# Lecture 2
# Risk and Return

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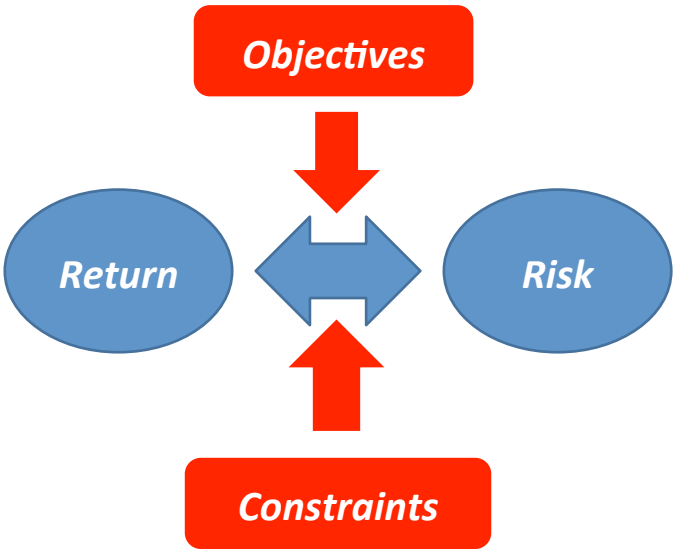
*FN 312 – INVESTMENTS*



## Conceptual framework of investment



## Real versus nominal returns

- The Fisher relation

  Real = Nominal – Expected inflation

  (The relationship is in fact a linear approximation, but usually treated as an equality – see BKM)

Nominal returns influenced by:

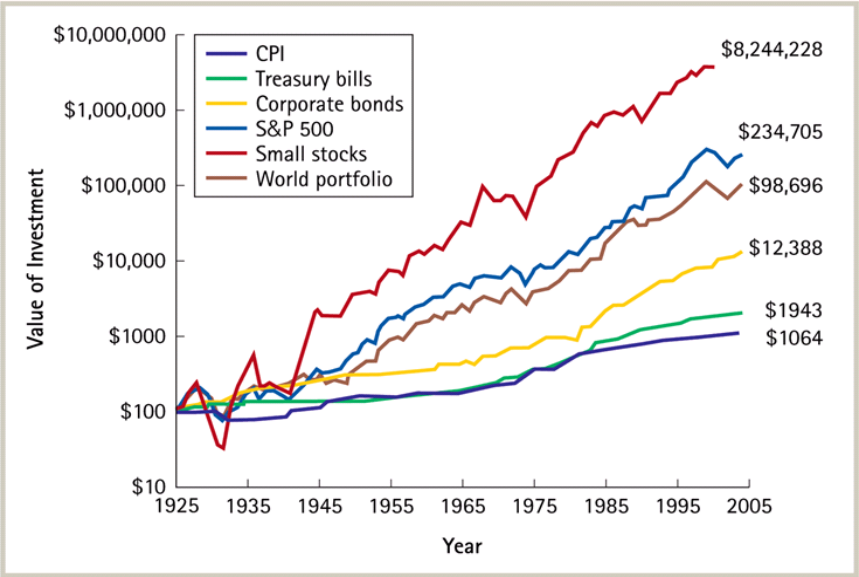
- The supply of funds from savers (eg. households)
- The demand for funds from businesses
- Government and Central Bank actions
- Expected inflation



## A First Look at Risk and Return

- Treasury Bills: An investment in three-month Treasury bills
- Corporate Bonds: Long-term, AAA-rated US corporate bonds with maturities of approximately 20 years.
- Standard & Poor's 500: 90 US stocks up to 1957 and 500 after that. Leaders in their industries and among the largest firms traded on US 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.

## Value of $100 invested at the end of 1925

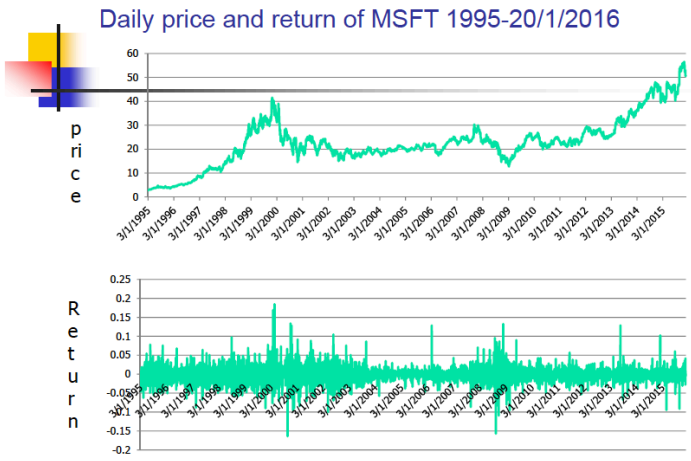



*Source: Berk & DeMarzo (2007)*

## Takeaways

- 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.

## Computing Historical Returns






## Historical Returns

- Realized return
  - The return that actually occurs over a particular time period

= Dividend Yield + Capital Gain Rate

Note: 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

# Annualized Historical Return

- Generally, longer horizons provide greater returns, so we need to express each rate or return for a common period, usually over a 1-year horizon
- Effective annual rate (EAR)

  Assumes compounded interest, i.e. you calculate interest on interest too, so your "effective principal" increases

- Annual percentage rate (APR)

  Rates on short-term investments (T<1) often are annualised using simple interest.



# Example: Historical Returns

- Ford stock

| 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% | | | | |

***What were the historical annualized returns for Ford stock in 1999 and in 2008?***

# Annualized Variance

- Variance is proportional to time

  Annualized Variance =

- Standard deviation is proportional to the square root of time

  Annualized Standard Deviation =

## Realized Return for the S&P500, GM and Treasury Bills

| 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% |

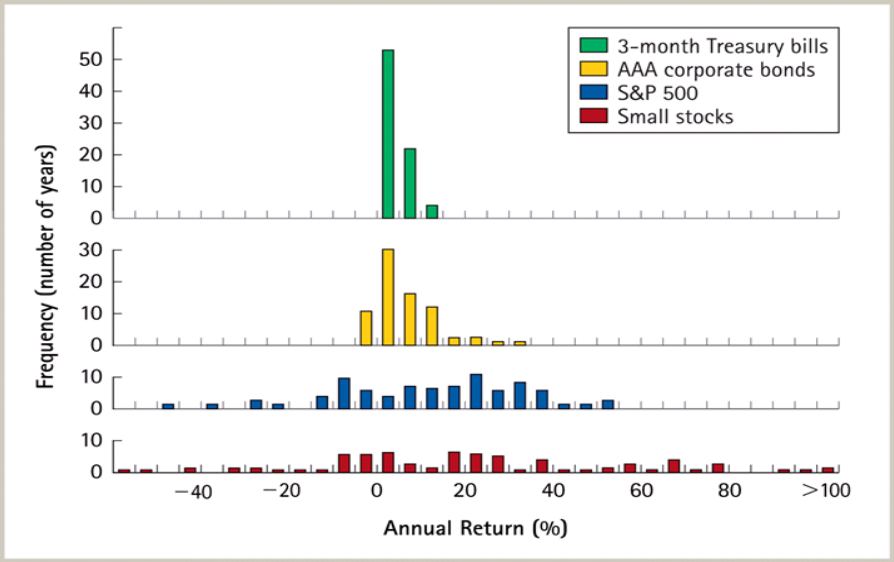
*Total dividends paid by the 500 stocks in the portfolio, based on the number of shares of each stock in the index, adjusted until the end of the year, assuming they were reinvested when paid.

*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

# Historical distributions of US returns




*Source: Berk & DeMarzo (2007)*

Average annual returns and volatility for US Stocks and Bonds in the US (1926-2008)

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

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

# Sample Average Annual Return

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

- What is the average annual return for the S&P 500 from 1999-2008?



## The Sample Variance and Volatility of Returns

- Variance estimate using realized returns
  - A measure of dispersion (around the mean), i.e. how observations can possibly deviate from the central tendency
  - The estimate of the standard deviation is the square root of the variance. **This is often used as a measure for volatility or risk.**

What is the variance and volatility of GM's return during 1999-2008?



# Other measures of risk

- Average absolute deviation
- Sharpe ratio
- Average of the squared deviations below the mean (semi variance)

- Value at risk measure

- Expected shortfall or conditional tail distribution



# Distribution of Returns: Non-normality

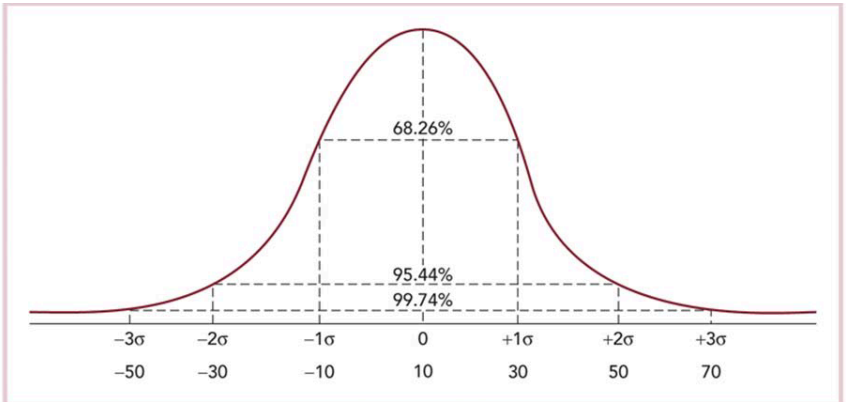



**FIGURE 5.4** The normal distribution

# Normal and Skewed Distributions

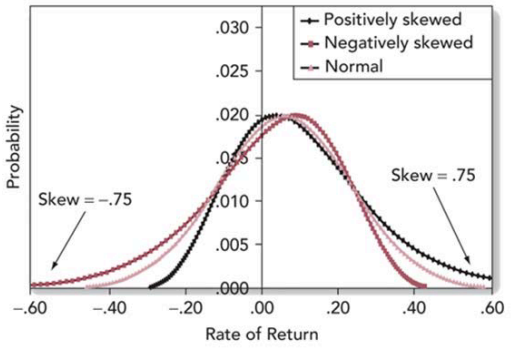



**FIGURE 5.5A** Normal and skewed distributions (mean = 6%, SD = 17%)



# Normal and Fat-tailed distributions

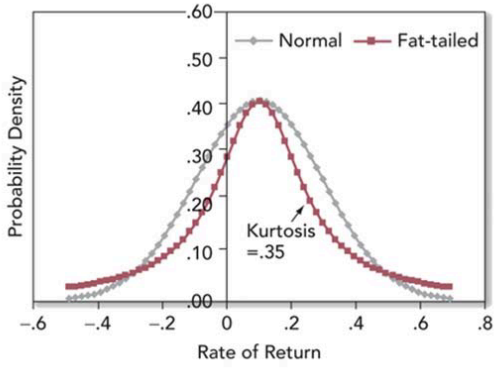



**FIGURE 5.5B** Normal and fat-tailed distributions (mean = .1, SD = .2)

# Non-normality and risk measures

- When returns are not normally distributed, volatility (standard deviation) is no longer a complete measure of risk
- We then need to consider 'higher moments'

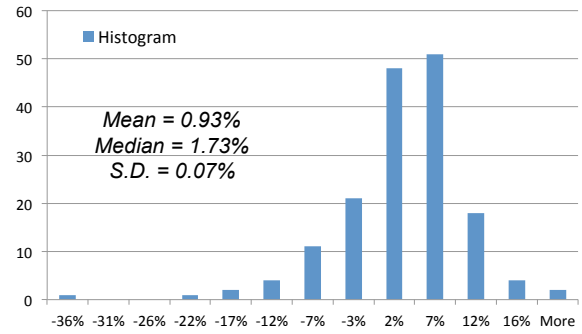
$$skew = average\left[\frac{\left(R-\bar{R}\right)^3}{\hat{\sigma}^3}\right] \qquad kurtosis = average\left[\frac{\left(R-\bar{R}\right)^4}{\hat{\sigma}^4}\right] - 3$$

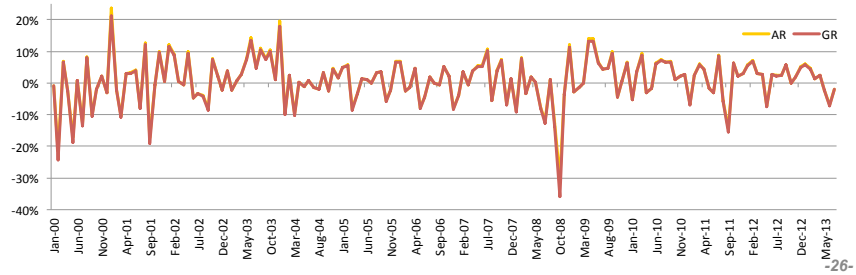
- Skewness measures symmetry, and kurtosis 'peakedness'
- For normal distributions
- Stock returns are usually



# Distribution of returns on SET

| Date | SET Index | AR | GR |
|---|---|---|---|
| 07/12 | 1,199.30 | 2.32% | 2.29% |
| 08/12 | 1,227.48 | 2.35% | 2.32% |
| 09/12 | 1,298.79 | 5.81% | 5.65% |
| 10/12 | 1,298.87 | 0.01% | 0.01% |
| 11/12 | 1,324.04 | 1.94% | 1.92% |
| 12/12 | 1,391.93 | 5.13% | 5.00% |
| 01/13 | 1,474.20 | 5.91% | 5.74% |
| 02/13 | 1,541.58 | 4.57% | 4.47% |
| 03/13 | 1,561.06 | 1.26% | 1.26% |
| 04/13 | 1,597.86 | 2.36% | 2.33% |
| 05/13 | 1,562.07 | -2.24% | -2.27% |
| 06/13 | 1,451.90 | -7.05% | -7.31% |
| 07/13 | 1,423.14 | -1.98% | -2.00% |

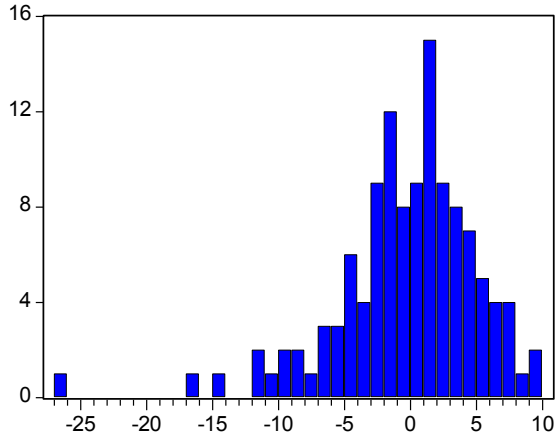





Data source: *CEIC*

# Example: Returns on S&P Global 100



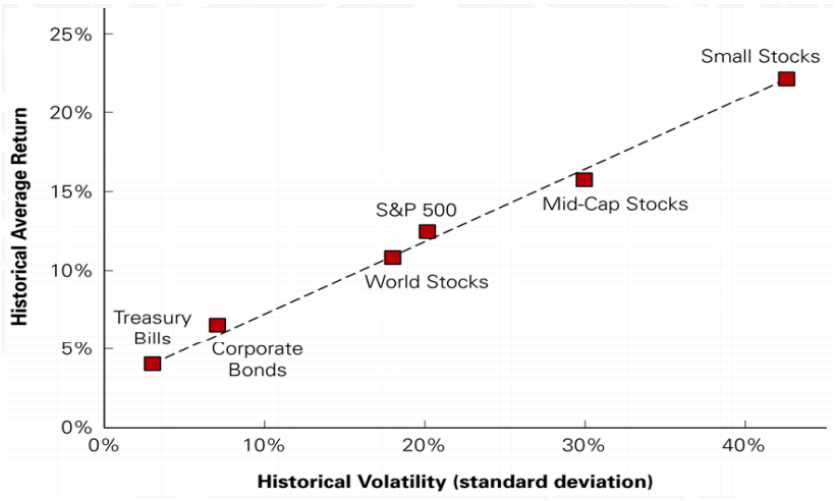

Series: Return on S&P Global 100
Sample 2000M05 2010M05
Observations 120

| | |
|---|---|
| Mean | -0.299859 |
| Median | 0.351000 |
| Maximum | 9.698172 |
| Minimum | -26.78273 |
| Std. Dev. | 5.438831 |
| Skewness | -1.381392 |
| Kurtosis | 7.122558 |
| Jarque-Bera | 123.1423 |
| Probability | 0.000000 |

***Downside risk***

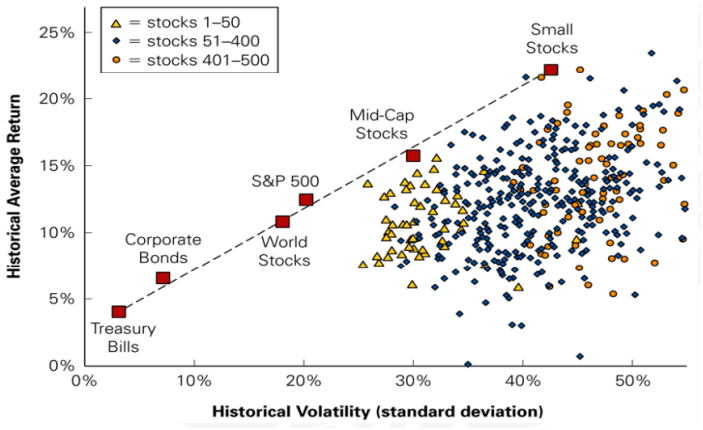


# Tradeoff between Risk and Return of Large Portfolios in the US - 1926-2005



# What about for individual stocks?

**Historical Volatility and Return for 500 individual stocks, 1926-2005**






- Is there a positive relationship between volatility and average returns for individual stocks?
  - There is no precise relationship
    - Larger stocks tend to have lower volatility than smaller stocks
    - All stocks tend to have higher risk and lower returns than large portfolios

# Common vs Independent Risk

- Common risk
  - Risk that is perfectly correlated and affects all securities
  - Also known as undiversifiable risk, systematic risk, market risk
- Independent risk
  - Risk that is uncorrelated and affects only a particular security
  - Also known as diversifiable risk, firm-specific risk, unique risk, unsystematic risk, idiosyncratic risk



# Diversification

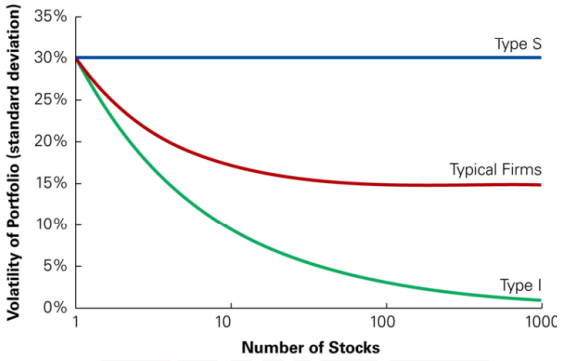
- Diversification
  - The averaging out of independent risks in a large portfolio
- When many stocks are combined in a large portfolio, the firm-specific risks for each stock will average out and be diversified.
- The systematic risk, however, will affect all firms and will not be diversified.

# Examples

- 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% chance the economy will be weak and the 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.
  - 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 their risks are firm specific, if we hold a portfolio of the stocks of many Type I firms, the risk is diversified.



- Actual firms are affected by both market-wide risks and firm-specific risks. When firms carry both types of risks, 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.



## 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



# Risk Premium and No Arbitrage

- 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, then investors could buy the stock, earn the premium, and simultaneously diversify and eliminate the risk
  - By doing so, investors could earn an additional premium without taking on additional risk. This opportunity to earn something for nothing would be quickly exploited and eliminated (no arbitrage)
  - 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.

## Risk Premium and No Arbitrage

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

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



## 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

- 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

- Sensitivity to systematic risk or Beta
  - 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.
    - A security's beta is how sensitive its underlying revenues 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

| 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