Probability
1	33,000	29,000	20,000	1/6
2	33,000	32,000	27,000	1/6
3	33,000	33,000	33,000	1/6
4	33,000	34,000	40,000	1/6
5	33,000	35,000	43,000	1/6
6	33,000	38,000	47,000	1/6

Q: Can we describe all distributions with a payoff matrix?

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Q: Can we describe all distributions with a payoff matrix? Hint: discrete v continuous outcomes

Describing Outcomes

There are other ways of describing a distribution of outcomes.

- Mean (or expected value): measuring central tendency

$$E(\pi) = \sum_{i=1}^{n} p_i \pi_i$$

- Variance or standard deviation: measuring dispersion

$$V(\pi) = \sum_{i=1}^{n} p_i (\pi_i - E(\pi))^2 \qquad S(\pi) = \sqrt{V(\pi)}$$

- Coefficient of variation: measuring dispersion relative to the mean

$$CV(\pi) = \frac{S(\pi)}{E(\pi)}$$

We can calculate these for discrete or continuous outcomes

Risk Attitudes and Choice Criteria

- Even with the same information and beliefs about the outcome distribution for alternative actions, people can make different choices.
- We attribute this to "risk attitudes or preferences": not everybody sees risk in the same way
- One way of doing this is using a utility function that represents utility of different outcomes
- And then computing expected utility as:

$$EU = \sum_{i=1}^{n} p_i U(\pi_i)$$

The expected utility agent maximizes this function

Risk Aversion

- What is risk aversion?

Risk Aversion

- What is risk aversion?
- Example definition (from Investopedia)

  The term risk-averse refers to investors who, when faced with two investments with a similar expected return, prefer the lower-risk option.
- Agents lose expected utility in the face of uncertainty
- Risk averse agents are willing to forego expected benefits in order to avoid risk

Expected Utility example

- Take the following utility function: $u(x) = \sqrt{x}$
- A person with this utility function exhibits risk aversion.
- Example: Two possible states of the world, equally likely: getting zero or 9 dollars. What is this agent's expected utility?

Expected Utility example

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- Example: Two possible states of the world, equally likely: getting zero or 9 dollars. What is this agent's expected utility?
- How much would this agent be willing to take in order to eliminate the uncertainty?
- is that over the expected value of the outcome?

Expected Utility example

- What if another agent has a utility function of the form $u(x) = x$
- We call this agent a risk neutral agent
- Calculate the expected utility for this agent.
- How much would this agent be willing to take in order to eliminate uncertainty?
- is that over the expected value of the outcome?


I DON`T ALWAYS
MAXIMIZE
BUT WHEN I DO,
I MAXIMIZE EXPECTED UTILITY

Expected Utility Alternatives

- Expected utility maximization requires us to know (or assume) a utility function, and probability distribution of outcomes
- Game theoretic rules do not require full information on probability distributions
- Maximin: select the alternative with the best outcome on is worst-case scenario
- Maximax: select the alternative with the best outcome on is best-case scenario
- Minimax Regret: select the alternative with the smallest maximum regret. (Q: what is regret?)

Example

Payoff Matrix			Regret Matrix		
Job A	Job B	Job C	Job A	Job B	Job C
33,000	29,000	20,000	0	4,000	13,000
33,000	32,000	27,000	0	1,000	6,000
33,000	33,000	33,000	0	0	0
33,000	34,000	40,000	7,000	6,000	0
33,000	35,000	43,000	10,000	8,000	0
33,000	38,000	47,000	14,000	9,000	0

Q: What would maximin, maximax, minimax regret do? What do we need to maximize expected utility?

Probabilistic Budgeting

- We have assumed we knew outcome distributions
- Some times we don't even know that!
- Stochastic simulation (or probabilistic budgeting) is a method for estimating outcome distributions

1. Develop a budget formula for calculating performance measure
2. Divide variables in formula into three groups:
   1. Budget parameters known with certainty
   2. Externally determined random factors
   3. Choice variables

   Q: what are examples of each of these?
3. Determine states of nature defined by levels of uncertain variables
4. For each alternative, calculate performance measure for each state of nature

A Simple Example: outcome distributions for three loan portfolios

- Two tipes of loans:
  - Loan A has low but stable return: $E(R_A) = 0{,}02$, $S(R_A) = 0{,}0066$
  - Loan B has higher but more variable return: $E(R_B) = 0{,}025$, $S(R_B) = 0{,}017$

1. Budget formula: $\pi = R_A Loan_A + R_B Loan_B - 20,000$
2. Classify variables:
   1. budget parameter: FC=20,000
   2. random factors: R_A and R_B
   3. choice variables: $Loan_A$, $Loan_B$
3. States of nature (table next)
4. Calculate performance measure for each state of nature (table next)

Example: Table

				Strategy		
				I	II	III
State of Nature	Rates of Return R_A	R_B	$Loan_A$:	1,000,000	500,000	0
			$Loan_B$:	0	500,000	1,000,000
				Profit by State of Nature		
1	1.00%	5.00%		-$10,000	$10,000	$30,000
2	1.50%	4.00%		-$5,000	$7,500	$20,000
3	1.80%	3.00%		-$2,000	$4,000	$10,000
4	2.20%	2.00%		$2,000	$1,000	$0
5	2.50%	1.00%		$5,000	-$2,500	-$10,000
6	3.00%	0.00%		$10,000	-$5,000	-$20,000
Mean	2.00%	2.50%		$0	$2,500	$5,000
Std Dev	0.66%	1.71%		$6,557	$5,276	$17,078

Managing Risk

There are several strategies to manage risk

- *Diversification*: using resources for two or more enterprises with different risk-return characteristics
  - Works best when returns are negatively correlated (why?)
  - may require some sacrifice of expected return (why?)
  - It could increase expected utility (when?)
- *Insurance* allows a firm to pay a premium to transfer a portion of the risk to another firm
  - may reduce expected return (why?)

Managing Risk

- *Contracting* is an agreement in advance on price or quantity of a transaction
  - May have other benefits
  - limits exposure to loss and opportunity for gain (how?)
- *Hedging* is a risk management strategy that involves taking offsetting positions in the ownership of an asset (can you construct an example?)
- *Gathering Information* can reduce uncertainty by gaining more knowledge.
  - may increase expected return and reduce risk
  - increased expenditure: only valuable if new information changes actions


WHAT IF I TOLD YOU
RISK MANAGEMENT DOES'NT HAVE TO BE HARD
memegenerator.net