Risk and Return: Introduction

- Traditionally, risk is viewed as a "negative".
- Webster's dictionary defines *risk* as "exposing to danger or hazard".
- However, risk is a mix of danger and opportunity (*no risk, no return!*):
  - the opportunity component encourages investors and companies to take on risk,
  - the danger component requires that they be rewarded for taking the risk.

How should we model risk and return in projects?

- Formulate a universal measure for risk.
  - should be easily quantifiable.
  - should be applicable to all investments (stocks, bonds, real estate, etc.), as they all compete for the same investment dollar.
- Specify what types of risk are rewarded and what are not.
- Translate the risk measure into an expected 'benchmark' return (risk premium measurement).
- The risk measure should work in real life, i.e., in the long run and across the cross section of investments, the risk measure should be positively correlated with returns.

The notion of a benchmark

- Since financial resources are finite, there is a hurdle that projects have to cross before being deemed acceptable.
- This hurdle will be *higher for riskier projects* than for safer projects.
- A simple representation of the hurdle rate is:

  Hurdle rate = Riskless rate + Risk premium

  - Riskless rate is what you would make on a riskless investment.
  - Risk premium is the extra return you demand for the riskiness of the project.
  - Risk premium is an increasing function of the riskiness of the project.

What is Risk?

- Uncertainty about returns.
- Consider two assets A & B, and their returns in 3 equally likely future states of the economy:

Future State of the Economy	Percentage Return	
	A	B
Boom	20%	5%
Stagnation	5%	5%
Bust	-10%	5%

  - Here, A is a *risky asset* as there is uncertainty (or *variability*) about its future returns.
  - B is *riskless*, as its return remains the same no matter what happens to the economy.
  - Both (A & B) have same *expected* returns (5%).
  - *Which one would you pick, and why?*

Why should risk demand a premium?

- Suppose you can pick one of the following two:
  - Receive $1 million for sure (option A), or
  - Participate in a lottery (option B), where you have a 99% chance of winning $1.1 million but a 1% chance of losing $8.9 million.

  Which one would you pick, and why?
- Both have same *expected* values ($ 1 million).
- Suppose you have the following five options, instead of the previous situation:

Probability	Cash Gain				
	A	B	C	D	E
50%	20k	0	0	0	0
50%	20k	40k	50k	60k	70k

Which one would you pick, and why?

- The investor has to be induced (by offering extra returns) to take on risk - the investor will only hold a risky security if its expected return is high enough to compensate for its risk.
- This extra (expected) return is the risk premium.

How should we measure risk?

- Which one would you pick?

Probability	Cash Gain				
	A	B	C	D	E
50%	20k	15k	10k	5k	0
50%	20k	25k	30k	35k	40k

Which one is the least attractive, and why?

- The variance in anticipated returns comprises the risk on the investment.
- Variance measures the disparity between actual and expected (mean) returns.
- Statistically, variance measures the squared difference between actual and expected returns.
- When all states are equally likely, the variance is given by:

$$Var(R) = \sum_{i=1}^{n} \frac{[R_i - E(R)]^2}{n}$$

- When different states have different probabilities of occurrence, p_i, the variance is given by:

$$VaR(R) = \sum_{i=1}^{n} p_i [R_i - E(R)]^2$$

- Higher variance implies higher risk.
- If returns follow a distribution, the variance of that distribution captures the *risk of these returns.*
- Standard deviation (σ), the square root of variance, is an equivalent risk measure.

$$\sigma(R) = \sqrt{Var(R)}$$

Why Variance?

- Why should variance be used, instead of some other measure of the variability of the return distribution?
  - theoretically, leads to elegant risk-return models.
  - empirically, for various investment classes, the average returns are found to be positively related to the variance of returns.

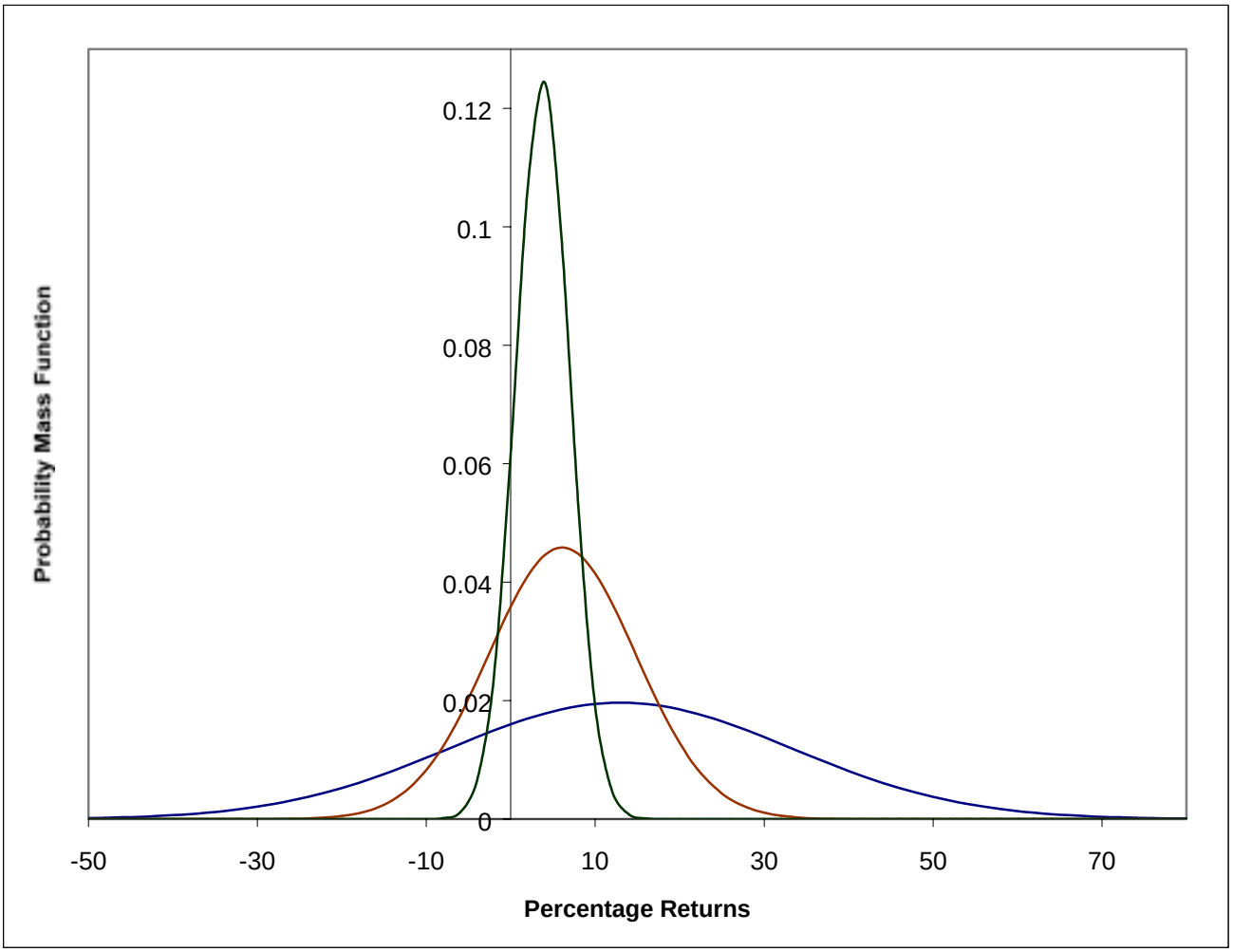
Investment Class	Avg Annual Return (%)	Standard Deviation (%)
Small Stocks	17.7	33.9
Common Stocks	13.0	20.3
LT Corporate Bonds	6.1	8.7
LT Govt Bonds	5.6	9.2
US Treasury Bills	3.8	3.2
Inflation	3.2	4.5

(1926-1997)

- The long-run excess return (the risk premium) on stocks over T-bills (riskfree assets) has been 9.2%. Is this justifiable?

The Normal Distribution

Probability distribution of returns for stocks, corporate bonds and T-bills, assuming normal distribution.



What part of risk should be rewarded?

- Not all part of the risk of a security is rewarded by financial markets.
- Some of the risk of a security can be *diversified* away by taking positions in a large array of other securities (stocks, bond, real estate, etc.).
- Only the non-diversifiable part of risk is rewarded by efficient markets.
- The contribution of the security to the risk of a portfolio can be different from the risk of the security in isolation.

Example: Consider the following returns scenario (under three economy growth rates) for two stocks A & B, and an index I, over the next one year:

Economy	Next-year return		
	A	B	I
High growth	-5%	12%	15%
Stagnation	5%	5%	5%
Negative growth	15%	-2%	-5%

- Var(A)>Var(B).
- Should A have a higher expected return?
- Consider two portfolios: A+I and B+I. Which portfolio has higher risk?
- Which stock (A or B) contributes more to the entire portfolio risk, when combined with the index?
- Even though A has higher stand-alone risk, its risk is nullified when combined with the index. So A should not command a risk premium!