BA870: Topics in Financial & Accounting Analytics

Lecture #5 (Thursday, April 7, 2022)

Professor Peter Wysocki

Topics: Intro to Financial Market Analytics: Stock Markets, Stock Prices, Risk and Volatility

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Objectives of this Lecture (and the BA870)

- Accounting & Financial Analytics:
  - Become Familiar with Finance Vocabulary
    - Remove Barriers to “Big Words”
  - Knowledge of Concepts/Theory from a **Data Analytics Practitioner’s Perspective** (Not a Finance MBA or CFA)
  - Data and Application Focused

What is a Stock Price?

Price per Share
= Market Cap / Shares Outstanding
= $1,050 Billion / 4.38 Billion
= $239.73 per share

Apple Inc. (AAPL)
NasdaqGS - NasdaqGS Real Time Price. Currency in USD

Add to watchlist | Visitors trend 2W ↓ 10

241.41 -3.52 (-1.44%)
At close: April 3 4:00PM EDT

Summary | Company Outlook | Chart | Conversations | Statistics | Historical Data | Profile

Get access to 40+ years of historical data with Yahoo Finance Premium. Learn more

Valuation Measures

Annual | Quarterly
Download Data

	Current	12/31/2019	9/30/2019	6/30/2019	3/31/2019
Market Cap (intraday) [5]	1.05T	1.29T	995.15B	910.64B	895.67B
Enterprise Value [3]	1.06T	1.30T	1.01T	943.18B	923.97B
Trailing P/E	18.97	24.70	19.01	16.58	15.57
Forward P/E [1]	18.62	22.17	17.27	15.97	16.58
PEG Ratio (5 yr expected) [1]	1.50	2.03	2.04	1.45	1.82
Price/Sales (ttm)	4.11	5.25	4.09	3.68	3.56
Price/Book (mrq)	11.77	14.23	10.32	8.47	7.42
Enterprise Value/Revenue [3]	3.94	14.11	15.76	17.53	15.93
Enterprise Value/EBITDA [6]	12.68	43.87	50.16	60.04	51.78

Trading Information

Stock Price History

Beta (5Y Monthly)	1.29
52-Week Change [3]	20.64%
S&P500 52-Week Change [3]	-14.06%
52 Week High [3]	327.85
52 Week Low [3]	170.27
50-Day Moving Average [3]	270.67
200-Day Moving Average [3]	271.13

Share Statistics

Avg Vol (3 month) [3]	49.3M
Avg Vol (10 day) [3]	46.18M
Shares Outstanding [5]	4.38B

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What is a Stock Price?

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NasdaqGS - NasdaqGS Real Time Price. Currency in USD

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Enterprise Value (Basically Market Value of Assets)
= Market Cap + Book Value of Debt

Market Cap = Total Market Value of Equity

<u>Related to Balance Sheet Equation:</u>

Assets = Liabilities + Shareholders' Equity

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Stock Prices on WRDS

CRSP

PERMNO	Names Date	Company Name	Ticker Symbol	Price or Bid Ask Average	Ask or High Price	Bid or Low Price	Bid	Ask	Dividend Cash Amount
14593	20160129	APPLE INC	AAPL	97.34000	105.35000	93.42000	97.11000	97.14000	.
14593	20160229	APPLE INC	AAPL	96.69000	98.12000	93.70000	96.65000	96.66000	0.52000
14593	20160331	APPLE INC	AAPL	108.99000	109.56000	100.53000	108.96000	108.97000	.
14593	20160429	APPLE INC	AAPL	93.74000	112.10000	93.74000	93.74000	93.75000	.
14593	20160531	APPLE INC	AAPL	99.86000	100.41000	90.34000	99.84000	99.85000	0.57000
14593	20160630	APPLE INC	AAPL	95.60000	99.65000	92.04000	95.60000	95.62000	.
14593	20160729	APPLE INC	AAPL	104.21000	104.34000	94.99000	104.19000	104.20000	.
14593	20160831	APPLE INC	AAPL	106.10000	109.48000	104.48000	106.11000	106.12000	0.57000
14593	20160930	APPLE INC	AAPL	113.05000	115.57000	103.13000	113.01000	113.03000	.
14593	20161031	APPLE INC	AAPL	113.54000	118.25000	112.52000	113.55000	113.56000	.
14593	20161130	APPLE INC	AAPL	110.52000	111.80000	105.71000	110.51000	110.52000	0.57000
14593	20161230	APPLE INC	AAPL	115.82000	117.26000	109.11000	115.84000	115.87000	.

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Calculating Stock Return

- Define Interval:
  - Hour, Day, Week, Month, Year, etc.

- Holding Period Return:
  - Stock Return for March 2022 = ?
    - Close Price at End of February = P(t-1)
    - Close Price at End of March = P(t)
    - Any Dividends Paid during March = Div(t)
  - Ret(March 2022)

    = [P(End of March) + Div(March) – P(End of Feb)]/P(End of Feb)

- What is trading volume in interval?
- Look at WRDS Example

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Stock Prices on WRDS – APPL Example for May 2016

CRSP

PERMNO	Names Date	Company Name	Ticker Symbol	Price or Bid Ask Average	Ask or High Price	Bid or Low Price	Bid	Ask	Dividend Cash Amount
14593	20160129	APPLE INC	AAPL	97.34000	105.35000	93.42000	97.11000	97.14000	.
14593	20160229	APPLE INC	AAPL	96.69000	98.12000	93.70000	96.65000	96.66000	0.52000
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Calculating May 2016 Stock Return (AAPL)

- Holding Period Return:
  - Ret(May 2016) = [P(t) +Div(t) – P(t-1)]/P(t-1) * 100%

- Apple Inc Holding Period Return for May 2016:
  - P(t-1) = $93.74
  - P(t) = $99.86
  - Div(t) = $0.57

  - Ret(t) = (99.86 + 0.57 – 93.74) / (93.74) * 100% = 7.14%

Accessing Historical Stock Prices from Yahoo Finance using Python: yfinance

- A good source of “free” stock price data is available:
  - Yahoo Finance (http://finance.yahoo.com)

- Various programmers have developed Python libraries to download stock data:
  - Example: “**yfinance**”: https://aroussi.com/post/python-yahoo-finance

What is a Stock Price?

- Single Share in a Company
  - Voting Rights
  - Cash Flow Rights
- What Determines the Price of a Share?
  - Economics Answer: Supply and Demand!
  - Whatever someone is willing to pay for it (and whatever someone is willing to sell it for)
- But, what is a rational price to pay?
  - What is the benefit of owning 1-share?
- Gives Rise to “Present Value Analysis”

Understanding Risk and Volatility

- Understanding and Measuring for Stocks
  - Components of Risk in Stock Returns
    - Systematic Risk
    - Idiosyncratic Risk
  - How to Measure Risk Using Historical Data
    - Market Risk Factor – Systematic Risk
    - Capital Asset Pricing Model (CAPM)
  - Multiple Risk Factors
    - Fama-French 3–Factor Model

Market and Firm-specific Risk

Learning Objectives

- Understand the difference between market and firm-specific risk
- Become familiar with how alpha, beta and R^2 are used for analyzing stock performance and risk
- Identify both the highest and lowest alpha stocks by industry, and note the stocks' beta and R^2 values

Two Types of Risk

- **Systematic risk** (or **market risk**) is comprised of risk factors common to the whole economy. This is considered non-diversifiable risk.

- **Idiosyncratic risk** (or **unsystematic risk**) is firm-specific risk. It can be mitigated by diversification and is, thus, also referred to as diversifiable risk. Idiosyncratic risk has little or no correlation with the market risk.

CAPM = Single-Factor Model of Stock Returns

- The traditional regression model for analyzing excess returns is the Capital Asset Pricing Model (CAPM), a single-factor model:

$$(R_i - R_f) = \alpha_i + \beta_i (R_{MKT} - R_f) + e_i$$

- The model stipulates there is only one risk factor: the return on the market portfolio.

R_i = stock return

R_f = risk-free rate of return

α_i = difference between the asset's return and the expected return

β_i = measure of the asset's systematic risk in relation to the market

R_{MKT} = the market return

e_i = idiosyncratic stock return

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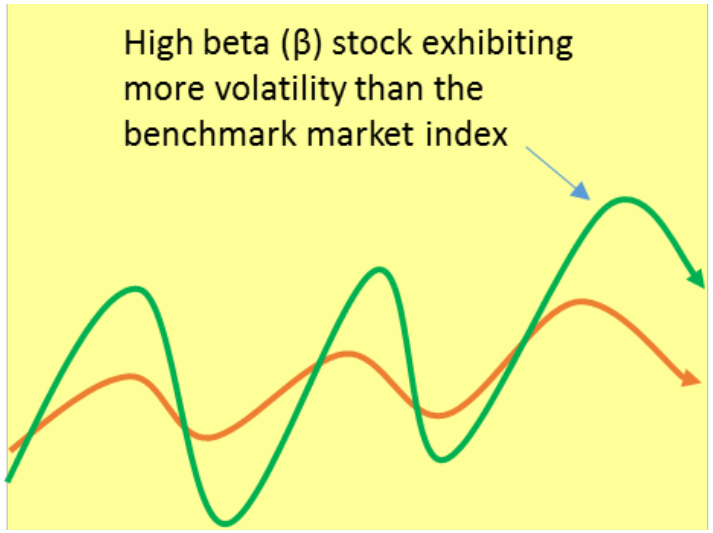
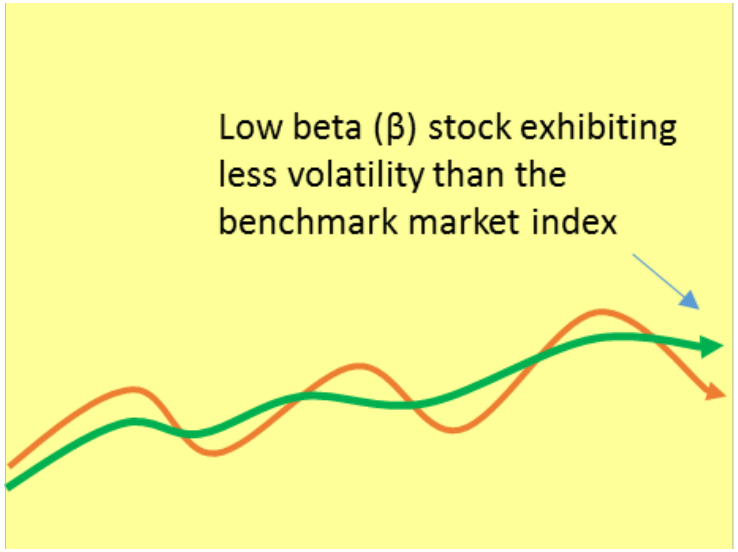
Beta

- Beta (β) is a measure of the *systematic* risk of an investment. It represents the sensitivity of the stock to the movement of the market.

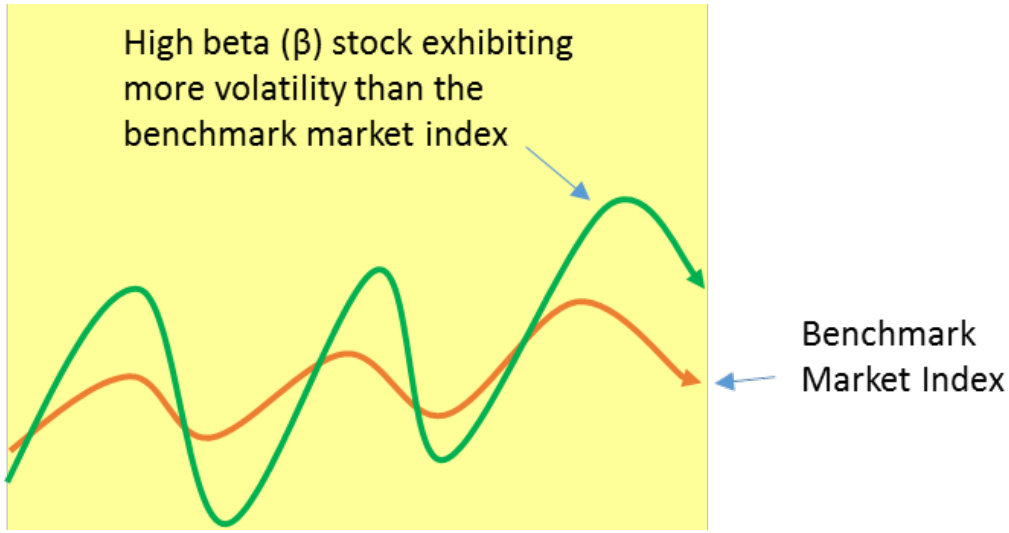




Interpreting Beta

- The beta of the benchmark index (a market portfolio) is always set at 1.

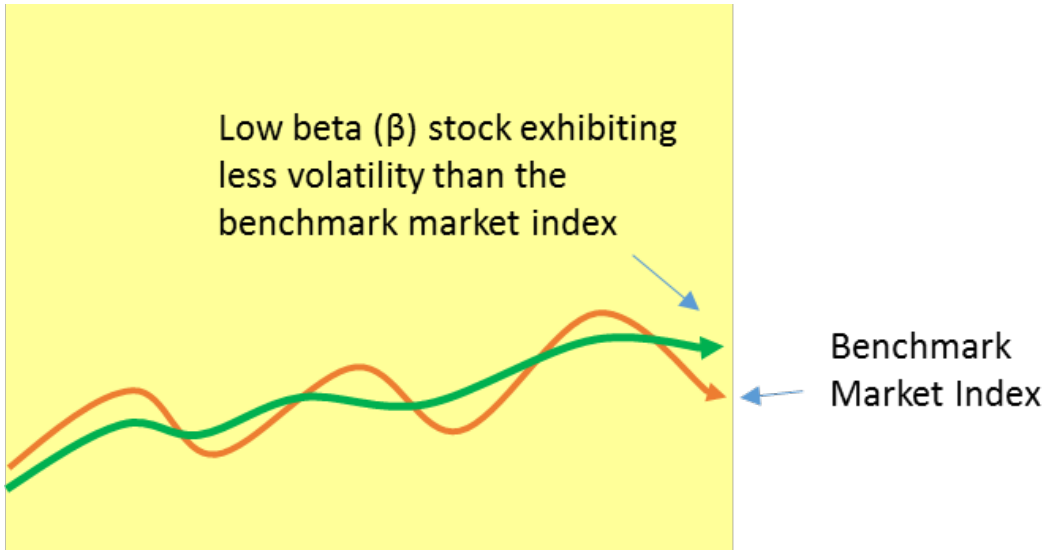
- Beta greater than 1 indicates the stock is more volatile than the market. It is more sensitive to the market's swings both up and down.



Interpreting Beta (cont.)

- A beta less than 1 indicates that the stock is less volatile than the benchmark market index.

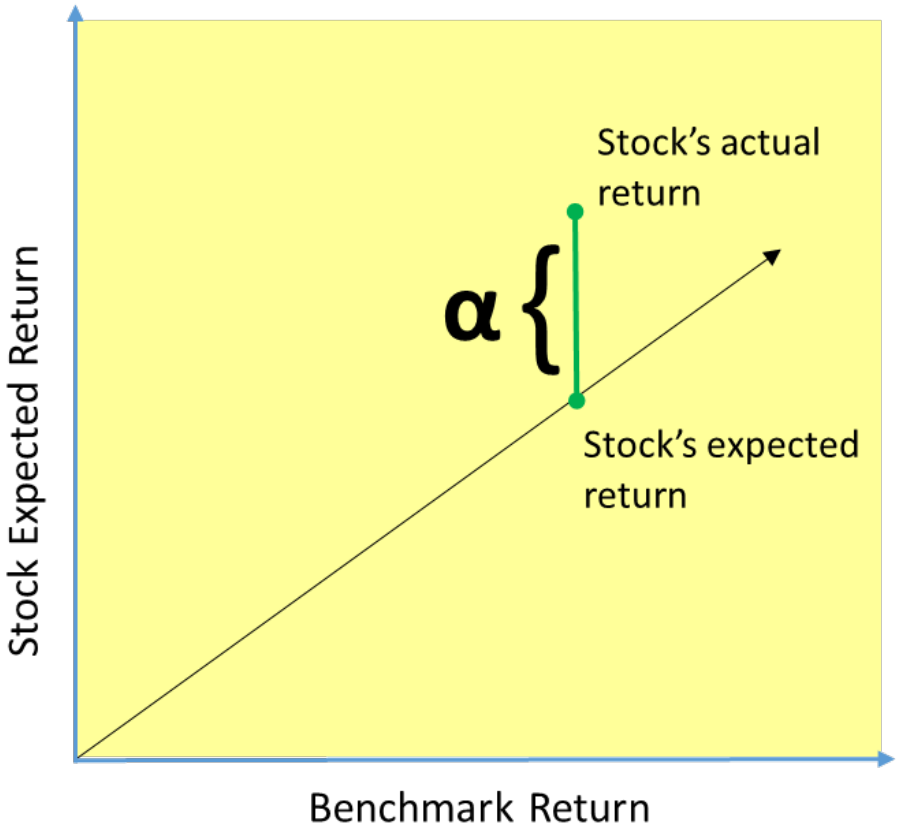
- Risk-free investments (such as Treasury Bills) have a beta of zero.



Alpha

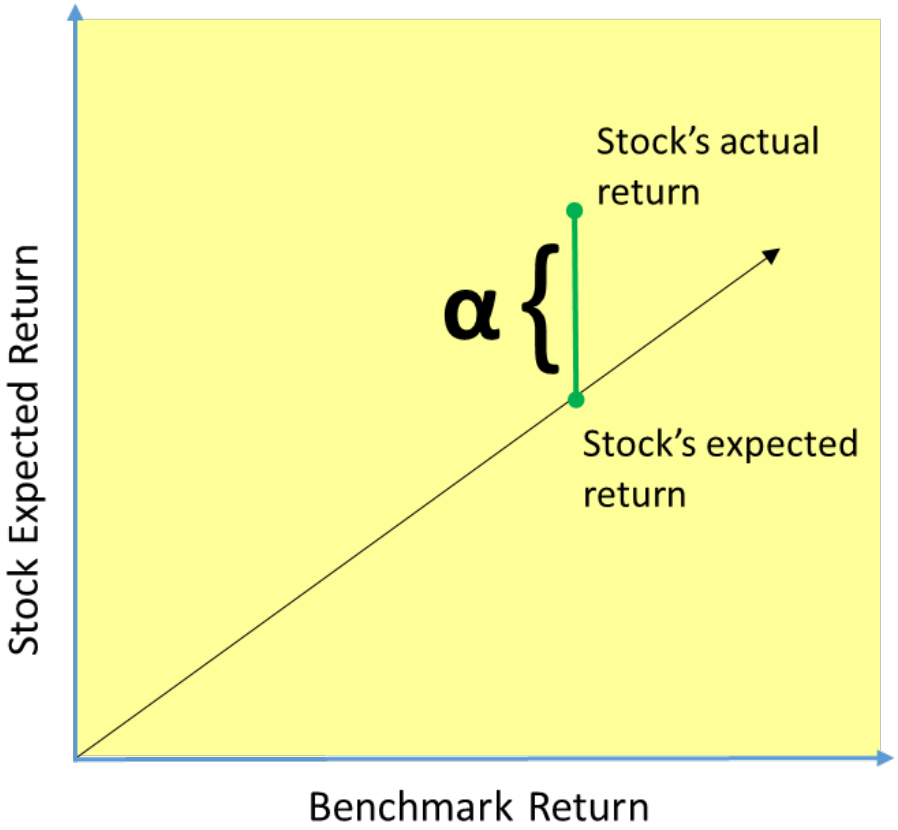
- Alpha (α) is the difference between a stock's actual return and the expected return predicted by the Capital Asset Pricing Model (CAPM).

- Alpha in this context is known as Jensen's Alpha.



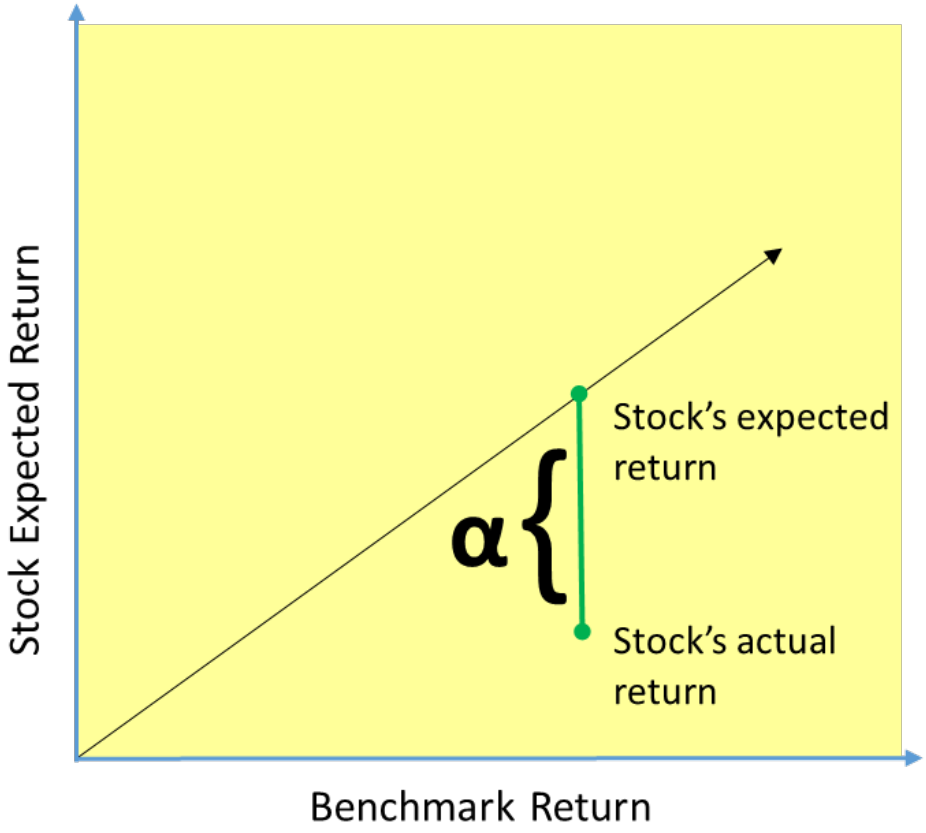
Interpreting Alpha

- Positive alpha indicates there was "abnormal" excess return relative to the market risk model.



Interpreting Alpha (cont.)

- Negative alpha indicates the stock failed to generate the returns as expected by the model; the security underperformed.



Alpha, Beta and Expected Return

- When the CAPM is used to predict the expected return of a security, the return is considered "risk-adjusted."

- In the CAPM, the beta of the security is the factor used to calculate this risk-adjusted return.

$$\alpha = r - R_f - \beta (R_m - R_f)$$

r = the security's actual return

R_f = risk-free rate of return

β = measure of the security's systematic risk

R_m = the market return

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Alpha, Beta and Expected Return (cont.)

- **Alpha**, as a measure of the difference between the expected return and the actual return, is a measure of the reward or penalty (i.e., negative alpha) for holding idiosyncratic risk.

$$\alpha = r - R_f - \beta (R_m - R_f)$$

r = the stock's actual return

R_f = risk-free rate of return

β = measure of the stock's systematic risk

R_m = the market return

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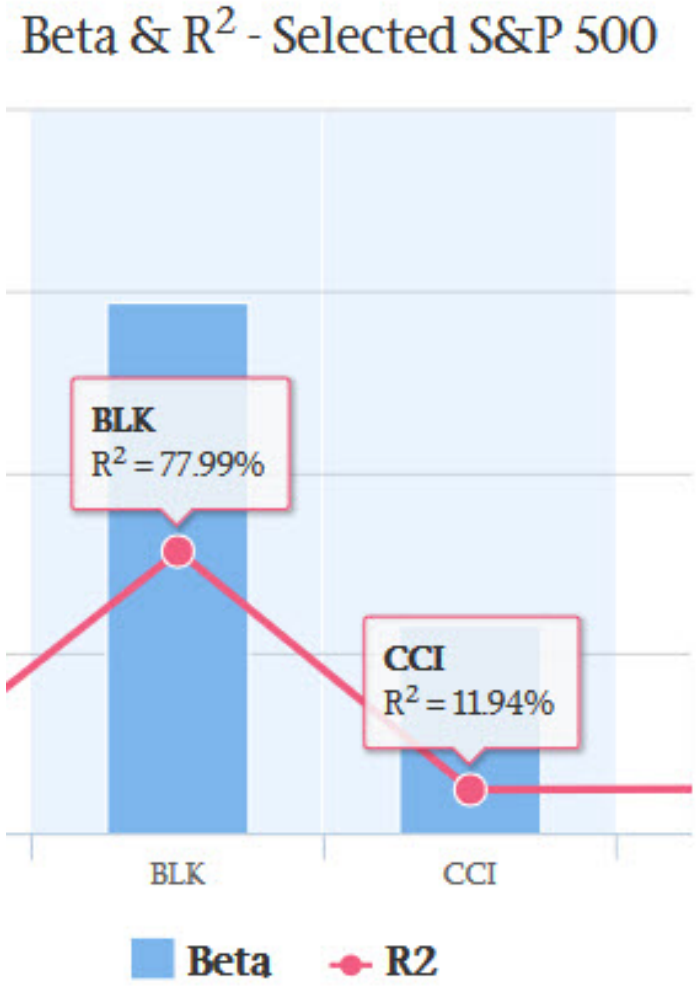
Importance of Considering R^2

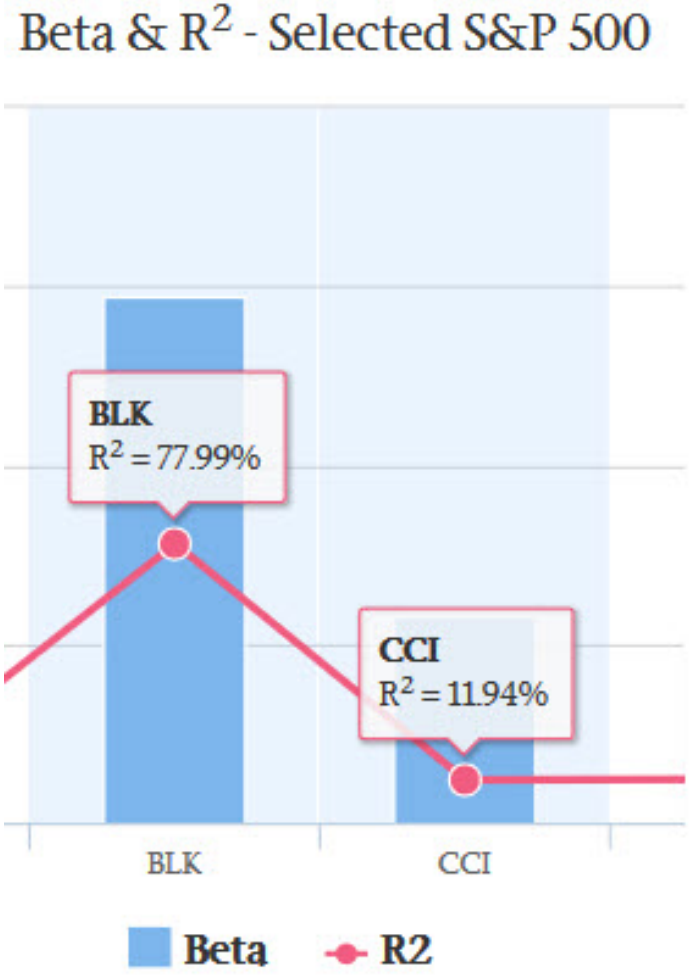
- R^2 , also called the coefficient of determination, is a measure of the degree to which the stock's return can be attributed to the benchmark return.

- R^2 is sometimes referred to as "the goodness of fit," as it indicates how well the stock and market returns "fit" together in the linear model.



Correlation, Beta and Alpha

- Here, BLK's R^2 value indicates 77.99% of the stock's return is explained by the return of the market's movement. Note that only 11.94% of CCI's return is explained by the market's movement during that same time period.



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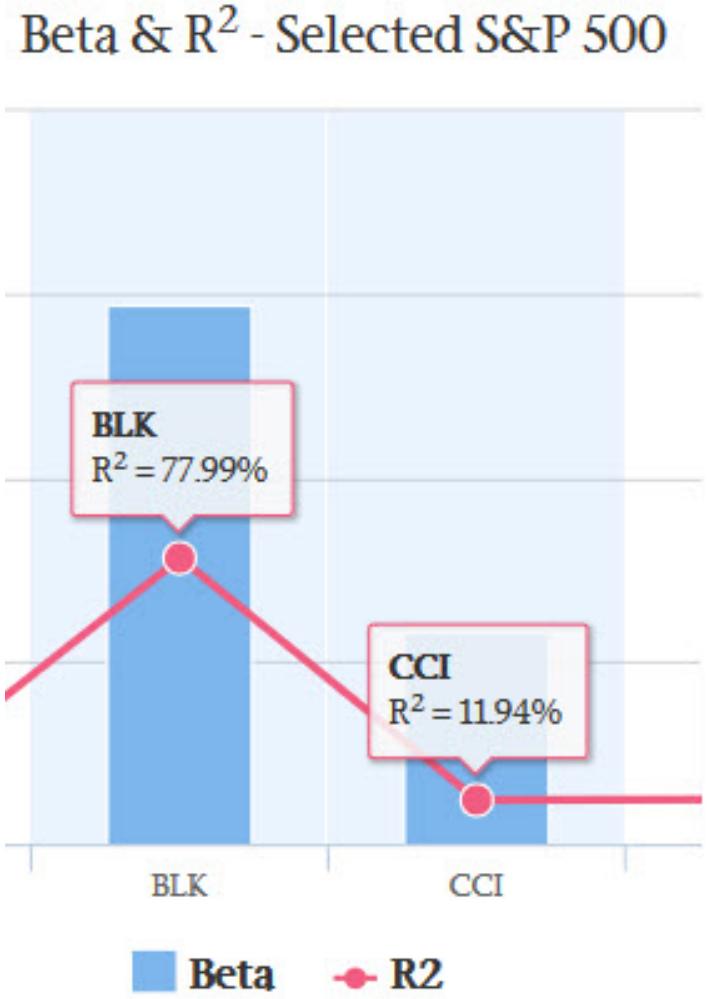
Correlation, Beta and Alpha (cont.)

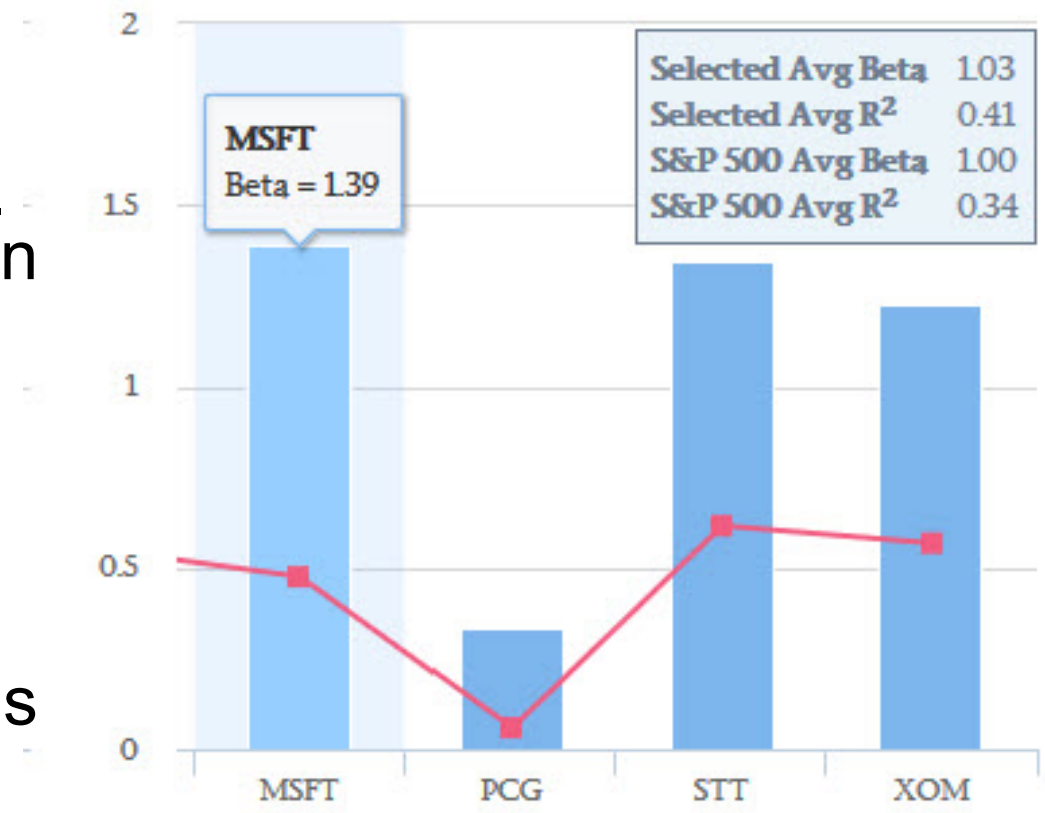
- Generally, a higher R^2 indicates a more useful beta; a low R^2 indicates the beta may not be reliable.
- Since alpha is calculated using beta, a low R^2 also indicates the alpha may also be unreliable.



Interpreting Beta

- A beta greater than 1 indicates that the investment is more volatile than the market. The swings up and down are more extreme.

- In this case, MSFT's returns were, on average, 39% more volatile than the market's returns.



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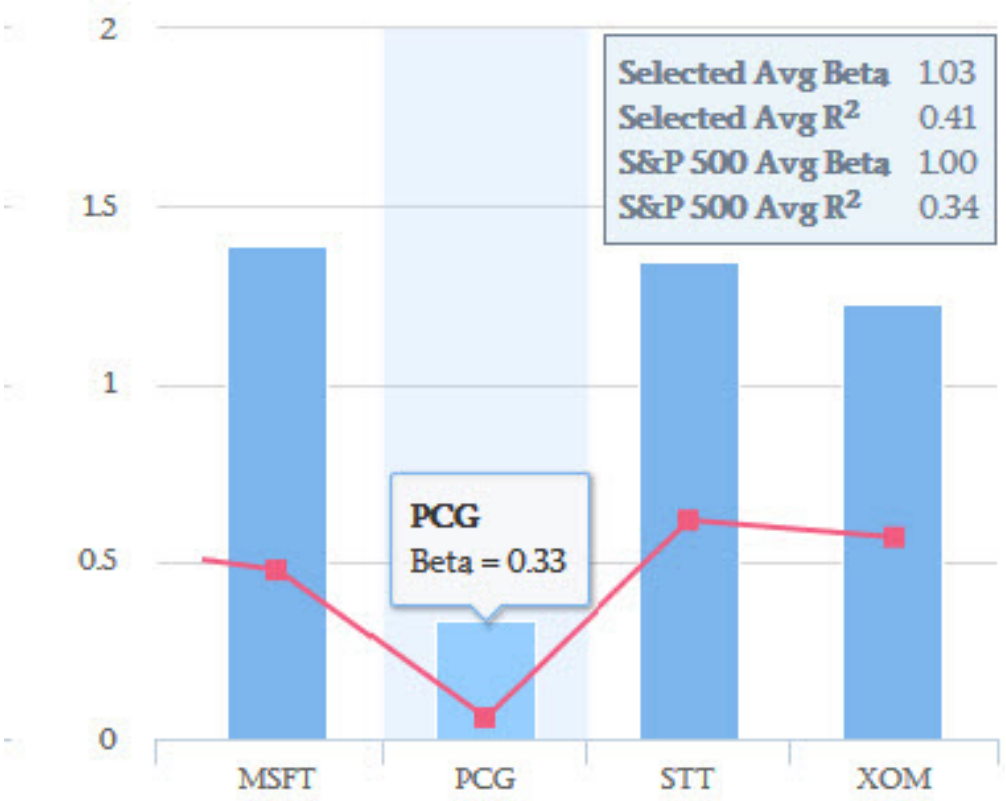
Interpreting Beta (cont.)

- A beta less than 1 (but greater than 0) indicates that the investment is less volatile than the market. The swings up and down are less extreme.

- In this case, PCG's returns were, on average, 33% less volatile than the market's returns.



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Calculating Beta

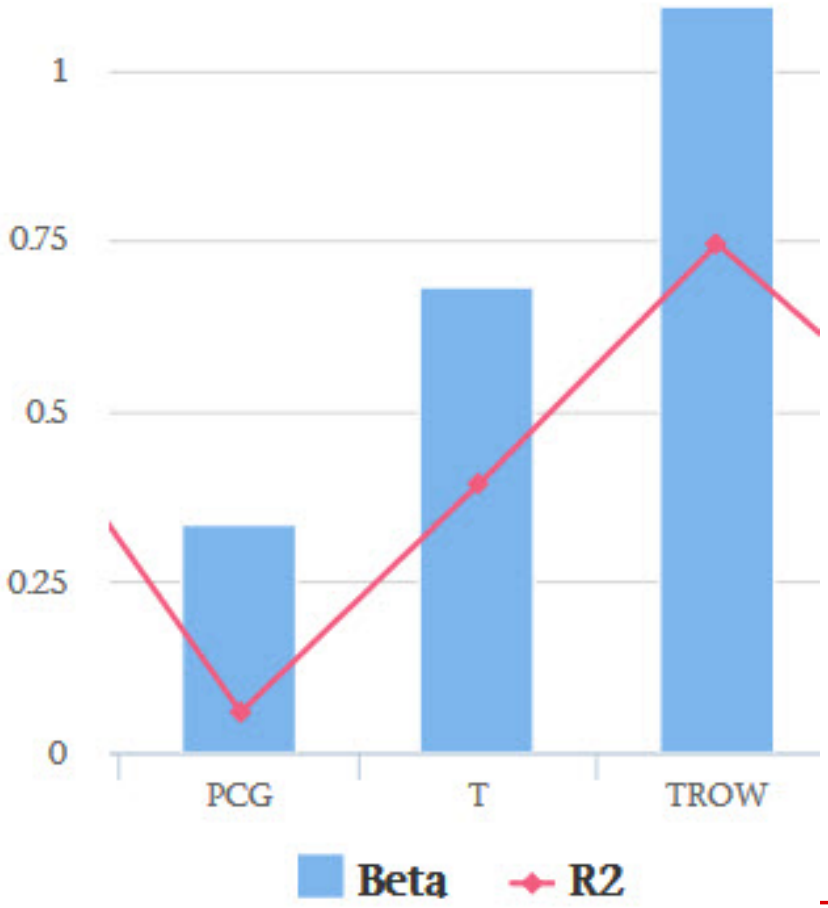
- Beta is calculated, for a specified period, as the covariance of the return of an asset and the return of the benchmark, divided by the variance of the return of the benchmark:

$$\beta = \frac{\text{Covariance } (r_s , r_M)}{\text{Variance } (r_M)}$$

r_s = return on the asset (stock)

r_M = return on the Market index

What is R^2?



- In investing, R^2 measures the degree to which a stock's return can be attributed to the return of the benchmark.

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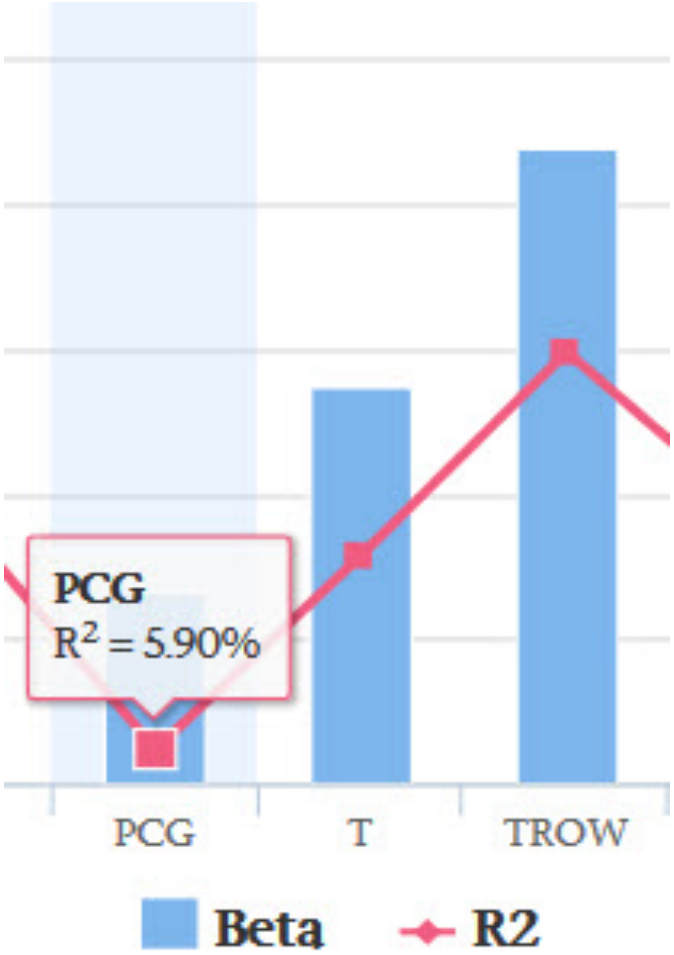
Interpreting R^2



- A low R^2 indicates a low correlation between the stock's returns and the benchmark's returns.
- In this case, only 5.9% of PCG's return can be explained by the return of the benchmark.

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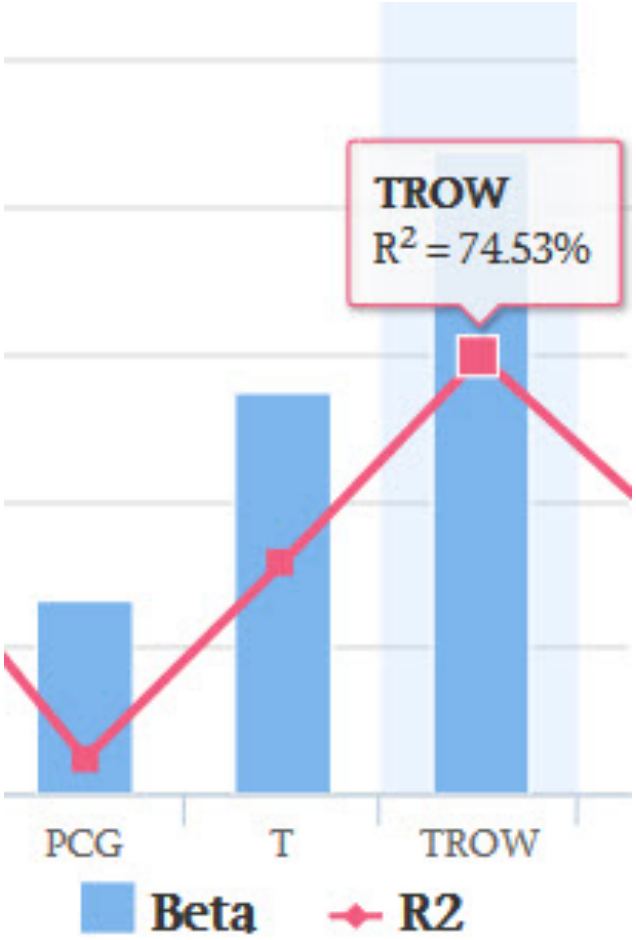
Interpreting R^2 (cont.)



- A high R^2 (often considered > .75) indicates a strong correlation between the stock's returns and the benchmark's returns.
- In this case, 74.53% of TROW's return is explained by the return of the benchmark.

Summary

- Alpha, beta and R^2 are important indicators to consider when evaluating stock performance.
- Beta (β) is a measure of the systematic risk of a stock, indicating its sensitivity to the movement of a benchmark market index.
- Alpha is a measure of the reward or penalty for holding firm-specific risk.

Summary

- Stocks with a positive alpha exceed their expected return; those with a negative alpha fall below their expected return.

- While positive alpha stocks are notable, they should be evaluated within the context of their corresponding R^2 values in order to assess their reliability.

Multi-Factor Models for Stock Risk
Fama-French Three-Factor Model
Learning Objectives

- Describe the Fama-French three-factor model
- Build a regression model to estimate exposure to 3 Systematic Factors
- Analyze how well an asset's returns are explained by the Fama-French three-factor model

Review: CAPM = Single-Factor Model

- The traditional regression model for analyzing excess returns is the Capital Asset Pricing Model (CAPM), a single-factor model:

$$(R_i - R_f) = \alpha_i + \beta_i (R_{MKT} - R_f) + e_i$$

- The model stipulates there is only one risk factor: the return on the market portfolio.

R_i = asset return

R_f = risk-free rate of return

α_i = difference between the asset's return and the expected return

β_i = measure of the asset's systematic risk in relation to the market

R_{MKT} = the market return

e_i = random error/non-systematic risk

From a Single to Multi-Factor Model

- According to the CAPM theory, in the previous slide's equation, α (alpha) should equal 0. However, that is not always the case.

- Researchers began investigating models where additional factors (e.g. interest rates) could be added to the market factor in order to better explain excess returns.

- Analyzing historical data, Eugene Fama and Kenneth French noticed that small-cap stocks and value stocks tended to outperform large-cap stocks and growth stocks.

Fama-French Three-Factor Model

- Fama and French added a size factor and a value factor to the market factor:

$$(R_i - R_f) = \alpha_i + \beta_i\,(R_{MKT} - R_f) + s_i(\text{SMB}) + h_i(\text{HML}) + e_i$$

- Empirically, their three-factor model explained historical returns better than the single-factor market model, explaining over 90% of excess returns as opposed to approximately 70%.

Size: (SMB) Small Minus Big Companies

$$(R_i - R_f) = \alpha_i + \beta_i (R_{MKT} - R_f) + s_i(\text{SMB}) + h_i(\text{HML}) + e_i$$

- The size premium (SMB) is the average monthly return on the smallest 30% of stocks (in terms of market capitalization) minus the average monthly return on the largest 30%.
- When small stocks do well relative to large stocks, this will be positive; when they do worse than large stocks, this will be negative.

Value: (HML) High Minus Low Value (B/M)

$$(R_i - R_f) = \alpha_i + \beta_i (R_{MKT} - R_f) + s_i(\text{SMB}) + h_i(\text{HML}) + e_i$$

- The value premium (HML) is the average monthly return for the 50% of stocks with the highest book-to-market ratio minus the average return for the 50% of stocks with the lowest book-to-market ratio.

- When high value stocks do well relative to low value stocks, this will be positive; when they do worse than low value stocks, this will be negative.

- High book-to-market stocks are considered "value" stocks; low book-to-market stocks are considered "growth" stocks.

Factor Betas

- Extending the single factor CAPM model, the Fama-French model uses three factor betas:

$$(R_i - R_f) = \alpha_i + \beta_i (R_{MKT} - R_f) + s_i(\text{SMB}) + h_i(\text{HML}) + e_i$$

- A **factor beta** (sometimes called a "factor loading") is the sensitivity of security's returns to a particular systematic factor.

- With this model, market returns can roughly be explained by three factors: (1) exposure to the overall market (R_{MKT} - R_f); (2) exposure to small cap stocks (SMB); and (3) exposure to value stocks (HML).

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The Fama-French Factors

- Ken French publishes datasets of the Fama-French factors for distribution from his web site at Dartmouth University.

- For more detailed information on how these factors were calculated, visit his web site at:

http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

- As research continues, additional factors continue to be added to the original three-factor model.

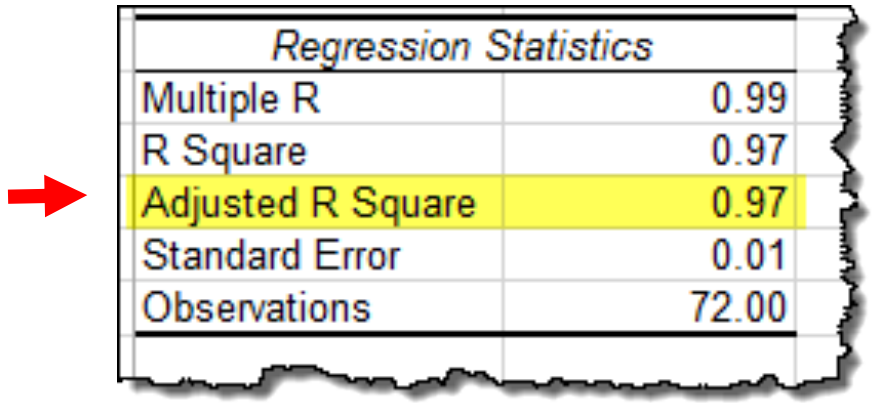
Example

- Use a WRDS query to download “Factor” Returns
  - Market Factor (Rm)
  - Size Factor (SMB)
  - Distress Factor or Value Factor (HML)
  - Others:
    - Momentum
- Estimate “Betas” for Apple Inc.

Summary Output: Interpreting R^2

- **R Square** provides information on the explanatory power of the linear regression model; it indicates how well the data "fits" the model.

- The **Adjusted R Square** is modified to adjust for the number of independent variables in the model, and is therefore considered the more conservative estimate.



Regression Statistics	
Multiple R	0.99
R Square	0.97
Adjusted R Square	0.97
Standard Error	0.01
Observations	72.00

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Interpreting R^2 (cont.)

- Here, the Adjusted R Square measures the degree to which this Apple Inc's excess returns can be attributed to the independent variables.

Regression Statistics	
Multiple R	0.99
R Square	0.97
Adjusted R Square	0.97
Standard Error	0.01
Observations	72.00

Interpreting the Regression Data

- The intercept is the alpha, and the three subsequent coefficients are the beta factor values.

	Coefficients	*Standard Error*	*t Stat*
Intercept	0.00	0.00	-0.47
FAMA-FRENCH MARKET FACTOR	1.07	0.03	38.62
FAMA-FRENCH SIZE FACTOR (SMB)	0.71	0.05	14.62
FAMA-FRENCH VALUE FACTOR (HML)	-0.14	0.05	-2.69

- The results can be rewritten as:

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lowe*
α	0.00	0.00	-0.47	0.64	
β with respect to Market	1.07	0.03	38.62	0.00	
β with respect to Size	0.71	0.05	14.62	0.00	
β with respect to Value	-0.14	0.05	-2.69	0.01	

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Interpreting the Regression Data (cont.)

- As you interpret the fund's sensitivity to the three factors, keep in mind that features of the stock (Size, Growth, etc).

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lowe*
α	0.00	0.00	-0.47	0.64	
β with respect to Market	1.07	0.03	38.62	0.00	
β with respect to Size	0.71	0.05	14.62	0.00	
β with respect to Value	-0.14	0.05	-2.69	0.01	

Compare the Betas in Terms of the Fama-French Factors

	Coefficients	Standard Error	t Stat	P-value	Lowe
α	0.00	0.00	-0.47	0.64	
β with respect to Market	1.07	0.03	38.62	0.00	
β with respect to Size	0.71	0.05	14.62	0.00	
β with respect to Value	-0.14	0.05	-2.69	0.01	

Firm 1

	Coefficients	Standard Error	t Stat	P-value	Lowe
α	0.00	0.00	0.73	0.47	
β with respect to Market	0.94	0.02	51.94	0.00	
β with respect to Size	-0.16	0.03	-5.20	0.00	
β with respect to Value	0.24	0.03	7.12	0.00	

Firm 2

Conclusion

- In the Capital Asset Pricing Model, the market portfolio return is the sole source of risk.

- The Fama-French three-factor model suggests that portfolio returns can roughly be explained by three factors:

  (1) exposure to the broad market (R_{MKT} - R_f)
  (2) exposure to small stocks (SMB)
  (3) exposure to value stocks (HML)

- A factor beta represents the sensitivity of a portfolio's returns to changes in a systematic factor.

Notes (cont.)

For Fama-French data:

- Monthly returns on the market portfolio are value-weighted returns for all firms listed on the NYSE, AMEX, and NASDAQ.
- The risk-free rate is the return on 1-month T-bills.
- Additional information is available on Ken French's web site: http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/index.html

Financial Market Analytics: Risk Summary

- How to measure Risk of investing in stocks
  - Market Risk (Systematic)
  - Idiosyncratic Risk (Individual Stock Volatility)
  - Other Systematic Risks – Size, Distress, Etc.

- Application of Regression Analysis Using WRDS stock data