Data Analytics in Business
Investing Analytics

Jonathan Clarke, Ph.D
Associate Professor
Scheller College of Business

Risk Adjusted Performance

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Lesson Objectives

At the end of this lesson, you should be able to:

- Calculate measures of risk adjusted performance including:
    - Comparison to a benchmark
    - Sharpe Ratio
    - Treynor Ratio
    - Jensen's Alpha

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A Way to Keep Score

- We need some way to gauge whether our investments are outperforming expectations
- Finance has developed a number of ways to compare actual performance to expected performance. In other words, to measure abnormal performance

Abnormal return = Actual Return − Expected Return

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Comparison to a Benchmark

- Perhaps the easiest thing to do is to compare our investment to a benchmark
- We have already seen this function in R
    Return.cumulative(All.dat, geometric = TRUE)
    chart.CumReturns(All.dat, wealth.index = FALSE, geometric = TRUE)

	ContraRet	MktReturn	Risk Free
Cumulative Return	141.5677	69.29182	4.072008

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Sharpe Ratio

• The Sharpe ratio is a measure of the investment reward per unit risk

Sharpe ratio = $\frac{(R - R^f)}{\sigma(R - R^f)}$

• Where $(R - R^f)$ is the excess of the portfolio's return above the risk free rate and $\sigma(R - R^f)$ is the standard deviation of the excess return.

A higher Sharpe ratio indicates higher reward per unit risk! Higher Sharpe ratios are better!

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Calculating a Sharpe Ratio in R

• The function is: SharpeRatio(All.dat$ContraRet,All.dat$Risk.Free)
• The output shows that the Sharpe ratio for the Contra fund is 0.190

	ContraRet
StdDev Sharpe (Rf=0.4%, p=95%):	0.19010682
Var Sharpe (Rf=0.4%, p=95%):	0.12900607
ES Sharpe (Rf=0.4%, p=95%):	0.05971594

• By way of comparison, the Sharpe ratio for the market index is 0.153. The Contra fund has enjoyed strong performance

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Treynor Ratio

- The Treynor ratio is similar to the Sharpe ratio except that the denominator is now beta:

    Sharpe ratio $= \frac{(R - R^f)}{Beta}$

Similar to the Sharpe Ratio, a higher Treynor ratio indicates higher reward per unit risk!

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The Treynor Ratio in R

- The function is:

    TreynorRatio(All.dat$ContraRet,All.dat$Market.Return,All.dat$Risk.Free)
- The output shows that the Treynor ratio for the Contra fund is 0.10
- By way of comparison, the Treynor ratio for the market index is 0.07. The Contra fund has enjoyed strong performance

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Jensen's Alpha

- Jensen's alpha measures the abnormal return that the portfolio earns after adjusting for beta
- We need to estimate the following regression equation:

$$r_{i,t} - r_f = \alpha_i + \beta_i(R_{m,t} - r_f) + \varepsilon_{i,t}$$

- Where:
  - $r_{i,t}$ is the return on asset i at time t
  - r_f is the risk free rate
  - $R_{m,t}$ is the return on the market index at time t
  - α_i and β_i need to be estimated from the regression

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Steps Involved in Estimating Jensen's Alpha

1. Calculate the asset's return in excess of the risk free rate ($r_{i,t} - r_f$)
2. Calculate the return on the market index in excess of the risk free rate $(R_{m,t} - r_f)$
3. Run a regression of ($r_{i,t} - r_f$) on the $(R_{m,t} - r_f)$,
4. Focus on the regression's intercept. If the intercept is positive and statistically significant, the fund has outperformed his benchmark. If its negative, the fund has underperformed

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Implementing Jensen's Alpha in R

- Let's first create the returns in excess of the risk free rate:

    All.dat<-transform(All.dat,
    MktExcess=Market.Return-
    Risk.Free,FundExcess=ContraRet-Risk.Free)

- Next, let's run the regression:

    Alpha=lm(FundExcess~MktExcess,data=All.dat)

    summary(Alpha)

- The summary regression output is to the right

    - The intercept (alpha) is 0.218% per month and is statistically significant. This indicates that the Contra Fund has generated significant outperformance

Call:
lm(formula = FundExcess ~ MktExcess, data = All.dat)

Residuals:

Min	IQ	Median	3Q	Max
-0.087553	-0.009588	0.001373	0.010343	0.060880

Coefficients:

	Estimate	Std. Error	t value	Pr (> | t |)
(Intercept)	0.0021850	0.0008362	2.613	0.00927
Market.Return	0.9013625	0.0188580	47.797	< 2e-16

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

Residual standard error: 0.01777 on 460 degress of freedom
Multiple R-squared: 0.8324,
Adjusted R-squared: 0.832
F-statistic: 2285 on 1 and 460 DF
p-value: < 2.2e-16

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Summary

1. In this lesson, we saw how to measure risk adjusted performance
2. In this case, the fund we examined performed extremely well!
3. This opens up a number of questions worth exploring:

    - Is it easy to outperform the stock market?
    - Do some people have an ability to persistently outperform the market?
    - If so, what are their strategies?
    - Could this outperformance be luck?

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Transaction Costs

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Lesson Objectives

At the end of this lesson, you should be able to:

- The impact of transaction costs on returns
- The different components of transaction costs: commissions; impact; and delay

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Impact of Transaction Costs on Performance

No transaction cost environment:
- Suppose that, you acquire $1,000 worth of shares and realize a 10% return. At this point, you sell and recognize a gain of $1,100
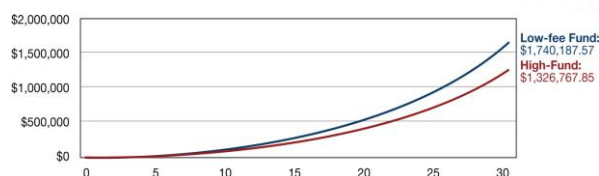 - Your net return is 10%

With transaction costs:
- In a real world market with $1,000 and a 150 bps cost when you buy, you would invest only $985 in shares. If shares rise 10% and you sell, again incurring a 150bp cost, you would put only $1067.25 in the bank.
  - Your net return is 6.73 percent!

Main point: Transaction costs always lower our returns

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Over an Investing Lifetime, Transaction Costs Can Have a Big Impact

John Bogle, the legendary founder, of Vanguard was quoted as saying:
"Performance comes and goes, but costs roll on forever"

- Consider a low-fee fund that charges fee of 0.1% and high-fee fund that changes a fee of 1% each year. Suppose that both funds earn a 10% return before fees. How much will you have after 30 years if you initially invest $100,000

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Main Components of Investing Fees

- **Commissions:** a fixed charge for executing a trade. For example, Charles Schwab currently charges $4.95 per trade
- **Bid-ask spread cost:** The difference between the price quoted for an immediate sale (offer) and an immediate purchase of the stock (bid)
- **Delay:** Represents the loss in investment value between the time you make an investment decision and the time the trade is executed

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Bid-ask Spread - Illustration

AE Advisors, Inc., a fictitious asset management firm, wants to buy 1,000 shares of XYZ

- Best offer price
  - Lowest displayed price at which AE can buy
  - In our example: AE can buy XYZ at $25.42
- Best bid price
  - Highest displayed price at which AE can sell
  - In our example: AE can sell XYZ at $25.38
- Definition of quoted spread
  - **Difference between best bid and offer**
  - In our example: 4¢ or 16 bps
  - Roundtrip cost when AE buys at offer and sells at bid
- Larger orders will pay higher transaction costs! They have a big market impact

Displayed Liquidity

Symbol XYZ

Buy Qty	Price	Sell Qty
	$25.46	1,100
	$25.45	1,200
	$25.44	1,000
	$25.43	1,500
	$25.42	2,000
2,000	$25.38	
3,000	$25.37	
1,200	$25.36	
1,500	$25.35	
800		

Offer → $25.42

Quoted Spread

Bid → $25.38

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Delay Cost Example

A fund manager discovers an undervalued stock that is currently trading in the market at a price of $50 and instructs the trader to by $250,000. The trader looks for the most capable broker to handle the order. However, by the time the trader chooses a broker and submits the buy order the price has risen to $50.25

- What's the delay Cost?

    ($50.25 – $50.00) = $0.25 or 50 bps

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Relative Size of Trading Costs

Commission (5 bps)
Impact* (10 bps)
Delay (46 bps)

- Bps stands for basis point
- 1 basis point = 0.01%
- So total transaction costs are approximately 0.60%

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Summary

1. Transaction costs lower your investment returns
2. Three main components:
   - Commission
   - Bid-ask spread and market impact
   - Delay
3. As investors, we care about returns net of transaction costs. That is, we care about returns after transaction costs

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Market Efficiency

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Lesson Objectives

At the end of this lesson, you should be able to:
- Understand the different types of market efficiency:
  - Weak form
  - Semi-strong form
  - Strong-form
- Describe evidence in support of market efficiency

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Thought Question

What if you have found out the following:
- Buy if out of the 20 trading days for the past month, stock XYZ has been rising for more than 2/3 of the times
- Sell if out of the 20 trading days for the past month, stock XYZ has been falling for more than 2/3 of the times
- By following this rule, you are able to earn returns that are "abnormally high"

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The Stock Price Reflects Information

- If you have spotted XYZ's stock pattern that guarantees you pure profit, what should you do?
    - You should definitely exploit it
    - How? Borrow as much as you can to invest
- The process of exploiting it actually makes the opportunity vanish because:
    - You would bid up XYZ stock price when you think it is hot
    - You would also likely bid down XYZ stock price when you think it is cold
- In short, the fact that you have figured out a stock price movement is very likely to be reflected by the stock price
    - The more greedy you are, the faster your pattern will be eliminated

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The Army of Investors

- Imagine not only you, there exists an "army" of intelligent, well-informed security analysts, arbitragers, traders, who literally spend their lives hunting for securities which are mispriced or following a price moving pattern based on currently available information
- They have high-tech computers, subscription to professional database, up-to-date information on thousands of firms, state-of-the-art analytical technique, etc…
- These people can assess, assimilate and act on information, very quickly
- In their intense search for mispriced securities, professional investors may "police" the market so efficiently that they drive the prices of all assets to fully reflect all available information

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Implications

- Competition for finding mispriced securities is fierce
- Such competition always kills the "sure-profit" pattern because, were there one, it would have been exploited by someone who first spotted it
- The first one does make profit
  - But the "very first" one is not likely to be you (or me)
- The implications:
  - Stock prices should have reflected all available information
  - Stock returns should be unpredictable

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Definition: Efficient Markets

- An *efficient* capital market is one in which stock prices fully reflect available information
- Three different types of market efficiency:
  - Weak Form
    - Security prices reflect all information found in past prices and volume
  - Semi-Strong Form
    - Security prices reflect all publicly available information
  - Strong Form
    - Security prices reflect all information—public and private

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Think of Market Efficiency as a "Theory of Sharks"

- Sometimes market efficiency is presented as a theory of rational man (Homo Economicus)

- It's not! It's a theory of intense competition:
  - In liquid securities markets, profit opportunities bring about infinite discrepancies between demand and supply
    - Well financed, knowledgeable arbitrageurs spot these opportunities, pile on, and by their actions they close aberrant price differentials

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Evidence in Support of Market Efficiency

- If the market is semi strong-form efficient, then no matter what publicly available information mutual-fund managers rely on to pick stocks, their average returns should be the same as those of the average investor in the market as a whole

- We can test efficiency by comparing the performance of professionally managed mutual funds with the performance of a market index

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It's Not Easy to Beat the Market!

Percentage of Active U.S. equity funds that outperform the passive benchmark

Fund Type	1-Year	3-Year	5-Year	10-Year	15-Year
All domestic equity funds	42.02%	17.88%	19.87%	14.07%	16.24%
All large-cap funds	36.54%	21.36%	23.51%	10.85%	7.57%
All mid-cap funds	45.82%	16.72%	18.26%	7.32%	4.87%
All small-cap funds	27.12%	6.41%	7.10%	6.64%	2.30%
All multi-cap funds	39.16%	17.58%	18.99%	10.93%	11.74%
Real estate funds	46.34%	25.88%	32.91%	22.81%	17.24%

- At long-time horizons, most funds fail to outperform! This is about what you would expect by chance.

- Most evidence shows that you can't predict the funds that will outperform

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Summary

1. Efficient markets are the result of intense competition
2. If markets are efficient, it shouldn't be possible to consistently generate alpha or to outperform a passive benchmark
3. The performance of mutual funds suggests that market are efficient

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Behavioral Finance

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Lesson Objectives

At the end of this lesson, you should be able to:

- Understand necessary conditions for markets to deviate from efficiency
- Describe the evidence against market efficiency

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Markets Can't Be Perfectly Efficient

- If they were, there would be no incentive to collect information
- There's also a lot of evidence on behavioral biases and failure of market efficiency
- Consider the Herzfeld Caribbean Basin Fund (stock ticker is CUBA)
  - 69% of its holdings are U.S. stocks with the rest mostly in Mexican stocks
  - Holds no assets in Cuba
  - On December 18th, 2014, Obama announced he was going to lift restrictions on Cuba
  - The CUBA fund's stock price went up over 70%

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Behavioral Finance

- Two key ingredients to behavioral finance:
  - Investors are not fully rational and the deviations from rationality are correlated across investors
    - That is, a large number of investors make similar mistakes
  - Arbitrage forces are limited
    - Capital may be limited
    - Investment constraints, such as limits to short positions
    - Noise trader risk – Arbitrageurs may have limited horizons and mispricings may persist for long periods of time
- Two main implications if the above hold true:
  - Irrational behavior may push prices away from fundamental values
  - Arbitrage is limited and can't completely eliminate mispricings
  - Net result: Market efficiency will hold generally, but may not hold for all securities at all times. When arbitrage forces are strong, prices will be more efficient

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Investors Have Lots of Behavioral Biases

1. Overconfidence: Tendency to overestimate one's ability
2. Loss aversion: The tendency of individuals to seek pride and avoid regret in their decisions
3. Recency effect: People tend to overemphasize a recent information when making investment decisions
4. Anchoring: Individuals tend to take action based on a single fact or figure that should have little bearing on their decision, while ignoring more important information
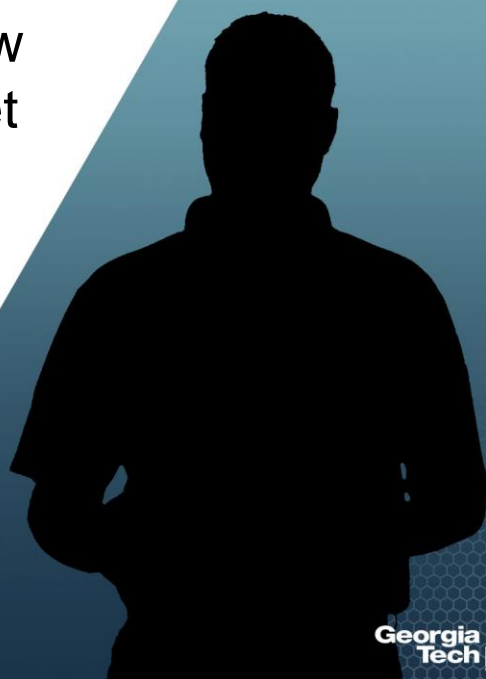
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Summary

1. Investors suffer from various behavioral biases.
2. Coupled with capital market frictions, this may push prices away from fundamental value

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Behavioral Biases May Allow Us to Outperform the Market

- In the next session, we will look at how behavioral biases may give rise to profitable trading opportunities
- We will look at several strategies:
  - Value
  - Momentum
  - Low volatility

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