

Data Analytics in Business

Investing Analytics

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Identifying Factors



Lesson Objectives

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

- Describe the factors that drive stock returns:
 - Size
 - Value
 - Momentum
 - Profitability
 - Volatility

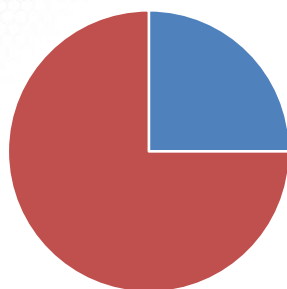


Which Factors Drive Stock Returns?

- Over the last 50 years, researchers have searched for factors that drive stock returns
- This is difficult work – some factors might appear to work because of [random chance](#) or [data mining](#)
- A handful of factors have stood the test of time. Understanding these factors can make you a better investor

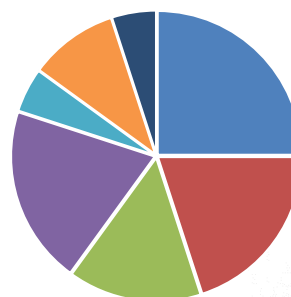
Our View is Constantly Evolving

View in the 1970s and 1980s



■ Market ■ Firm specific

View today



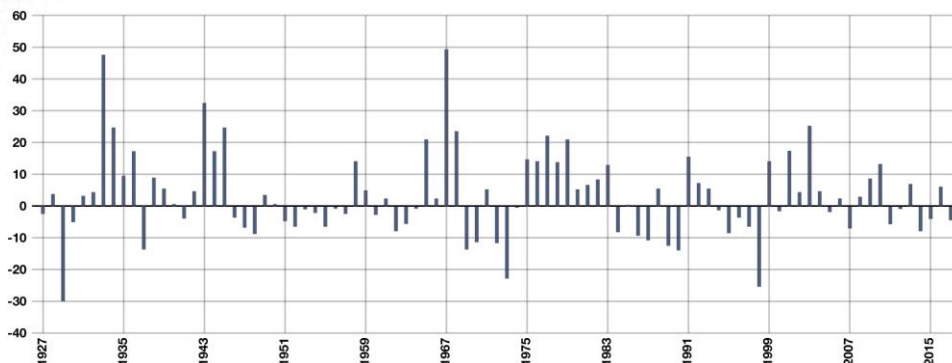
■ Market ■ Firm specific ■ Value ■ Momentum ■ Size ■ Quality ■ Volatility

The Size Effect

- Smaller firms have higher returns than larger firms, on average
 - Discovered by Banz (1981)
- Size is measured via market capitalization (price * shares outstanding)
 - Apple has a price of \$176 and about 4.6 billion shares outstanding
 - Apple's market cap is over \$800 billion
 - It's one of the largest companies in the world!
- The size effect is economically meaningful!
 - Small cap stocks have outperformed large stocks by about 3% per year since 1927

The Size Effect Since 1927

Annual Return to Small Cap Stocks Minus Return to Large Cap Stocks



From Ken French's Data library at https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

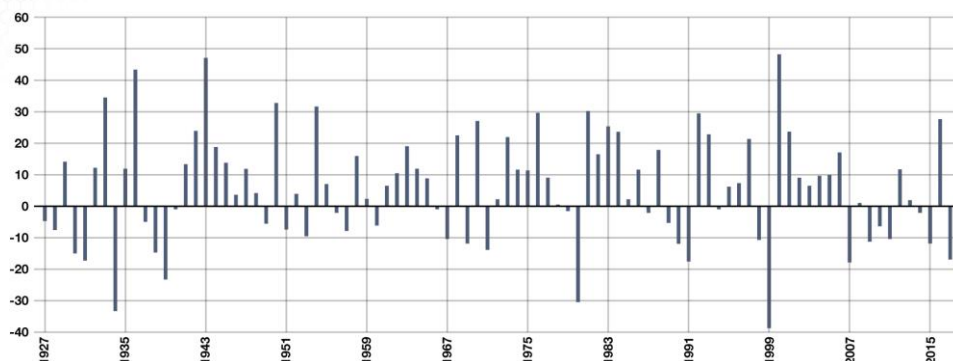
The Value Effect

- Inexpensive stocks tend to outperform expensive stocks
 - Fama and French (1993)
- A stock's expensiveness is calculated by looking at the book value relative to market value [the Book to Market ratio (B/M)]
 - A low B/M ratio implies the stock is expensive (Growth)
 - A high B/M ratio implies that the stock is inexpensive (value)
- The value effect is large! Value stocks have outperformed growth stocks by 4.67% per year, on average.



The Value Effect Since 1927

Annual Return to High B/M Stocks Minus Low B/M Stocks



From Ken French's Data library at https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

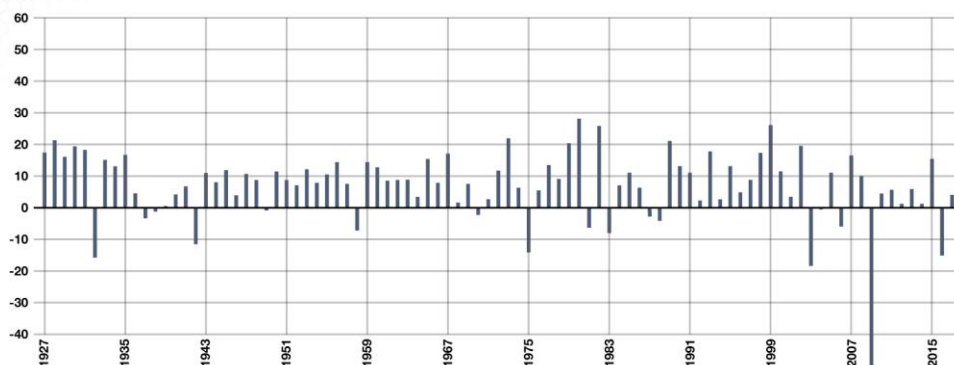


The Momentum Effect

- The momentum effect is the tendency of stocks that have performed well over the past year to continue to perform well
 - Past winners outperform past losers
 - Originally attributed to Jegadeesh and Titman (1992)
- The effect is large!
 - Past winners outperform past losers by about 9.23% per year

The Momentum Effect Since 1927

Annual Return to Wining Stocks Minus Return to Losing Stocks

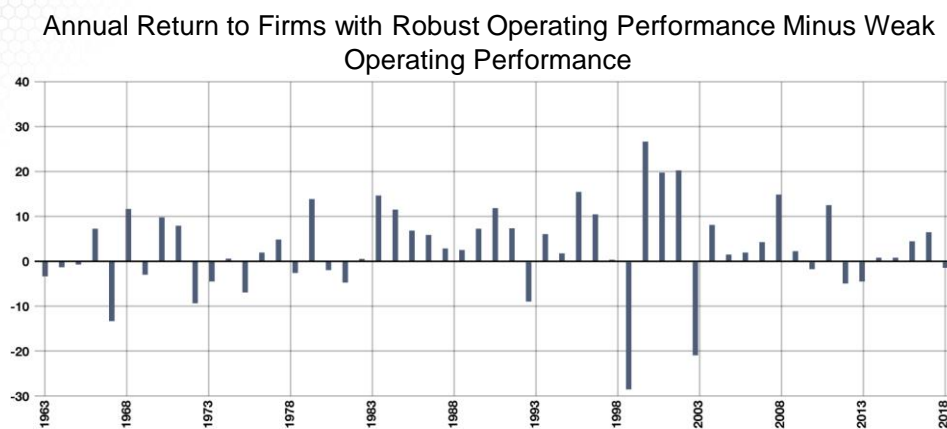


From Ken French's Data library at https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

The Profitability Effect

- Profitable stocks tend to outperform unprofitable stocks
 - Attributed to Fama and French (2015)
- Stocks with robust operating performance outperform those with weak performance by about 3.2% per year

The Profitability Effect Since 1964

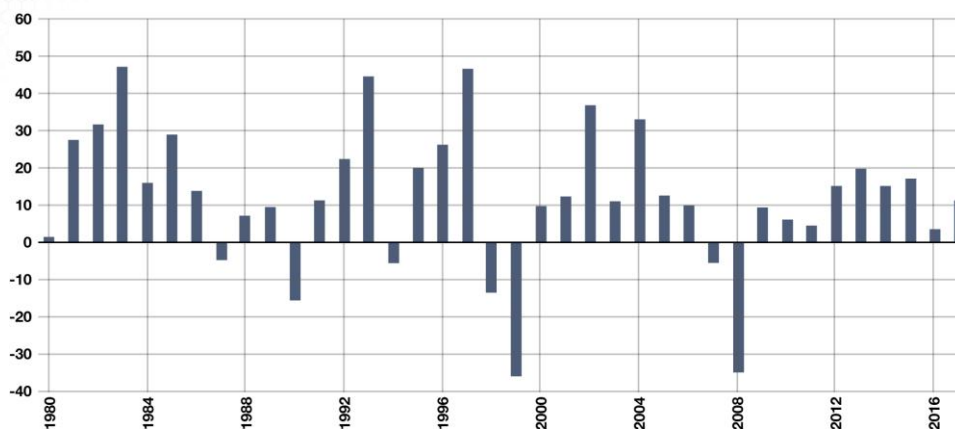


From Ken French's Data library at https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

Risk Effect

- Low beta assets outperform high beta assets
 - Betting against beta
 - Frazzini and Pedersen (2014)
 - Similar results hold when considering the standard deviation of past returns
- The effect is about 12.2% per year since 1980

Yearly Returns to the Betting-Against-Beta Strategy



These Effects are Important for Investors!

- We can construct better portfolios for investors
- We can tell what has driven a fund's historical performance
- The 'smart beta' revolution

Summary

1. Prior academic research has uncovered a number of fundamental factors that drive stock returns:
 - Size
 - Value
 - Momentum
 - Profitability
 - Volatility

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Interpreting Factor Regressions



Lesson Objectives

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

- Run factor regressions in R
- Interpret the output of factor regressions
- Describe applications of factor investing



Factors that Drive Stock Returns

From the previous lesson, there are a number of factors that drive stock returns:

1. **Beta:** The traditional market beta
2. **Size:** Small stocks tend to generate higher returns than large-cap stocks
3. **Value:** Inexpensive stocks outperform expensive stocks
4. **Momentum:** Stocks that have performed well in the previous year continue to perform well
5. **Quality:** High quality stocks (highly profitable) stocks tend to outperform
6. **Risk:** Stocks with low betas have traditionally generated higher returns



Summarizing the Factors

Factor	Notation	Cite	Magnitude since 1980 (per month)
Market Beta	$r^m - r^f$	Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk , William Sharpe (1964), Journal of Finance 19 (3), 425-442.	0.68%
Size	SMB	The Cross-Section of Expected Stock Returns , Eugene Fama and Kenneth French (1992), Journal of Finance 47(2), 427-465.	0.12%
Value	HML	The Cross-Section of Expected Stock Returns , Eugene Fama and Kenneth French (1992), Journal of Finance 47(2), 427-465.	0.27%
Momentum	MOM	Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency , Narasimhan Jegadeesh and Sheridan Titman (1993), Journal of Finance 48 (1), 65-91	0.59%
Risk	BAB	Betting Against Beta , Andrea Frazzini and Lasse Heje Pederson (2014), Journal of Financial Economics 111 (1), 1-25.	0.48%
Quality	QMJ	Quality Minus Junk , Cliff Asness, Andrea Frazzini, and Lasse Heje Pederson (2019), Review of Accounting Studies, 24 (1), 34-112.	0.90%



Factor Regressions

- We typically estimate factor models using linear regression:
 - The dependent variable is typically the fund's excess return above the risk free rate
 - The factors are typically the independent variables
- The typical specification is of the following form:

$$r_t^{\text{fund}} - r_t^f = \alpha + \beta_1(r_t^m - r_t^f) + \beta_2SMB_t + \beta_3HML_t + \beta_4MOM_t + \beta_5BAB_t + \beta_6QMJ_t + \varepsilon_t$$



Interpreting Factor Regressions

The coefficients on Mkt-rf; SMB; HML; MOM; BAB; and QMJ tell us about exposure to the different factors

- A positive coefficient on SMB indicates that the fund is tilted toward small cap stocks
- A positive coefficient on HML indicates that the fund is tilted toward value stocks
- A positive coefficient on MOM indicates that the fund is tilted toward high momentum stocks
- A positive coefficient on QMJ indicates that the fund is tilted toward profitable stocks
- A positive coefficient on BAB indicates that the fund is tilted toward safe stocks

The intercept tells us about the skill of the fund manager

- A positive (negative) and significant coefficient indicates that the fund manager has outperformed (underperformed)



Data Snapshot of Monthly Factor Data

Date	Fund_rf	Mkt_rf	SMB	HML	MOM	QMJ	BAB
1/31/1980	0.016	0.055	0.017	0.018	0.075	-0.027	0.026
2/29/1980	-0.026	-0.012	-0.018	0.007	0.079	-0.020	-0.015
3/31/1980	-0.102	-0.066	-0.066	-0.011	-0.096	0.047	-0.047
4/30/1980	0.005	0.009	0.009	0.011	-0.004	-0.034	0.021
5/31/1980	0.071	0.022	0.022	0.004	-0.011	0.007	0.037
6/30/1980	0.006	0.017	0.017	-0.009	0.016	-0.011	0.037
7/31/1980	0.098	0.043	0.043	-0.064	0.004	0.035	-0.009
8/31/1980	0.002	0.039	0.039	-0.026	0.032	-0.001	0.015
9/30/1980	0.029	0.009	0.009	-0.047	0.054	0.012	0.013
10/31/1980	0.010	0.024	0.024	-0.028	0.074	0.005	-0.002
11/30/1980	0.055	-0.034	-0.034	-0.084	0.153	0.010	-0.063
12/31/1980	0.006	-0.003	-0.003	0.027	-0.066	0.009	0.009

*This data is contained in the FactorExample.csv file on Canvas



What Drove the Performance of this Mutual Fund?



This mutual fund has clearly outperformed the overall stock market, but can we say something about why it outperformed?



Estimating the Regression in R

A few notes:

1. I like to use the stargazer library to display linear regressions
2. The below code runs series of factor models using 1, 3, 4, and then 6 factors. This allows for some useful comparisons

R code:

```
# load data
setwd("C:/Users/jc414/Dropbox (GaTech)/Computer/Desktop/OnlineInvesting")
library(stargazer)
data<-read.csv("FactorExample.csv")
#Run factor models
factor1<-lm(Contra.rf~Mkt_rf,data=data)
factor3<-lm(Contra.rf~Mkt_rf+SMB+HML,data=data)
factor4<-lm(Contra.rf~Mkt_rf+SMB+HML+Mom,data=data)
factor6<-lm(Contra.rf~Mkt_rf+SMB+HML+Mom+BAB+QMJ,data=data)
stargazer(factor1,factor3,factor4,factor6,align=TRUE,type="html",out='factorModelFull.html')
```



The Intercept Indicates the Fund's Skill

Dependent variable:				
	1	2	3	4
Mkt_rf	0.901*** (0.019)	0.885*** (0.020)	0.913*** (0.019)	0.914*** (0.022)
SMB		0.048* (0.029)	0.042 (0.027)	0.038 (0.030)
HML		-0.048 (0.030)	-0.004 (0.029)	-0.070** (0.032)
MOM			0.132*** (0.018)	0.096*** (0.019)
BAB				0.150*** (0.025)
QMJ				-0.011 (0.045)
Constant	0.002*** (0.001)	0.002*** (0.001)	0.001 (0.001)	0.0004 (0.001)
Observations	462	462	462	462
R2	0.833	0.835	0.852	0.863
Adjusted R2	0.832	0.834	0.851	0.861
Residual Std. Error	0.018 (df=460)	0.018 (df=458)	0.017 (df=457)	0.016 (df=455)
F Statistic	2,288.618*** (df=1;460)	773.355*** (df=3;458)	658.014*** (df=4;457)	478.797*** (df=6;455)

*p < 0.1; **p < 0.05; ***p < 0.01

The coefficients on the six factors tell us what is driving the fund's performance.

Four coefficients are significant:

- Mkt_rf: The fund has a market beta of 0.914.
- HML: The fund is tilted away from value stocks
- MOM: The fund is tilted toward high momentum stocks
- BAB: The fund is tilted toward safe stocks (those with low beta)



The Intercept Indicates the Fund's Skill

Dependent variable:				
	Contra.rf			
	1	2	3	4
Mkt_rf	0.901*** (0.019)	0.885*** (0.020)	0.913*** (0.019)	0.914*** (0.022)
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- The Constant term captures alpha: the measure of skill for the fund
- A positive alpha indicates the fund manager is outperforming the regression-based benchmark
- In the specification (1), the fund is outperforming by 0.2% per month
- After adjusting for all of the factors, the alpha is only 0.04% per month and not significant

Takeaways from the Factor Regression

- The factor regression framework allows us to uncover the driving forces behind this fund's outperformance
- In particular, this fund performed well because of its exposure to high momentum (MOM) and low risk stocks (BAB)

Factor Investing is Becoming Popular

- Blackrock, Fidelity, Invesco, and Vanguard are all active in the factor investing space
- Blackrock estimates [that by 2022 approximately \\$3.4 trillion will be invested in factor-based strategies](#)

A couple of words of caution:

1. As investors invest more money into these factors, the performance might dissipate
2. Each of these factors has experienced prolonged periods of underperformance

Example: The Underperformance of Value

- Between 2009 and 2018, the average annual premium on value stocks was - 2.33%. [That is, value stocks underperformed!](#) There has been talk that the value premium is dead
- Between 1927 and 2008, the average premium on value stocks was 5.52% per year. However, the annual standard deviation was 14.35%. It's consequently not that unusual that we would observe this level of underperformance

Main point: You may need to be patient with some of these factors

Summary

1. Factor regressions allow us to understand the drivers of a fund's return.
2. The intercept from the factor regression allow us to assess the fund's skill.



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Concluding Thoughts



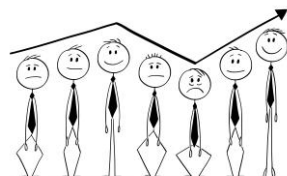
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Analytics Plays a Big Role in Finance and Investing

We deal with huge datasets capturing stock returns; firm performance; and even investor sentiment



Financial Statements and Financial Ratios			
	Actual	Budget	Last Year
Revenue	434,251	407,803	408,500
Expenses	411,822	396,535	398,500
Profit	22,429	11,268	10,000



Finance professionals spend a great deal of time teasing out relations between these different types of data

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We Covered 3 Core Concepts in our 3 Modules

1. Quantifying prices in financial markets
2. Identifying superior performance in financial markets
3. Describing the driving forces of returns in stock markets

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Topic 1: Quantifying Financial Prices

In module one, we quantified ways to think about stock and mutual fund prices:

- Simple and compound returns
- Standard deviation
- Beta
- R^2
- Drawdown



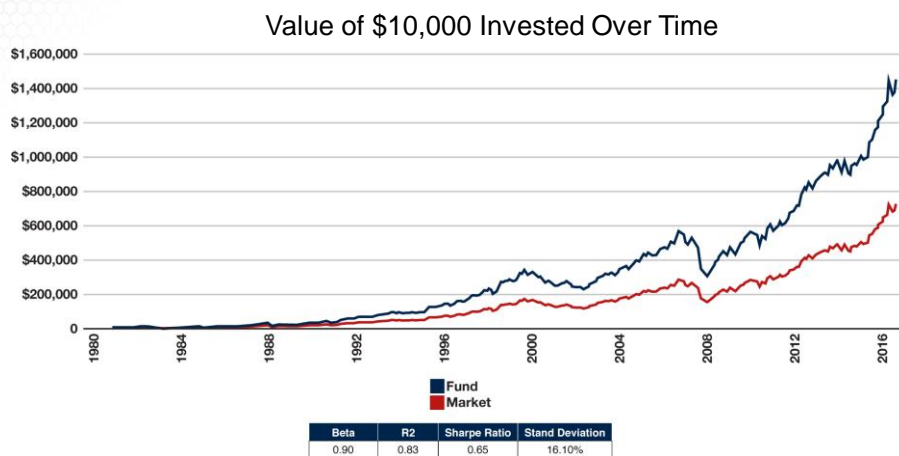
Topic 2: Measuring Superior Performance

In module 2, we looked at ways to identify superior performance:

- Comparison to an appropriate benchmark
- Sharpe Ratio
- Treynor Ratio
- Jensen's Alpha



You Will Likely See these Measures When Examining Your own Portfolio



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Topic 3: Identifying the Drivers of Returns

We looked at the factors that drive stock returns:

- Size
- Value
- Momentum
- Profitability
- Volatility

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You Will Likely be Investing in Funds that use these Trading Strategies

Some examples:

- iShares Edge MSCI USA Quality ETF (QUAL)
- AQR Large Cap Momentum Style Fund (AMOMX)
- Vanguard Small-Cap Index Fund (NAESX)
- Fidelity Large Cap Value Enhanced Index Fund (FLVEX)

I hope you have a good sense of the strategies behind these funds



We've Just Covered the Basics

Recommend texts for future reading:

[Efficiently Inefficient: How Smart Money Invests and Market Prices are Determined](#) by Lasse Pederson

[Asset Management: A Systematic Approach to Factor Investing](#) by Andrew Ang

Both books are written by industry leaders!



Summary

1. Analytical methods play a big role in investing.
2. Analytics allow us:
 - To measure the risk, return, and performance of different asset classes.
 - Understand the drivers of asset class performance.

