Chapter 10: Introduction to Risk, Return, and the Opportunity Cost of Capital

Holding Period Rate of Return

The return from holding an investment for one period

$$r = \frac{D_1 + \left(P_1 - P_0\right)}{P_0}$$

Expected Dividend returns $= \frac{\mathrm{D}_1}{\mathrm{P}_0}$

Expected Capital Gains returns = $\frac{P_1 - P_0}{P_0}$

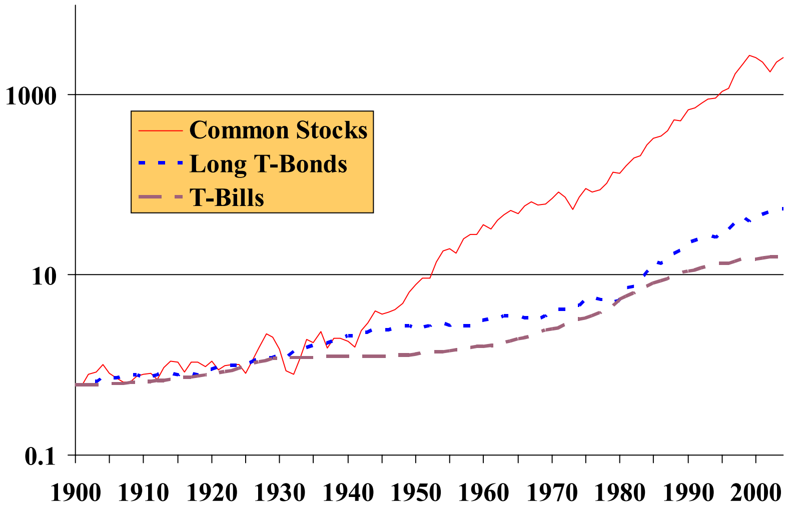
Return = $\frac{\text{Amount Received – Amount Invested}}{\text{Amount Invested}}$

Example: If you buy a share for \$60 and within one year you received \$3 dividends on the stock then you were able to sell it after one year for \$ 80, the return on your investment would be

$$= \frac{80+3-60}{60} = 0.3833 \text{ or } 38.33\%$$

Financial markets historical returns:

The historical returns of Treasury bills, long-term Treasury bonds, corporate bonds, and common stock are compared in Figures 10.1.



With Treasury bills' average returns at the low end of the risk scale, a **maturity premium** is added for long-term Treasury bond returns.

The return differentials between risk-free Treasury bills and corporate bonds and common stock returns is a **risk premium**, or the added return required by investors to invest in risky securities.

Long-term average returns are a starting point in estimating required rates of return for the future, and the opportunity rate of return used in the capital budgeting process.

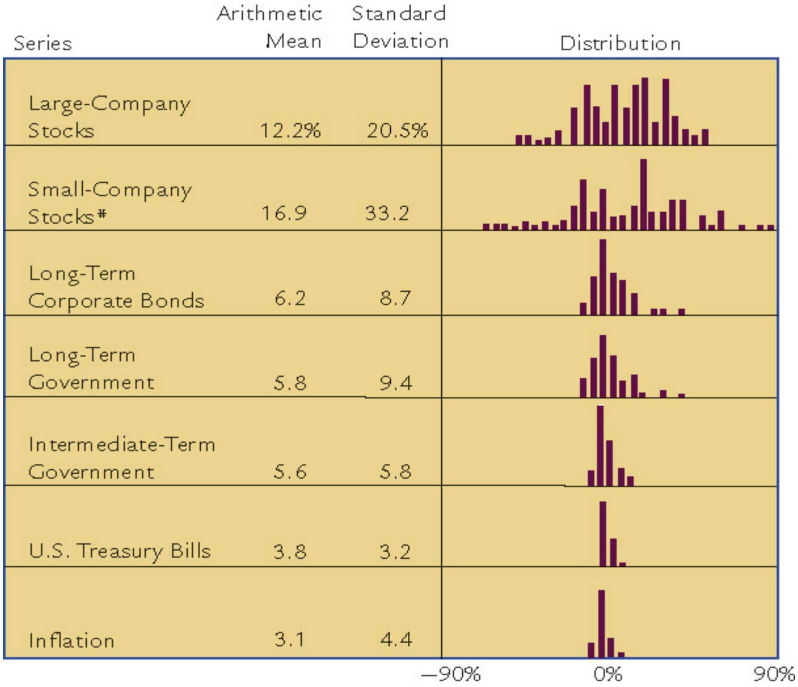
The riskier securities had wider fluctuations in their yearly returns.

A dollar invested at the end of 1925 will be worth how many dollars at the end of 2002?

Small-company stocks → $6,816.41
Large-company stocks → $1,775.34
Long-term government bonds → $59.70
Treasury bills → $17.48

Why would not everybody invest in Small-company stocks?
Can you identify risk visually from the trend line for each security class?

Historical Rates of Return 1926-2002



Series	Arithmetic Mean	Standard Deviation	Distribution
Large-Company Stocks	12.2%	20.5%	
Small-Company Stocks*	16.9	33.2	
Long-Term Corporate Bonds	6.2	8.7	
Long-Term Government	5.8	9.4	
Intermediate-Term Government	5.6	5.8	
U.S. Treasury Bills	3.8	3.2	
Inflation	3.1	4.4	

Stock Market Averages:

Price-weighted index:

- Dow Jones Industrial Average

Value-weighted indices:

- S&P 500 ,NYSE Composite, AMEX Composite, NASDAQ Composite, Saudi sock index

THE MEANING OF RISK

- **Risk and Uncertainty:** People tend to call something risky if there are more than one possible outcome and some outcomes are bad. For example, gambles, speeding.

How about holding a financial security? Is it risky? How?

➔ Variability of return → Default risk

- Risk in finance is not only related to bad events.

More formally:

Risk from finance perspective is the possibility that actual future returns will deviate form expected returns

Expected Return: a statistical measure of the mean or average value of possible returns.
Each possible return is weighted by its own probability or chance of happening. The sum of all these weighted possible returns is the expected return.

$$\hat{r} = \sum_{j=1}^{n} r_j p_j$$ **For n possible returns**

<u>Probability Distribution is</u> List of possible outcomes using probabilities. These probabilities must sum to 1

<u>Example:</u>

You hold a stock in XYZ Co. and the state of economy is uncertain with three possible states associated with their probability. The return on XYZ Co. stock is going to be different among the three omissible states. Calculate the expected return on the XYZ Co.

State of Economy	Probability	Return
Strong	0.3	20%
Normal	0.4	10%
Weak	0.3	-2%
	1	

$$\hat{r} = \sum_{j=1}^{3} r_j p_j = r_1 p_1 + r_2 p_2 + r_3 p_3$$

State of Economy	Probability	Return	Weighted return	
Strong	**0.3**	**20%**	**0.3 * 20% = 6%**	
Normal	**0.4**	**10%**	**0.4 * 10% = 4%**	**sum**
Weak	**0.3**	**-2%**	**0.3 * -2% = -0.6%**	
	1		Expected Return $\hat{r}$ = 9.4%	

The uncertainty with respect to which state of nature will occur causes the riskiness (variability) in the returns.

How to measure Risk mathematically?

<u>Standard Deviation</u>: a statistic that captures the degree of dispersion around the mean or the expected value.

The larger the Standard Deviation the more variable is the return and the riskier is the stock.

$$\sigma = \sqrt{\sum_{j=1}^{n} \left[(r_j - \hat{r})^2 * p_j \right]}$$

Standard deviation (sigma σ):

1. Calculate expected return $\hat{r}$
2. Find deviation $r_j - \hat{r}$
3. Squaring deviation $(r_j - \hat{r})^2 = (r_j - \hat{r})*(r_j - \hat{r})$
4. Multiply Squaring deviation by probability $\left[(r_j - \hat{r})^2 * p_j \right]$
5. Calculate the variance (V) by summing the amount in step 4 over all possible returns.
   $\sigma^2 = \sum_{j=1}^{n} \left[(r_j - \hat{r})^2 * p_j \right]$
6. Find the square root of the variance to find the standard deviation $\sigma = \sqrt{\sigma^2}$

Therefore the standard deviation is the weighted average of the deviations from the expected value.

The previous calculations of expected return and risk are based on **subjective distribution.** It is subjective because it depends on people's expectation. The mean and standard deviation in subjective distribution are mostly **based on discrete distribution of outcomes.** It is discrete because returns take only countable number of certain specific values.

Objective Distribution

Objective Distributions are based on objective data such as historical data.

Expected Return:

$$\hat{r} = \frac{\sum_{j=1}^{n} r_j}{n}$$ **for n periods**

Standard Deviation:

$$\sigma = \sqrt{\frac{\sum_{j=1}^{n} (r_j - \hat{r})^2}{n}}$$

See Table 10.4

Risk in a Portfolio Context

Portfolio = Investment in multiple assets

Expected return on a Portfolio = $r_p = \sum_{j=1}^{n} w_j r_j = w_1 r_1 + w_2 r_2 + ... + w_n r_n$

For n securities

= (The sum of the weighted average of the expected returns of individual securities in the portfolio).(*Weighted by amount invested*)

Example 1:
Suppose a portfolio consists of an equal investment in the following stocks. By using the expected return on each stock, calculate the portfolio return.

Stocks	Expected Return
Stock A	10%
Stock B	8%
Stock C	-3%
Stock D	20%

$r_p = \sum_{j=1}^{4} w_j r_j$ **= 0.25(10%) + 0.25(8%) + 0.25(-3%)+0.25(20%)= 8.75**

Example 2:
Suppose a portfolio consist of the following stocks with the amount of dollars Invested in each stock and the expected return on each stock. Calculate the portfolio return.

Stocks	Amount invested	Expected Return	weights
Stock A	$40,000	10%	0.4=[40,000/100,000]
Stock B	$10,000	8%	0.1=[10,000/100,000]
Stock C	$20,000	-3%	0.2=[20,000/100,000]
Stock D	$30,000	20%	0.3=[30,000/100,000]
	$100,000 (Total Investment)		1 (total of weights)

$r_p = \sum_{j=1}^{4} w_j r_j$ = 0.4(10%) + 0.1(8%) + 0.2(-3%)+0.3(20%)= 10.2%

- **In almost every case the portfolio risk is actually smaller than the weighted average of the risks of the individual assets in the portfolio.**

Why does this happen (using the example of stocks) ?
==➔ Because of Correlation between stocks

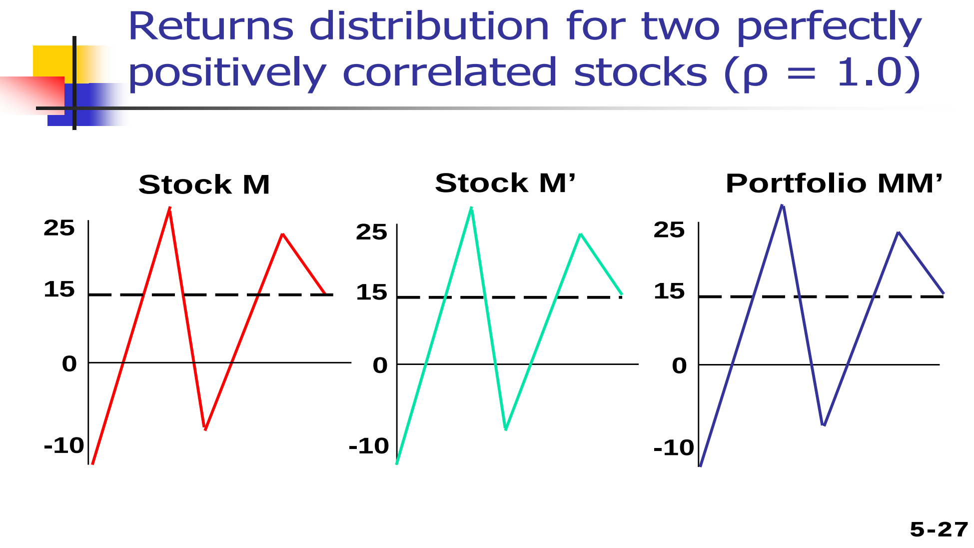
- **Correlation is the tendency of stocks to move together**
- **It is measured by the Correlation Co-efficient.**

Example: in a portfolio of two stocks A and B, the total risk of the portfolio is measured as the standard deviation of the portfolio return:

$$\sigma_p = \sqrt{w_A^2\sigma_A^2 + w_B^2\sigma_B^2 + 2w_A w_B \sigma_A \sigma_B \rho_{A,B}}$$

Correlation Coefficient ρ :

- Always between –1.0 and 1.0
- 1.0 signifies a perfectly positive correlation (in this case, the portfolio risk and the weighted average of individual assets risk in the portfolio will be equal)
- - 1.0 signifies a perfectly negative correlation
- 0 would signify that the stocks are totally uncorrelated
- Most stocks are positively correlated between 0.5 and 0.7 (so when a portfolio of stocks is formed, the risk gets reduced but not totally eliminated).



Returns distribution for two perfectly positively correlated stocks (ρ = 1.0)

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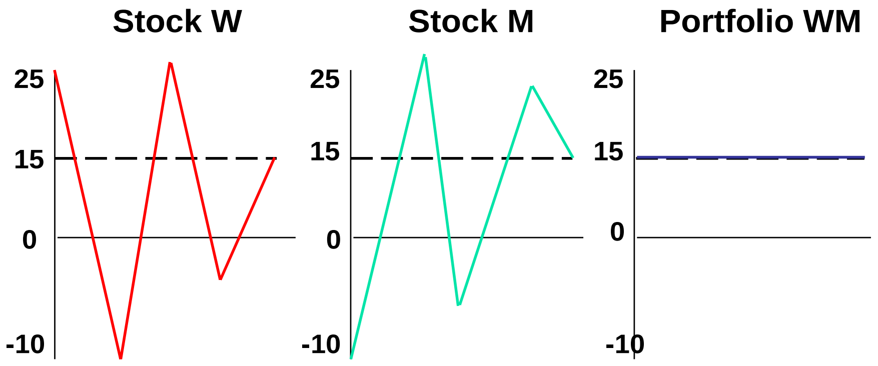
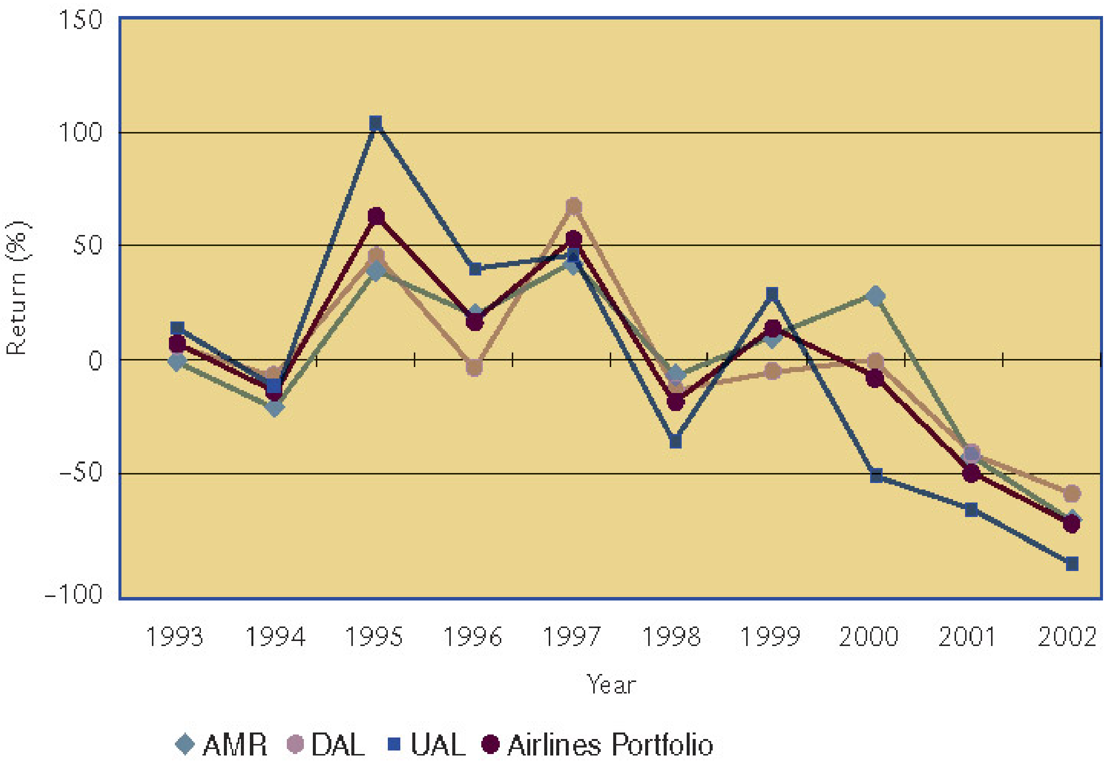
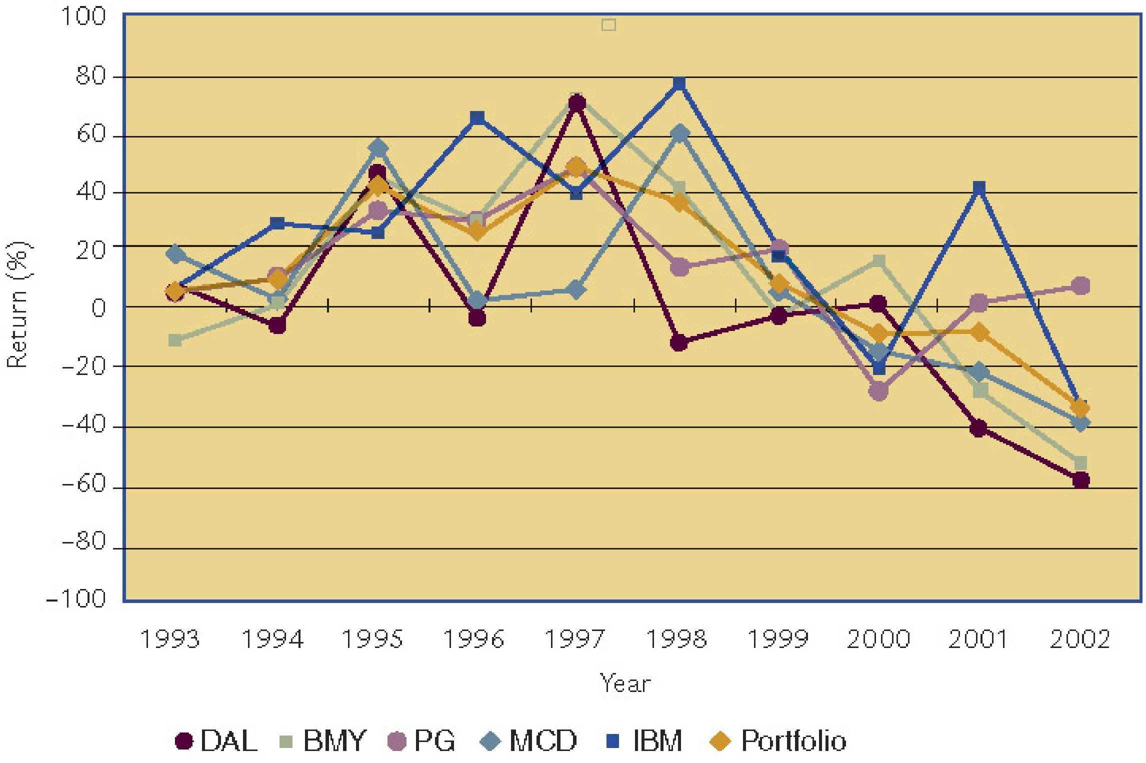
Returns distribution for two perfectly negatively correlated stocks (ρ = -1.0)







Portfolio’s Total Risk

Diversifiable Risk or Unsystematic Risk or Firm-specific risk or Unique risk

-Can be eliminated by Diversifying

(Buying different stocks)

- Firm Specific risk

-Not rewarded with Risk Premium

(As per the CAPM method)

Undiversifiable Risk or Systematic Risk or Market Risk

- Cannot be eliminated by Diversification

- Affects all firms

- Relevant type of risk for pricing securities.

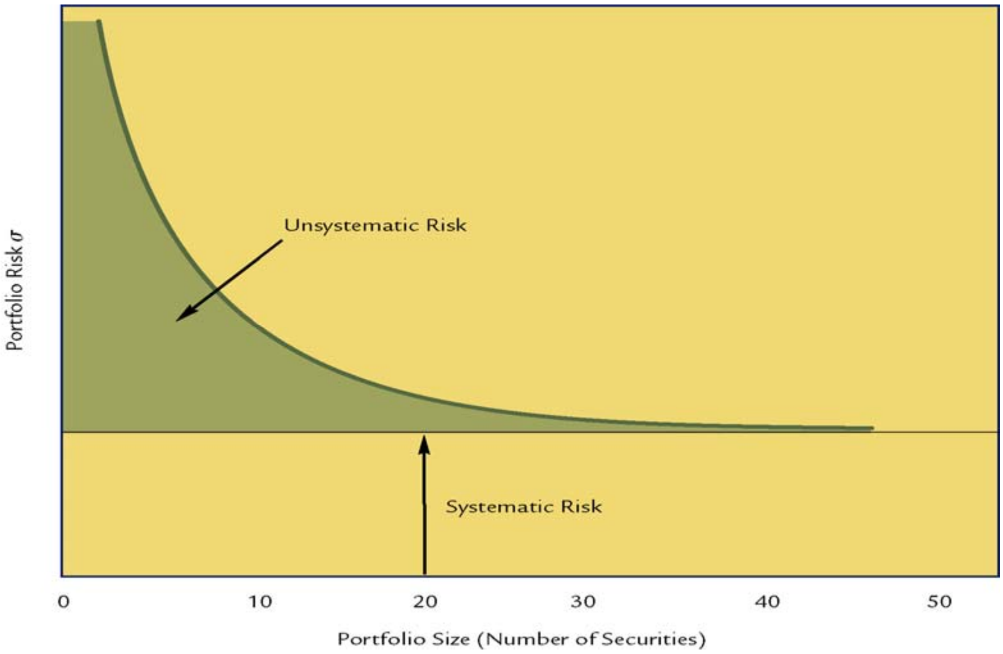
- Rewarded with risk premium

Diversifiable risk – a portion of a security's risk associated with random events
(a bad event for 1 company may be offset (diversified)
against good events in another company.)

Market risk- factors that affect most firms, therefore they can not be eliminated by diversification

The more we diversify across different industries the more we are able to eliminate unsystematic risk

Normally the riskiness of a portfolio declines as we include more and more stocks in it.



Theoretically, as we add more stocks to a portfolio, the unsystematic risk is reduced, and if we carry this diversification far enough we can eliminate all unsystematic risk. For this to happen, we must invest in all assets that exist in the economy (stock, bonds, real estate, gold, etc. to form a market portfolio. Because this is almost impossible, we use a proxy for the market portfolio (for example S&P 500 index).

Because the market portfolio is well diversified and is only subject to systematic risk we can use it as a reference to measure the systematic risk on individual stocks.