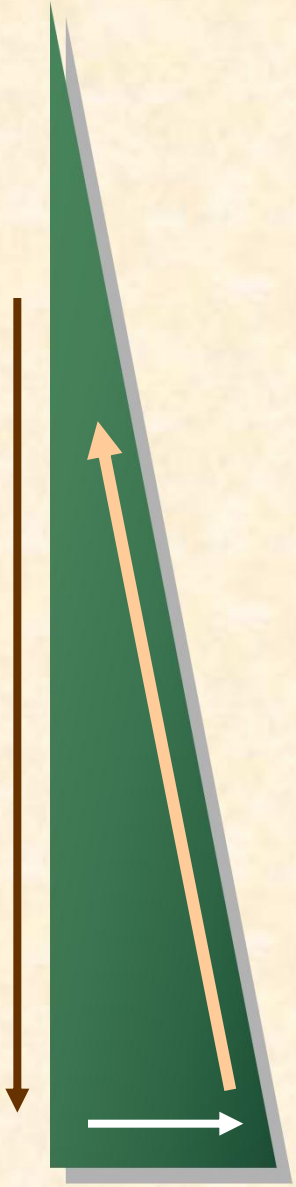


Chapter 5

Choice Under Uncertainty

Topics to be Discussed

- Describing Risk
- Preferences Toward Risk
- Reducing Risk
- The Demand for Risky Assets

Introduction

- Choice with certainty is reasonably straightforward.
- How do we choose when certain variables such as income and prices are uncertain (i.e. making choices with risk)?

Describing Risk

- To measure risk we must know:

  1) All of the possible outcomes.

  2) The likelihood that each outcome will occur (its probability).

Describing Risk

- Interpreting Probability
  - The likelihood that a given outcome will occur

Describing Risk

- Interpreting Probability
  - Objective Interpretation
    - Based on the observed frequency of past events

Describing Risk

- Interpreting Probability
  - Subjective
    - Based on perception or experience with or without an observed frequency
      - Different information or different abilities to process the same information can influence the subjective probability

Describing Risk

- Expected Value
  - The weighted average of the payoffs or values resulting from all possible outcomes.
    - The probabilities of each outcome are used as weights
    - Expected value measures the *central tendency*; the payoff or value expected on average

Describing Risk

- An Example
  - Investment in offshore drilling exploration:
  - Two outcomes are possible
    - Success -- the stock price increase from $30 to $40/share
    - Failure -- the stock price falls from $30 to $20/share

Describing Risk

- An Example
  - Objective Probability
    - 100 explorations, 25 successes and 75 failures
    - Probability (Pr) of success = 1/4 and the probability of failure = 3/4

Describing Risk

Expected Value (EV)

- An Example:

$$EV = \Pr(\text{success})(\$40/\text{share}) + \Pr(\text{failure})(\$20/\text{share})$$

$$EV = 1/4\,(\$40/\text{share}) + 3/4\,(\$20/\text{share})$$

$$EV = \$25/\text{share}$$

Describing Risk

- Given:
  - Two possible outcomes having payoffs X_1 and X_2
  - Probabilities of each outcome is given by Pr_1 & Pr_2

Describing Risk

- Generally, expected value is written as:

$$E(X) = Pr_1X_1 + Pr_2X_2 + \ldots + Pr_n\ X_n$$

Describing Risk

- Variability
  - The extent to which possible outcomes of an uncertain even may differ

Describing Risk

Variability

- A Scenario
  - Suppose you are choosing between two part-time sales jobs that have the same expected income ($1,500)
  - The first job is based entirely on commission.
  - The second is a salaried position.

Describing Risk

Variability

- A Scenario
  - There are two equally likely outcomes in the first job--$2,000 for a good sales job and $1,000 for a modestly successful one.
  - The second pays $1,510 most of the time (.99 probability), but you will earn $510 if the company goes out of business (.01 probability).

Describing Risk

Income from Sales Jobs

	Outcome 1		Outcome 2		
	Probability	Income ($)	Probability	Income ($)	Expected Income
Job 1: Commission	.5	2000	.5	1000	1500
Job 2: Fixed salary	.99	1510	.01	510	1500

Describing Risk

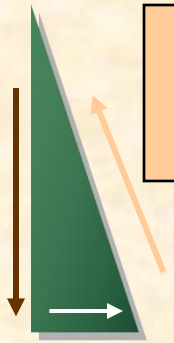
Income from Sales Jobs

- Job 1 Expected Income

$$E(X_1) = .5(\$2000) + .5(\$1000) = \$1500$$

- Job 2 Expected Income

$$E(X_2) = .99(\$1510) + .01(\$510) = \$1500$$



Describing Risk

- While the expected values are the same, the variability is not.
- Greater variability from expected values signals greater risk.
- Deviation
  - Difference between expected payoff and actual payoff

Describing Risk

Deviations from Expected Income ($)

	Outcome 1	Deviation	Outcome 2	Deviation
Job 1	$2,000	$500	$1,000	-$500
Job 2	1,510	10	510	-900

Describing Risk

Variability

- Adjusting for negative numbers
- The standard deviation measures the square root of the average of the *squares* of the deviations of the payoffs associated with each outcome from their expected value.

Describing Risk

Variability

- The standard deviation is written:

$$\sigma = \sqrt{\Pr_1\left[X_1 - E(X)^2\right] + \Pr_2\left[X_2 - E(X)^2\right]}$$

Describing Risk

Calculating Variance ($)

	Deviation Squared	Outcome 2	Deviation Squared	Deviation Squared	Standard Deviation	Outcome 1
Job 1	$2,000	$250,000	$1,000	$250,000	$250,000	$500.00
Job 2	1,510	100	510	980,100	9,900	99.50

Describing Risk

- The standard deviations of the two jobs are:

$$\sigma_1 = \sqrt{.5(\$250{,}000) + .5(\$250{,}000}$$

$$\sigma_1 = \sqrt{\$250{,}000}$$

$$\sigma_1 = 500$$ ***Greater Risk**

$$\sigma_2 = \sqrt{.99(\$100) + .01(\$980{,}100)}$$

$$\sigma_2 = \sqrt{\$9{,}900}$$

$$\sigma_2 = 99.50$$

Describing Risk

- The standard deviation can be used when there are many outcomes instead of only two.

Describing Risk

Example

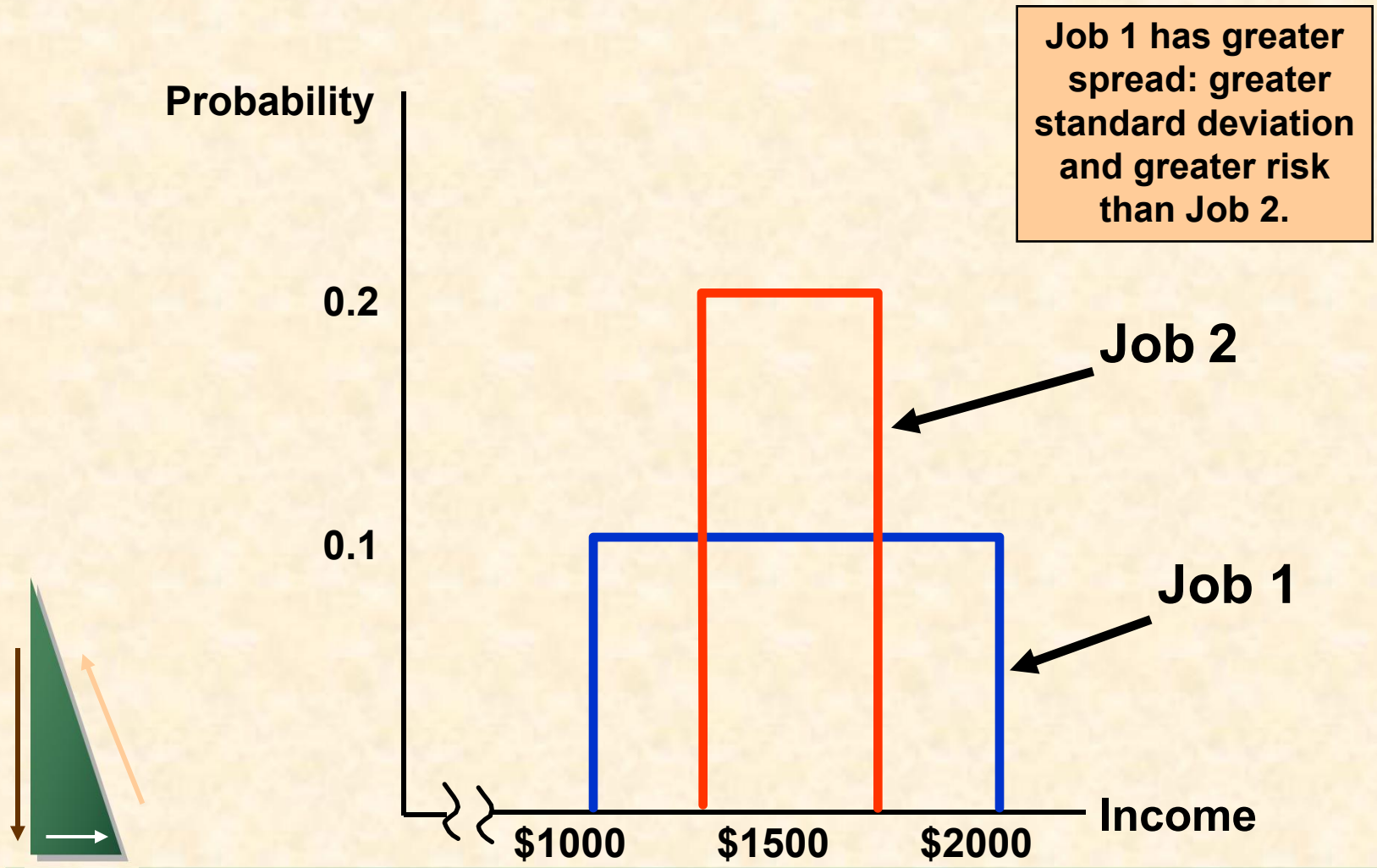
- Job 1 is a job in which the income ranges from $1000 to $2000 in increments of $100 that are all equally likely.

Describing Risk

Example

- Job 2 is a job in which the income ranges from $1300 to $1700 in increments of $100 that, also, are all equally likely.

Outcome Probabilities for Two Jobs



Describing Risk

- Outcome Probabilities of Two Jobs (unequal probability of outcomes)
  - Job 1: greater spread & standard deviation
  - Peaked distribution: extreme payoffs are less likely

Describing Risk

- Decision Making
  - A risk avoider would choose Job 2: same expected income as Job 1 with less risk.
  - Suppose we add $100 to each payoff in Job 1 which makes the expected payoff = $1600.