Week 6:

Simple and Compound Returns

I. Both important for understanding how investments are performing over time\
II. Prices of assets observed over time and can then be predicted
III. Return: percentage change in stock price from one period to the next

Example data:

Month	Price
April	15
May	17
Return	(May – April) / April

Formula for general return calculation:

t is time period

p is stock price

f is an adjustment factor for stock splits

d is the dividend (added back in)

$$r_t = \frac{p_t f_t + d_t}{p_{t-1}} - 1$$

IV. Stock splits and Dividends
    a. Can complicate calculation of returns
    b. Stock splits must be adjusted for because they are a cosmetic event
        i. i.e. a company has 1k shares outstanding w/$20 price making the market value $20k
        ii. if company does a 2 for 1 stock split there will be 2000 shares outstanding at $10/share
        iii. the company has the same market value after the stock split
        iv. split factor is always the top number divided by the bottom number i.e. 3 for 2 stock split is = 3/2 or 1.5
        v. multiply stock split by current stock price to determine what stock price would have been if it hadn't been split
        vi. Price after stock split = current price/stock split = 20/(2/1)= $10

Example: Calculating Stock Returns for Charles Schwab

Date	Price	Dividend	Stock Split	Return
September 1991	31.125			
October 1991	37.750	$0.06		=(37.750 + 0.06) / 31.25 - 1 = 20.99%
November 1991	32.750			=(32.750) / 37.750 - 1 = -13.25%
December 1991	30.375		3 for 2	=(30.375 * 1.5 / 32.750) - 1 = 39.12%

V. Compound Returns
   a. Tells you how much money a return would have been if investment held for a period of time
   b. Gives you total return over entire period
   c. Represents cumulative effect that a series of gains or losses has on original investment over time
   d. Tells you experience of an investor over time and what their gain has been since they started investing

$$\text{Compound return} = (r_1 + 1) \times (r_2 + 1) \times \cdots \times (r_n + 1) - 1$$

r is the return for that period i.e. r_1 is return for first period

- What's the compounded for Charles Schwab?
  - Compounded Return = (1+.2099)*(1-0.1325)*(1+0.3912) -1= 46%

VI. R Programming for Return Calculations
   a. Packages Needed
      i. PerformanceAnalytics : great for working w/stock price data
      ii. XTS: great for working with time series data and creating a time series dataset
      iii. lubridate: creates and manipulates dates
   b. load packages and data
   c. convert data into time series package
   d. data prep now complete
   e. calculate fund performance and compound return

```
R code

library(PerformanceAnalytics)
library(xts)
library(lubridate)

# load data and create an xts dataset
fund<-read.csv("contrafund.csv")
fund$Date<-mdy(fund$Date)
fund2<-fund[order(fund$Date),]

#create an xts dataset
All.dat<-xts(fund2[,-
1],order.by=fund2[,1],)
```

f. use the return.cumulative function to calculate compound return
   i. first argument points to fund return (All.data$ContraRet)
   ii. last argument compounds the return w/geometric = TRUE

- The function here is Return.cumulative(All.dat$ContraRet, geometric = TRUE)

   iii. Cumulative return is 141.58 which implies fund has increased 14,158% since 1980
   iv. Can chart the returns using code below

- We can also look at the compounded return over time using the chart.CumReturns functions:

  chart.CumReturns(All.dat$ContraRet, wealth.index = FALSE, geometric = TRUE)

Measuring Risk

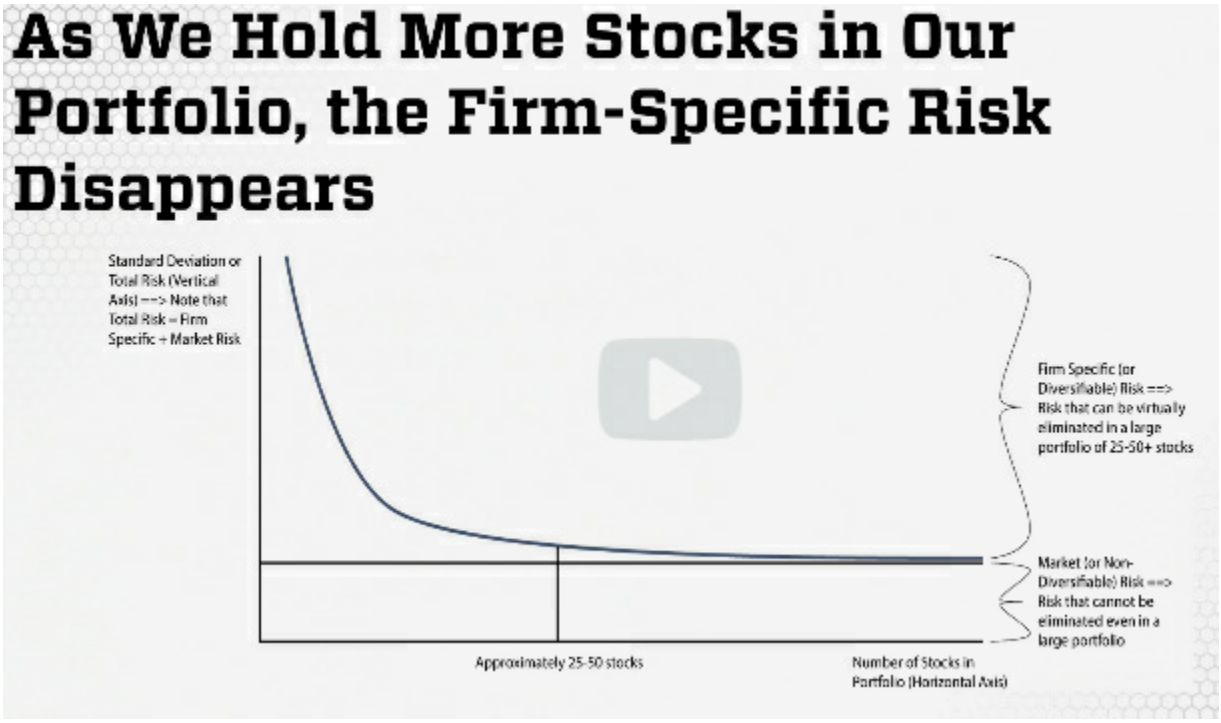
I. Treasury Bonds = generally very safe/low risk
II. Tech and Big Pharma = high risk/uncertainty about payoffs
III. Quantifying/Measuring Risk
   a. Standard Deviation of Returns
      i. Tells us how far away from the mean on average
      ii. Higher standard deviation = higher risk

It's calculated as:

$$s = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$$

iii. Really good measure of total risk of a stock or mutual fund
iv. Standard deviation is total risk

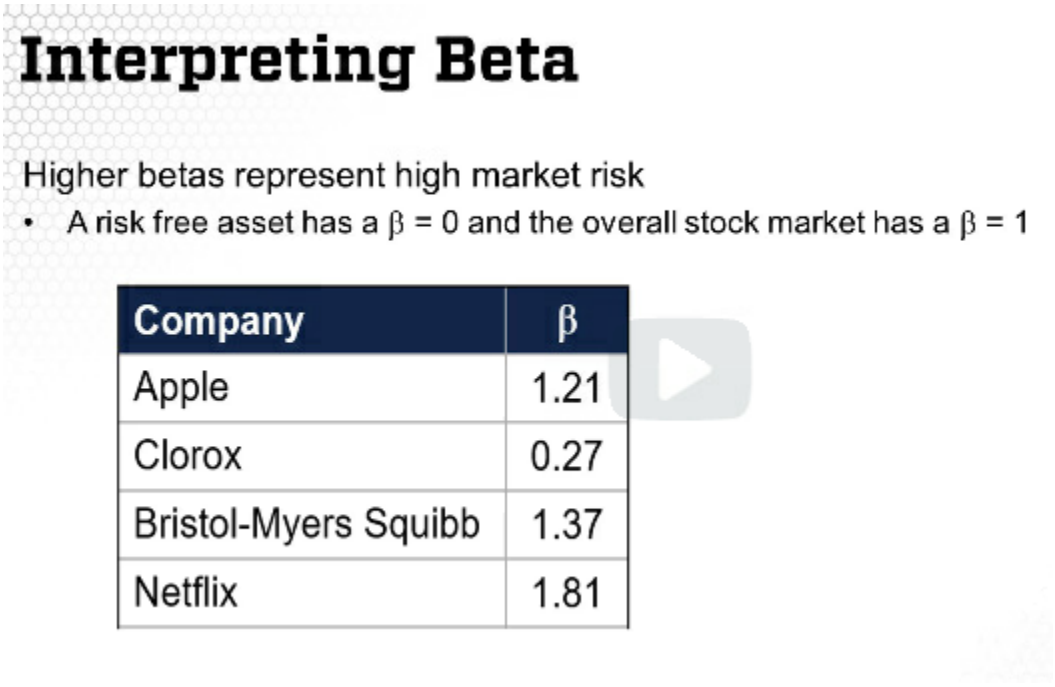
b. 2 components of standard deviation
    i. Firm specific component
        1. Events directly related to firm like good/bad news about the firm
        2. Disappears as number of stocks you hold increases
    ii. Market wide component
        1. Overall news about market like interest rate movements, likelihood of recession
c. By adding stocks to portfolio the firm specific risk falls to a certain point and you are left with market risk
    i. Going from 1 to 5 stocks shows dramatic decrease in risk eliminating firm specific risk
    ii. Going from 100-300 stocks standard deviation doesn't fall as much
    iii. Add stocks to portfolio continually and will be left with only market risk which can't be diversified away like firm specific risk



d. Can decompose risk components using simple linear regression model
    i. Dependent variable: return or fund interested in
    ii. Independent variable: return on a broad stock index i.e. Vanguard Total Stock Market Index or S&P 50
    iii. Beta: coefficient on market return that's a measure of a stock sensitivity to the overall market that can be used to measure risk as well
        1. Beta = 0 for risk free assets
        2. Beta = 1 for Overall stock market

3. Companies typically have betas of one extreme very close to zero and another extreme as high as 2 or 3

e. Interpreting Beta
   i. Clorox close to no risk beta of 0 @ 0.27 making it low risk
   ii. Apple close to overall market risk of 1 @ 1.21 so slight risk
   iii. BMS (pharma company) slightly higher risk @ 1.37
   iv. Netflix very high risk @ 1.81

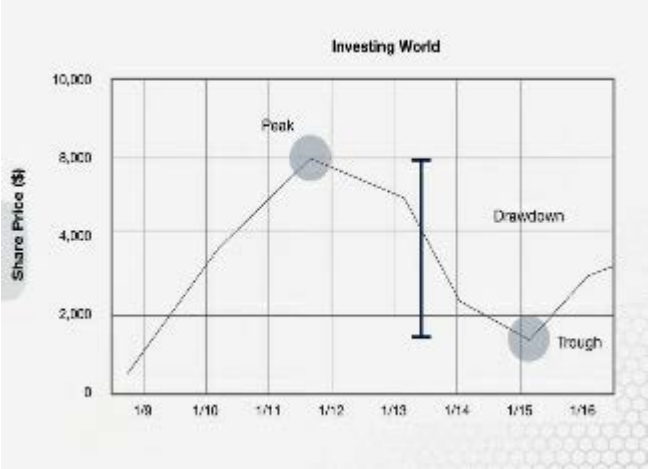


f. Linear Regression for risk
   i. Running linear regression model gives a goodness of fit or R2
   ii. R2 tells you percentage of fund's performance that occurs as result of the market
   iii. Higher R2 means fund more closely correlated with overall market

g. Asset drawdown
   i. High-water mark: highest price a fund achieved in the past
   ii. Drawdown shows us cumulative losses since losses have started
   iii. Calculated by taking high-water mark and subtracting the current price of the asset then divide by high-water mark

- A high-water mark (HWM) is the highest price a fund has achieved in the past
- Drawdown (DD) is the cumulative loss since losses started:
  - $DD_t = \frac{(HWM_t - P_t)}{HWM_t}$

iv. High watermark tells us the peak-to-trough decline in our investment
   1. Peak is the high water-mark
   2. Tells us something about how risky a firm is



h. Calculating in R

- To calculate standard deviation, we can use the table.Stats function
  - table.Stats(All.dat$ContraRet)
  - It's worth noting that the arithmetic mean return is 0.65% and the standard deviation is 4.65% *per month*

*use same packages as last R example

i. calculate R2 and beta using linear regression model

We can estimate Beta and R^2 via a simple linear model:

Mod1=lm(ContraRet~Market.Return,= All.dat) summary(mod1)

The summary regression output is to the right

- Beta is the coefficient on Market.Return and is 0.9004 indicating that this fund is less risky than average
- The Adj. R^2 is 0.8313 indicating that this fund is correlated with the overall market

Call:
lm(formula = ContraRet ~ Market.Return, data = All.dat)

Residuals:

Min	1Q	Median	3Q	Max
-0.087523	-0.009502	0.001399	0.010316	0.060957

Coefficients:

	Estimate	Std. Error	t value	Pr (>|t|)
(Intercept)	0.0025419	0.0008485	2.996	0.00288
Market.Return	0.9004602	0.0168912	47.666	< 2e-16

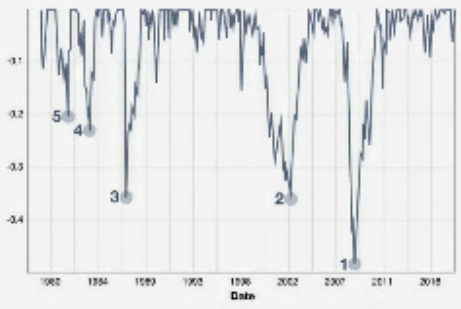
Signif. Codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.01776 on 460 degress of freedom
Multiple R-squared: 0.8316,
Adjusted R-squared: 0.8313
F-statistic: 2272 on 1 and 460 DF
p-value: < 2.2e-16

Drawdown

We can plot the drawdowns and show the five largest draw downs using the following functions:

chart.Drawdown(All.dat$ContraRet)
table.Drawdowns(All.dat$ContraRet,top=5,digits=4)



	From	Trough	To	Depth	Length	Trough	Recovery
1	2007-11-30	2009-02-28	2012-02-29	-0.4634	52	16	36
2	1987-09-30	1987-11-30	1989-04-30	-0.3416	20	3	17
3	2000-04-30	2003-02-28	2004-11-30	-0.3324	56	35	21
4	1983-05-31	1984-07-31	1985-03-31	-0.2214	23	15	8
5	1981-06-30	1982-07-31	1982-10-31	-0.1952	17	14	3

- Notice that the largest drawdown occurred between 2007-11-30 and 2009-2-28. The Contra Fund fell 46.34% from its peak. It took 16 months to reach bottom and 36 months to recover. The total episode lasted 52 months

Historical Returns

I. Four Asset Classes
   a. Small Cap stocks: 30% of smallest companies traded on US exchanges i.e. startups etc
   b. Large Cap stocks: AMazon, Apple, Google etc. largest 30% companies traded on US exchanges
   c. Treasury bills: very short term debt; very safe
   d. Treasury bonds: longer maturities out to 30 years
   e. Use inflation rate as benchmark

II. Letting your money compound over a long time frame results in very large returns
III. Small cap stocks have highest return over time but had large drops