Out in Tech Mentorship Program Project
Prediction of FAANG Stock Prices using VAR Modeling in R
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Objectives:

1. Explore options for continuing education by getting familiar with the MFE Berkeley curriculum. As an alternative, explore options of working in the tech field of the Finance industry by networking with the mentor.
2. Learn Macroeconomics related applications of R.
3. Get familiar with topics from Corporate Finance.

Major Learnings: Data Science Approach, R Development & Corporate Finance Fundamentals.

Overview: I am going to be looking at the set of FAANG companies (Facebook, Amazon, Apple, Netflix, and Alphabet) and valuing them using technical analysis in R with validation from the Corporate Finance related topics. By researching a specific segment of the market (technical companies) that significantly influences it I will be developing an evaluation model to predict which company has better returns and therefore is the best candidate to invest in over 5 years.

Problem: As a small investor, I'd like to find a company to invest in by evaluating a set of five the most popular and best-performing technology companies and valuing them over 5 years.

Hypothesis: Companies with high Gross Margin, sticky customers and continual investments will yield highest returns over the next 5 years.

The following financial metrics were chosen to be predictors of the Stock Price:

1. *Net Income*
2. *Revenue*
3. *Gross Profit*
4. *SG&A Expense*
5. *Free Cash Flow*
6. *MAU (Monthly Active Users)*

Scoping Data Requirements, Exploring Data Sources & Extraction: Period was chosen to be five years on an annual basis. Data was collected from the Yahoo Financials and ycharts.com and Excel file was created to be modified to a .csv file later. To simplify our model, I decided to combine some of the metrics into key ratios. For example,

Net Income Margin = Net Income / Revenue
Gross Profit Margin = Gross Profit / Revenue

Explorations and Data Transformation: As I mentioned above because I decided to combine some of my metrics into key ratios, I had to calculate values for those using Excel. Also, MAU (monthly active users) metric had to be eliminated due to the uncertainty and inconsistency of the data. For example, monthly users of Facebook will be incomparable to monthly users of Apple due to the different meanings of an active user. Therefore, in the end, I had to work with 4 predictors of the Stock Price (Net Income Margin, Gross Profit Margin, SG&A Expense, and Free Cash Flow).

Model Creation: My data consisted of the Time Series for five different financial metrics for five consecutive years including the Stock Price. I decided to use the Auto-Regressive (AR) model for stationary time series which is the part of the ARIMA (Auto-Regressive Integrated Moving Average) model which is used for non-stationary cases. Since I wanted to have a multivariate response (time series that included not only a Stock Price but also other metrics above) I had to use the Vector Autoregressive model (VAR).

Essentially, I created a vector of response variables including Net Income Margin, Gross Profit Margin, SG&A Expense, Free Cash Flow, and Stock Price. Therefore, in the prediction of Stock Price, I included the Stock Price metrics itself as well i.e. in my model to predict the future Stock Price I needed to know the previous stock price values.

Significant predictors of the future year's Stock Price are the previous year's Net Income Margin, the previous year's Gross Profit Margin, and the previous year's Stock Price Values.

Fitted Model: Stock Price = -5832.8187*Net Income Margin +3505.9496*Gross Profit Margin -44.8321*SG&A Expense +20.2994*Free Cash Flow +0.9882*Stock Price -579.5719

Model Validation: FAANG Stock Prices at the end of Q1 look as following:

Company	Stock Price, $
Facebook	204.71
Amazon	1,949.72
Apple	254.29
Netflix	375.50
Alphabet (Google)	1,162.81

In order to validate our model, I used the fitted model to predict FAANG Stock Prices and compare them with the values above retrieved from the Yahoo Financials.

Facebook Stock Price: -5832.8187*0.26 +3505.9496*0.819 -44.8321*20.34 +20.2994*21.21 +0.9882*201.91 -579.5719 = 493.46

Amazon Stock Price: -5832.8187*0.04 +3505.9496*0.266 -44.8321*24.08 +20.2994*21.65 +0.9882*2008.72 -579.5719= 1464.64

Apple Stock Price: -5832.8187*0.215 +3505.9496*0.38 -44.8321*18.25 +20.2994*63.97 +0.9882*309.51 -579.5719 = 284.85

Netflix Stock Price: -5832.8187*0.09 +3505.9496*0.383 -44.8321*3.57 +20.2994*(-3.14) +0.9882*345.09 -579.5719 = 355.48

Alphabet Stock Price: -5832.8187*0.212 +3505.9496*0.56 -44.8321*28.02 +20.2994*30.97 +0.9882*1434.23 -579.5719 = 936.98

One-year prediction: According to my model, by the end of 2020 Facebook's Stock Price will double its value, while Amazon Stock Price will lose about 25% of its 2019 value. Apple Stock Price will soar about 10% compared to the end of 2019 while Netflix Stock Price will increase its value but by only 3%. Google's Stock Price will decrease in value by about 35%.

Recommendation: Given the one-year prediction, I can recommend Facebook as the most favorable stock to invest in. In a one-year time frame, it will double its stock price value while Amazon, Google, and Apple will all lose its 2019 stock price values. Netflix's stock price will rise as well by the end of 2020 but by only a few percent.

Executive Summary: From the intermediate values given above for the first quarter of 2020, I can see that my model correlates with the current trends of FAANG Stock Prices. It also corresponds with the financial analysts' predictions during the market crisis caused by the COVID-19. Even though Amazon has earned a great sales revenue during the first quarter of 2020 it also had to hire more employees to deliver all orders in time complying with the Prime membership policies, therefore its SG&A Expense had risen significantly which caused the decline in Stock Price. Apple and Alphabet have been also affected negatively by the COVID-19. Apple had to shut down most of its stores for a while and Alphabet largely relying on the revenue from advertisements has lost a lot of its customers due to the crisis. Even though Facebook is also dependent on the revenue from the advertisements it has the 2020 Presidential Elections streaming to look forward to attracting more monthly active users hence more revenue. Netflix's revenue has risen due to sheltering in place recommendations during the Covid-19 but its negative free cash flow due to the recent large investments in the content creation has prevented its Stock Price from rising as significantly as Facebook did. Of course, the winner might change in the long run given that the COVID-19 won't be here forever.

Further Research: To improve the accuracy of the model it might be helpful to increase the period of collected data going from 5 to 10 years which will give a better outlook on the companies' dynamic histories. All of the FAANG Stock companies have grown a lot in recent years and it might be useful to look further back in their history to better understand them. Taking quarterly values instead of yearly ones will also help to increase the accuracy of the time series prediction. Incorporating more financial metrics like Monthly Active Users, and investments in the company can also help to better understand what drives FAANG stock prices.

Lessons Learned: Agile development, Time Series predictions for stationary and non-stationary cases, Financial metrics & Financial Fundamentals.

Appendix (R code and output)

```
install.packages("vars")
install.packages("astsa")
library(vars)
library(astsa)
outintech<- read.csv(file="~/Desktop/FAANG3.csv")
str(outintech)
x = cbind( outintech$NetIncMargin, outintech$GrossProfMargin, outintech$SGA,
        outintech$FreeCashFlow, outintech$StockPrice)
plot.ts(x , main = "", xlab = "")
fitvar1=VAR(x, p=1, type='const')
summary(fitvar1)
```

Estimation results for equation y5:
==================================
y5 = y1.l1 + y2.l1 + y3.l1 + y4.l1 + y5.l1 + const

	Estimate	Std. Error	t value	Pr(>|t|)	
y1.l1	-5832.8187	2205.7782	-2.644	0.01648	*
y2.l1	3505.9496	1179.3576	2.973	0.00815	**
y3.l1	-44.8321	33.1391	-1.353	0.19285	
y4.l1	20.2994	10.8718	1.867	0.07825	.
y5.l1	0.9882	0.3828	2.582	0.01880	*
const	-579.5719	384.3453	-1.508	0.14892	

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

Residual standard error: 425.9 on 18 degrees of freedom
Multiple R-Squared: 0.5828,   Adjusted R-squared: 0.4669
F-statistic: 5.029 on 5 and 18 DF, p-value: 0.004669

Where y1 - Net Income Margin
        y2 - Gross Profit Margin
        y3 - SG&A Expense

y4 - Free Cash Flow
y5 - Stock Price

Covariance matrix of residuals:

	y1	y2	y3	y4	y5
y1	0.006862	0.006803	0.2197	0.9430	-6.31
y2	0.006803	0.012383	0.1139	0.4287	-12.81
y3	0.219712	0.113859	49.7313	99.2580	2172.93
y4	0.942966	0.428680	99.2580	378.1095	1150.16
y5	-6.309675	-12.813922	2172.9287	1150.1577	181379.41

Correlation matrix of residuals:

	y1	y2	y3	y4	y5
y1	1.0000	0.7380	0.3761	0.5854	-0.1788
y2	0.7380	1.0000	0.1451	0.1981	-0.2704
y3	0.3761	0.1451	1.0000	0.7238	0.7235
y4	0.5854	0.1981	0.7238	1.0000	0.1389
y5	-0.1788	-0.2704	0.7235	0.1389	1.0000