

Data Analytics in Business

Investing Analytics

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Risk Adjusted Performance



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



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

$$\text{Abnormal return} = \text{Actual Return} - \text{Expected Return}$$

Abnormal return, also known as "alpha" or "excess return," is the fraction of a security's or portfolio's return not explained by the rate of return of the market. Instead, it is a result of the expertise of the investor.

<https://investinganswers.com/dictionary/a/abnormal-return>



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)
```



Sharpe Ratio

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

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

- 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!

The ratio is the average return earned in excess of the risk-free rate per unit of volatility or total risk.

Generally, the greater the value of the Sharpe ratio, the more attractive the risk-adjusted return.



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



Treynor Ratio

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

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

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

The Treynor ratio, also known as the reward-to-volatility ratio, is a performance metric for determining how much excess return was generated for each unit of risk taken on by a portfolio.

<https://www.investopedia.com/terms/t/treynorratio.asp>



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



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

dependent variable: R funds return in excess of the risk free rate
 independent variable: market return in excess of the risk free rate



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

The measure of performance is the intercept!!!

If the intercept is insignificant, the performance is "in line" (under control) the expectation (how market behaves)



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	1Q	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 degrees 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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For Beta (coefficient), anything less than 1 is less riskier than average!!!

High R² shows that "high fraction" of this funds return can be explained by the overall market.

Summary

- In this lesson, we saw how to measure risk adjusted performance
- In this case, the fund we examined performed extremely well!
- 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

1 bps = 0.01%

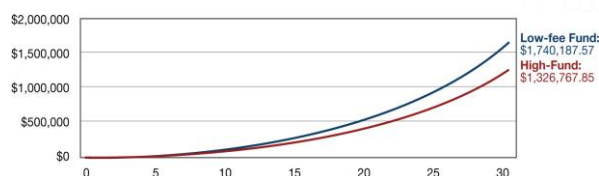
150 basis point (bps) = 1.50%

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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 charges 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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1 basis point = 0.01%.

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 buy \$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



- 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



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 $\frac{2}{3}$ of the times
- Sell if out of the 20 trading days for the past month, stock XYZ has been falling for more than $\frac{2}{3}$ of the times
- By following this rule, you are able to earn returns that are “abnormally high”



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



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



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



The Efficient Market Hypothesis, or EMH, is an investment theory whereby share prices reflect all information and consistent alpha generation is impossible. Theoretically, neither technical nor fundamental analysis can produce risk-adjusted excess returns, or alpha, consistently and only inside information can result in outsized risk-adjusted returns.

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

Well explained:

<https://www.investopedia.com/ask/answers/032615/what-are-differences-between-weak-strong-and-semistrong-versions-efficient-market-hypothesis.asp>



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



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



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

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



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



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%



Arbitrage is the simultaneous purchase and sale of an asset to profit from an imbalance in the price.
<https://www.investopedia.com/terms/a/arbitrage.asp>

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



a strong aversion to snakes and spiders

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

