Introduction To Risk & Return

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E. Zivot 2005
R.W. Parks/L.F. Davis 2004

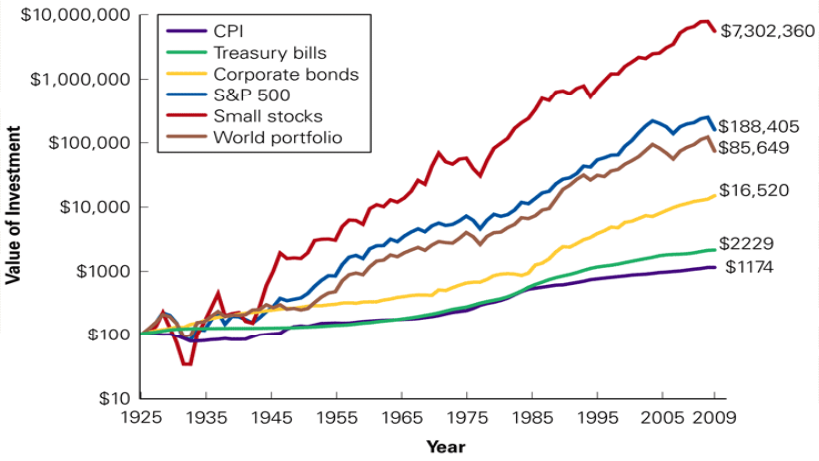
A First Look at Risk and Return

- Standard & Poor's 500: 90 U.S. stocks up to 1957 and 500 after that. Leaders in their industries and among the largest firms traded on U.S. Markets.
- Small stocks: Securities traded on the NYSE with market capitalizations in the bottom 10%.
- World Portfolio: International stocks from all the world's major stock markets in North America, Europe, and Asia.

A First Look at Risk and Return (cont'd)

- Corporate Bonds: Long-term, AAA-rated U.S. corporate bonds with maturities of approximately 20 years.
- Treasury Bills: An investment in three-month Treasury bills.

Figure 10.1 Value of $100 Invested at the End of 1925



Source: Chicago Center for Research in Security Prices (CRSP) for U.S. stocks and CPI, Global Finance Data for the World Index, Treasury bills and corporate bonds.

A First Look at Risk and Return (cont'd)

- Small stocks had the highest long-term returns, while T-Bills had the lowest long-term returns.
- Small stocks had the largest fluctuations in price, while T-Bills had the lowest.
  - » Higher risk requires a higher return.

Historical Returns of Stocks and Bonds

- Computing Historical Returns
  - » Realized Return
    - – The return that actually occurs over a particular time period.

$$R_{t+1} = \frac{Div_{t+1} + P_{t+1}}{P_t} - 1 = \frac{Div_{t+1}}{P_t} + \frac{Div_{t+1} - P_t}{P_t}$$

$$= \text{Dividend Yield} + \text{Capital Gain Rate}$$

Historical Returns of Stocks and Bonds (cont'd)

- Computing Historical Returns
  - » If you hold the stock beyond the date of the first dividend, then to compute your return you must specify how you invest any dividends you receive in the interim. Let's assume that *all dividends are immediately reinvested and used to purchase additional shares of the same stock or security*.

Historical Returns of Stocks and Bonds (cont'd)

- Computing Historical Returns
  - » If a stock pays dividends at the end of each quarter, with realized returns $R_{Q1}, \ldots, R_{Q4}$ each quarter, then its annual realized return, R_{annual}, is computed as:

$$1 + R_{\text{annual}} = (1 + R_{Q1})(1 + R_{Q2})(1 + R_{Q3})(1 + R_{Q4})$$

Example: Computing Historical Returns

- **Problem:**
  - » What were the realized annual returns for Ford stock in 1999 and in 2008?

Example: Computing Historical Returns

- **Solution**
  - » First, we look up stock price data for Ford at the start and end of the year, as well as dividend dates. From these data, we construct the following table:

Date	Price ($)	Dividend ($)	Return	Date	Price ($)	Dividend ($)	Return
12/31/1998	58.69			12/31/2007	6.73	0	
1/31/1999	61.44	0.26	5.13%	3/31/2008	5.72	0	-15.01%
4/30/1999	63.94	0.26	4.49%	6/30/2008	4.81	0	-15.91%
7/31/1999	48.5	0.26	-23.74%	9/30/2008	5.2	0	8.11%
10/31/1999	54.88	0.29	13.75%	12/21/2008	2.29	0	-55.96%
12/31/1999	53.31		-2.86%				

Alternative Example 10.2 (cont'd)

- **Solution**
  - » We compute each period's return. For example, the return from December 31, 1998 to January 31, 1999 is:

$$\frac{61.44 + 0.26}{58.69} - 1 = 5.13\%$$

  - » We then determine annual returns by compounding the quarterly returns:

$$R_{1999} = (1.0513)(1.0449)(0.7626)(1.1375)(0.9714) - 1 = -7.43\%$$
$$R_{2008} = (0.8499)(0.8409)(1.0811)(0.440) - 1 = -66.0\%$$

Example: Computing Historical Returns

- **Solution**
  - » Note that, since Ford did not pay dividends during 2008, the return can also be computed as:

$$\frac{2.29}{6.73} - 1 = -66.0\%$$

Realized Return for the S&P 500, GM, and Treasury Bills, 1999–2008

Year End	S&P 500 Index	Dividends Paid*	S&P 500 Realized Return	GM Realized Return	3-Month T-Bill Return
1998	1229.23				
1999	1469.25	18.10	21.0%	25.1%	4.8%
2000	1320.28	15.70	–9.1%	–27.8%	6.0%
2001	1148.08	15.20	–11.9%	–1.0%	3.3%
2002	879.82	14.53	–22.1%	–20.8%	1.6%
2003	1111.92	20.80	28.7%	52.9%	1.0%
2004	1211.92	20.98	10.9%	–21.5%	1.4%
2005	1248.29	23.15	4.9%	–57.0%	3.3%
2006	1418.30	27.16	15.8%	58.0%	5.0%
2007	1468.36	27.86	5.5%	–10.1%	4.5%
2008	903.25	21.85	–37.0%	–86.9%	1.2%

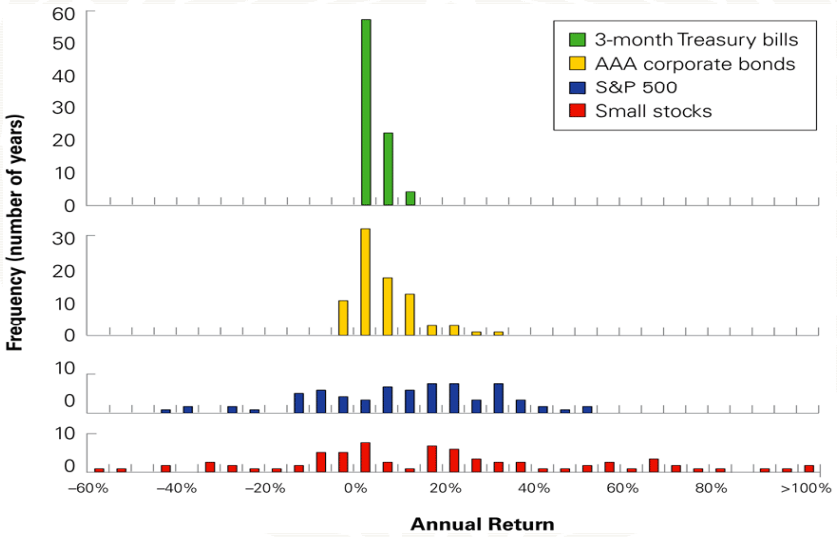
*Total dividends paid by the 500 stocks in the portfolio, based on the number of shares of each stock in the index, adjusted until the end of the year, assuming they were reinvested when paid.

Source: Standard & Poor's, GM, and U.S. Treasury Data

Empirical Distribution of Historical Returns of Stocks and Bonds

- Computing Historical Returns
  - » By counting the number of times a realized return falls within a particular range, we can estimate the underlying probability distribution.
  - » Empirical Distribution
    - – When the probability distribution is plotted using historical data

The Empirical Distribution of Annual Returns for U.S. Large Stocks (S&P 500), Small Stocks, Corporate Bonds, and Treasury Bills, 1926–2008



Average Annual Returns for U.S. Small Stocks, Large Stocks (S&P 500), Corporate Bonds, and Treasury Bills, 1926–2008

Investment	Average Annual Return
Small stocks	20.9%
S&P 500	11.6%
Corporate bonds	6.6%
Treasury bills	3.9%

Sample Average Annual Return

$$\bar{R} = \frac{1}{T}\left(R_1 + R_2 + \cdots + R_T\right) = \frac{1}{T}\sum_{t=1}^{T} R_t$$

» Where R_t is the realized return of a security in year t, for the years 1 through T

Using the data from Table 10.2, the average annual return for the S&P 500 from 1999-2008 is:

$$\bar{R} = \frac{1}{10}(0.210 - 0.091 - 0.119 - 0.221 + 0.287 + 0.109 + 0.109 + 0.158 + 0.055 - 0.37) = 0.7\%$$

The Sample Variance and Volatility of Returns

- Variance Estimate Using Realized Returns

$$Var(R) = \frac{1}{T-1}\sum_{t=1}^{T}\left(R_t - \bar{R}\right)^2$$

» The estimate of the standard deviation is the square root of the variance.

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

Example: Computing Sample Statistics

- **Problem:**
  - » Using the data from Table 10.2, what are the variance and volatility of GM's returns from 1999 to 2008?

Example: Computing Sample Statistics

- **Solution:**
  - » First, we need to calculate the average return for GM over that time period, using equation 10.6:

$$\begin{aligned}\bar{R} &= \frac{1}{10}(0.251 - 0.278 - 0.01 - 0.208 + 0.529 - 0.215 \\ &\quad -0.570 + 0.580 - 0.101 - 0.869) \\ &= -8.9\%\end{aligned}$$

Example: Computing Sample Statistics

Next, we calculate the sample variance

$$Var(R) = \frac{1}{T-1}\sum_t (R_t - \bar{R})^2$$
$$= \frac{1}{10-1}\left[(0.251-(-0.089))^2 + (-0.278-(-0.089))^2 + \ldots + (-0.869-(-0.089))^2\right]$$
$$= 0.2063$$

The volatility or standard deviation is therefore

$$SD(R) = \sqrt{Var(R)} = \sqrt{0.2063} = 45.4\%$$

Volatility of U.S. Small Stocks, Large Stocks (S&P 500), Corporate Bonds, and Treasury Bills, 1926–2008

Investment	Return Volatility (Standard Deviation)
Small stocks	41.5%
S&P 500	20.6%
Corporate bonds	7.0%
Treasury bills	3.1%

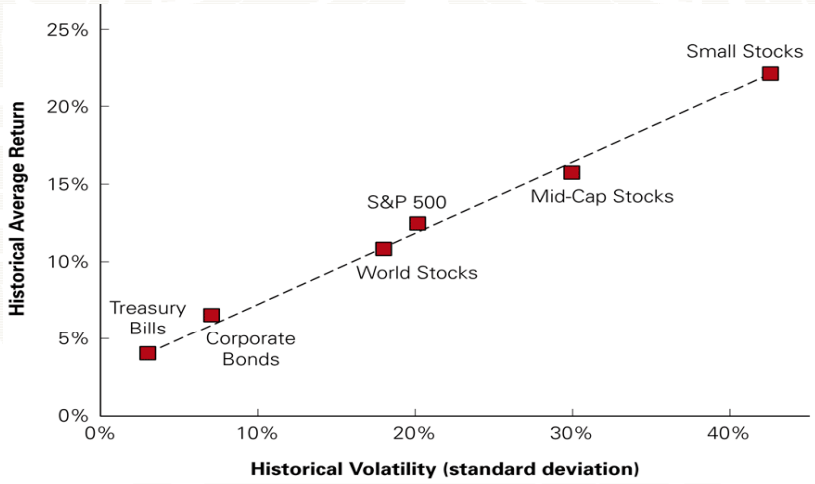
The Historical Tradeoff Between Risk and Return

- The Returns of Large Portfolios
  - » Excess Returns
    - – The difference between the average return for an investment and the average return for T-Bills

Volatility Versus Excess Return of U.S. Small Stocks, Large Stocks (S&P 500), Corporate Bonds, and Treasury Bills, 1926–2008

Investment	Return Volatility (Standard Deviation)	Excess Return (Average Return in Excess of Treasury Bills)
Small stocks	41.5%	17.1%
S&P 500	20.6%	7.7%
Corporate bonds	7.0%	2.7%
Treasury bills	3.1%	0.0%

The Historical Tradeoff Between Risk and Return in Large Portfolios, 1926–2005

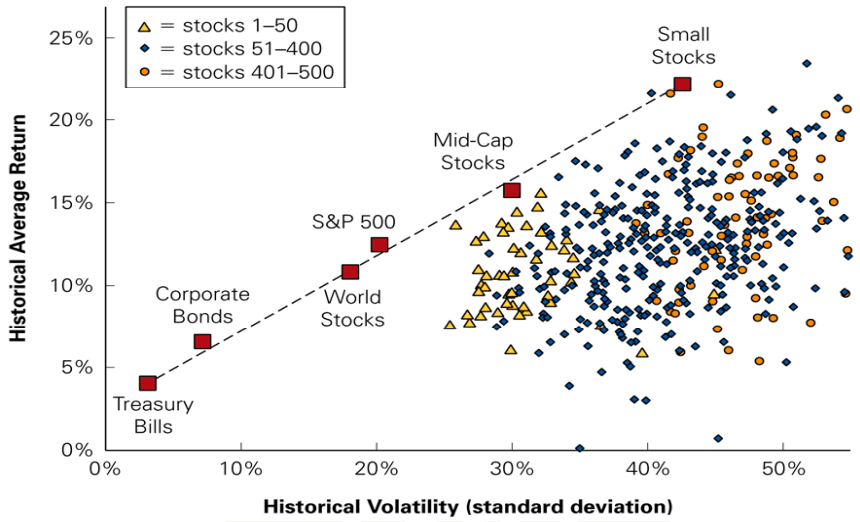


Source: CRSP, Morgan Stanley Capital International

The Returns of Individual Stocks

- Is there a positive relationship between volatility and average returns for individual stocks?
  - » As shown on the next slide, there is no precise relationship between volatility and average return for individual stocks.
    - – Larger stocks tend to have lower volatility than smaller stocks.
    - – All stocks tend to have higher risk and lower returns than large portfolios.

Historical Volatility and Return for 500 Individual Stocks, by Size, Updated Quarterly, 1926–2005



Common Versus Independent Risk

- Common Risk
  - » Risk that is perfectly correlated
    - – Risk that affects all securities
- Independent Risk
  - » Risk that is uncorrelated
    - – Risk that affects a particular security
- Diversification
  - » The averaging out of independent risks in a large portfolio

Diversification in Stock Portfolios

- Firm-Specific Versus Systematic Risk
  - » Firm Specific News
    - – Good or bad news about an individual company
  - » Market-Wide News
    - – News that affects all stocks, such as news about the economy

Diversification in Stock Portfolios (cont'd)

- Firm-Specific Versus Systematic Risk
  - » Independent Risks
    - – Due to firm-specific news
      - Also known as:
        - » Firm-Specific Risk
        - » Idiosyncratic Risk
        - » Unique Risk
        - » Unsystematic Risk
        - » Diversifiable Risk

Diversification in Stock Portfolios (cont'd)

- Firm-Specific Versus Systematic Risk
  - » Common Risks
    - – Due to market-wide news
      - ı Also known as:
        - » Systematic Risk
        - » Undiversifiable Risk
        - » Market Risk

Diversification in Stock Portfolios (cont'd)

- Firm-Specific Versus Systematic Risk
  - » When many stocks are combined in a large portfolio, the firm-specific risks for each stock will average out and be diversified.
  - » The systematic risk, however, will affect all firms and will not be diversified.

Diversification in Stock Portfolios (cont'd)

- Firm-Specific Versus Systematic Risk
  - » Consider two types of firms:
    - – Type S firms are affected only by systematic risk. There is a 50% chance the economy will be strong and type S stocks will earn a return of 40%; There is a 50% change the economy will be weak and their return will be –20%. Because all these firms face the same systematic risk, holding a large portfolio of type S firms will not diversify the risk.

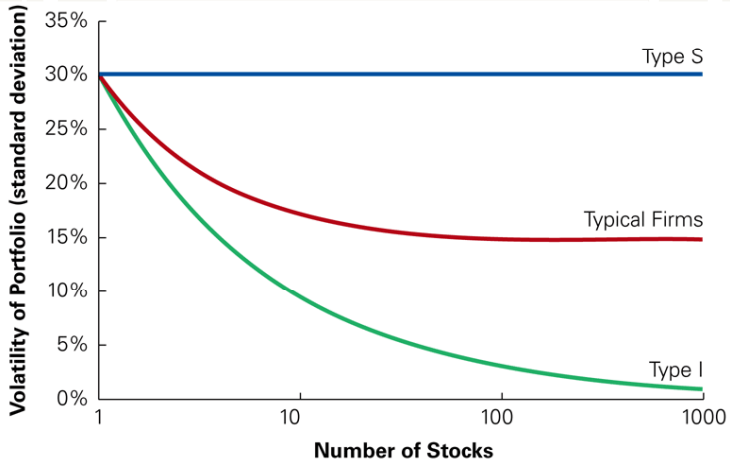
Diversification in Stock Portfolios (cont'd)

- Firm-Specific Versus Systematic Risk
  - » Consider two types of firms:
    - – Type I firms are affected only by firm-specific risks. Their returns are equally likely to be 35% or –25%, based on factors specific to each firm's local market. Because these risks are firm specific, if we hold a portfolio of the stocks of many type I firms, the risk is diversified.

Diversification in Stock Portfolios (cont'd)

- Firm-Specific Versus Systematic Risk
  - » Actual firms are affected by both market-wide risks and firm-specific risks. When firms carry both types of risk, only the unsystematic risk will be diversified when many firm's stocks are combined into a portfolio. The volatility will therefore decline until only the systematic risk remains.

Volatility of Portfolios of Type S and I Stocks



No Arbitrage and the Risk Premium

- *The risk premium for diversifiable risk is zero, so investors are not compensated for holding firm-specific risk.*
  - » If the diversifiable risk of stocks were compensated with an additional risk premium, then investors could buy the stocks, earn the additional premium, and simultaneously diversify and eliminate the risk.

No Arbitrage and the Risk Premium (cont'd)

- » By doing so, investors could earn an additional premium without taking on additional risk. This opportunity to earn something for nothing would quickly be exploited and eliminated. Because investors can eliminate firm-specific risk "for free" by diversifying their portfolios, they will not require or earn a reward or risk premium for holding it.

No Arbitrage and the Risk Premium (cont'd)

- *The risk premium of a security is determined by its systematic risk and does not depend on its diversifiable risk.*
  - » This implies that a stock's volatility, which is a measure of total risk (that is, systematic risk plus diversifiable risk), is not especially useful in determining the risk premium that investors will earn.

No Arbitrage and the Risk Premium (cont'd)

- Standard deviation is not an appropriate measure of risk for an individual security. There should be no clear relationship between volatility and average returns for individual securities. Consequently, to estimate a security's expected return, we need to find a measure of a security's systematic risk.

Textbook Example

Diversifiable Versus Systematic Risk

Problem

Which of the following risks of a stock are likely to be firm-specific, diversifiable risks, and which are likely to be systematic risks? Which risks will affect the risk premium that investors will demand?

a. The risk that the founder and CEO retires
b. The risk that oil prices rise, increasing production costs
c. The risk that a product design is faulty and the product must be recalled
d. The risk that the economy slows, reducing demand for the firm's products

Textbook Example (cont'd)

Solution

Because oil prices and the health of the economy affect all stocks, risks (b) and (d) are systematic risks. These risks are not diversified in a large portfolio, and so will affect the risk premium that investors require to invest in a stock. Risks (a) and (c) are firm-specific risks, and so are diversifiable. While these risks should be considered when estimating a firm's future cash flows, they will not affect the risk premium that investors will require and, therefore, will not affect a firm's cost of capital.

Measuring Systematic Risk

- To measure the systematic risk of a stock, determine how much of the variability of its return is due to systematic risk versus unsystematic risk.
  - » To determine how sensitive a stock is to systematic risk, look at the average change in the return for each 1% change in the return of a portfolio that fluctuates solely due to systematic risk.

Measuring Systematic Risk (cont'd)

- Efficient Portfolio
  - » A portfolio that contains only systematic risk. There is no way to reduce the volatility of the portfolio without lowering its expected return.
- Market Portfolio
  - » An efficient portfolio that contains all shares and securities in the market
    - – The S&P 500 is often used as a proxy for the market portfolio.

Measuring Systematic Risk (cont'd)

- Sensitivity to Systematic Risk: Beta (β)
  - » *The expected percent change in the excess return of a security for a 1% change in the excess return of the market portfolio.*
    - – Beta differs from volatility. Volatility measures total risk (systematic plus unsystematic risk), while beta is a measure of only systematic risk.

Betas with Respect to the S&P 500 for Individual Stocks (based on monthly data for 2004–2008)

Company	Ticker	Industry	Equity Beta
Family Dollar Stores	FDO	Retail	0.10
Abbott Laboratories	ABT	Pharmaceuticals	0.18
Consolidated Edison	ED	Utilities	0.19
Hershey	HSY	Food Processing	0.19
Piedmont Natural Gas	PNY	Gas Utilities	0.24
General Mills	GIS	Food Processing	0.25
Wal-Mart Stores	WMT	Superstore	0.31
Altria Group	MO	Tobacco	0.31
Kellogg	K	Food Processing	0.44
Amgen	AMGN	Biotechnology	0.45
DeVry	DV	Education Services	0.49
Exxon Mobil	XOM	Oil and Gas	0.56
Procter & Gamble	PG	Household Products	0.57
The Coca-Cola Company	KO	Soft Drinks	0.60
Newmont Mining	NEM	Gold	0.65
McDonald's	MCD	Restaurants	0.79
United Parcel Service	UPS	Air Freight and Logistics	0.79
Southwest Airlines	LUV	Airline	0.83
Costco Wholesale	COST	Superstore	0.85
Walt Disney	DIS	Movies and Entertainment	0.96
Microsoft	MSFT	Systems Software	0.98
Starbucks	SBUX	Restaurants	1.04
Target	TGT	Retail	1.07
General Electric	GE	Conglomerates	1.12
Cisco Systems	CSCO	Communications Equipment	1.27
Marriott International	MAR	Hotels and Resorts	1.29
Intel	INTC	Semiconductors	1.35
Dell	DELL	Computer Hardware	1.36
Sears	SHLD	Department Stores	1.36
Google	GOOG	Internet Services	1.45
Tiffany & Co.	TIF	Specialty Stores	1.64
Coach	COH	Apparel and Luxury Goods	1.65
Apple	AAPL	Computer Hardware	1.89
Amazon.com	AMZN	Internet Retail	1.89
eBay	EBAY	Internet Services	1.93
Sotheby's	BID	Auction Services	2.07
Autodesk	ADSK	Application Software	2.31
Salesforce.com	CRM	Application Software	2.39

Source: CapitalIQ

Measuring Systematic Risk (cont'd)

- Interpreting Beta (β)
  - » A security's beta is related to how sensitive its underlying revenues and cash flows are to general economic conditions. Stocks in cyclical industries are likely to be more sensitive to systematic risk and have higher betas than stocks in less sensitive industries.

Beta and the Cost of Capital

- Estimating the Risk Premium
  - » Market risk premium
    - – The market risk premium is the reward investors expect to earn for holding a portfolio with a beta of 1.

$$\text{Market Risk Premium} = E\left[R_{Mkt}\right] - r_f$$

Beta and Cost of Capital (cont'd)

- Adjusting for Beta
  - » Estimating a Traded Security's Cost of Capital of an investment from Its Beta

$$E[R] = \text{Risk-Free Interest Rate} + \text{Risk Premium}$$
$$= r_f + \beta \times (E[R_{Mkt}] - r_f)$$

Example: Using Beta

- **Problem**
  - » Assume the economy has a 60% chance of the market return will 15% next year and a 40% chance the market return will be 5% next year.
  - » Assume the risk-free rate is 6%.
  - » **If Microsoft's beta is 1.18, what is its expected return next year?**

Example: Using Beta

- **Solution**
  - » $E[R_{Mkt}] = (60\% \times 15\%) + (40\% \times 5\%) = 11\%$
  - » $E[R] = r_f + \beta \times (E[R_{Mkt}] - r_f)$
  - » $E[R] = 6\% + 1.18 \times (11\% - 6\%)$
  - » $E[R] = 6\% + 5.9\% = 11.9\%$

Beta and the Cost of Capital (cont'd)

- The equation

$$E[R] = \text{Risk-Free Interest Rate} + \text{Risk Premium}$$
$$= r_f + \beta \times (E[R_{Mkt}] - r_f)$$

is often referred to as the **Capital Asset Pricing Model (CAPM)**. It is the most important method for estimating the cost of capital that is used in practice.