DATA VISUALIZATION CA-2

National College of Ireland

Forecasting Stock Prices in Sports Apparel Industry and studying Under Armour's declining trend

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Story – Specification

There are lot of sports apparel brands in the market now a days, each of them having its unique range of product that sets them apart. We'll look at the behavior of some of the top brands like Nike, Under Armor, Puma, Skechers and Columbia. Our story in the infographic is to have a look at the stock prices of the last 20 years in accordance to which brand came when and the inspect their highs & the downfalls.

The Primary aim is to see the decline in the sales of Under Armor when comparing to last decade. Under Armor's sales shrank 4.5% and the profit was down 68%. We'll try to find out which brands impacted it the most & by far what products let it down.

Fig 1: Declining Trend in Under Armour Stocks

A brand which rose fastest in the sports apparel market last decade is now taking a plunge. Under Armour, a reputed sports apparel brand is taking the heat. But, what is the reason behind the gradual downfall of the brand?

Under Armour has a wide variety of products in its pool, such as bags, footwear, clothing, accessories, apparel being the biggest segment of all. The growth of UA started from the year 2005 wherein it swelled its money chest from $87 million to $1.4 billion in just a few years, but, now the sales have shrunk, and it has completely lost its place in the market. Below is the growth trend of UA in recent years (Fig 1)
We are interested to find out the downtrend & uptrend of Under Armor. We will analyze each company's stocks separately, to know what the impact is of one stock on another. Our analysis will bring the insights about the market, this will not only tell a story to us about UA but also for other brands like Nike, Puma, Columbia, Skechers.

Data Source and Preparation (Background)

Data Source

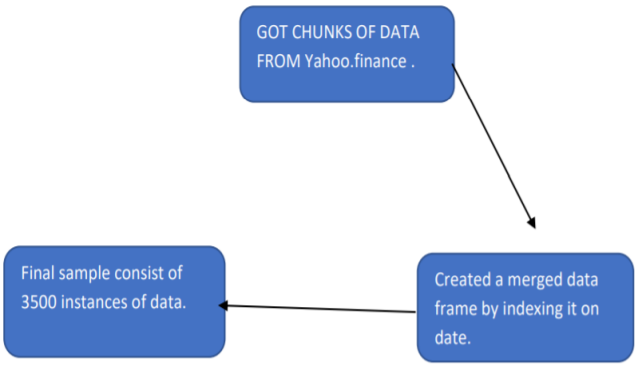
The data is collected from the Yahoo finance. The data set includes 7 attributes for each company. We gathered data for 5 companies which includes Nike, Skechers, Puma, Columbia and Under Armor. The data contains different companies and their respective opening stock price, highest price of stock, lowest price of stock, closing price of stock, adjusted closing price of stock and volume according to their respective dates. Open is the price on the open day of the stock market. High is the highest price the stock reached that day and low is the lowest price the stock reached that day. Close is the price of the

last trade when the market closed that day. The adjusted close price shows the stock's value after posting a dividend. Volume refer to the number of share's traded that day. However, these variables are different for each company.

****The stock prices are from only NYSE & NASDAQ. The Analysis is done solely for the US Market*

Data Preparation

There wasn't any issue for data cleaning as we had the data for each company from the time when they had gone public. There was no such variable that needs to be removed, each has it is own significance. To simplify our analysis, we merged the data of all the companies by taking 'date' as a reference. Below is the tabulation of what has been done to the dataset.



Hypothesis Testing (Process)

To study the interdependence of these characteristic features we are in the process of implementing OLS, ARIMA and VARMA models to study the impact of different Stocks on Under Armor. Following are the null / alternate hypothesis.

H0OLS: There is no effect of sports brands in determining the stock prices of Under Armor.

HAOLS: There is some effect on UA

H0ARMA: There is no effect of lagged variable in determining stock prices of any stock

HAARMA: There is an effect of lagged variable of a stock parameter on its stock price.

Descriptive Analytics

Now on forward, we will inspect the rise and fall of companies simultaneously based on adjusted close stock price in accordance with date. From the information given in the fig.1, we infer that while Nike, Puma and Columbia have got an uplift in their adjusted closing prices over the last decade. And more importantly adjusted closing prices of Under Armor and sketchers have dropped to their all time.

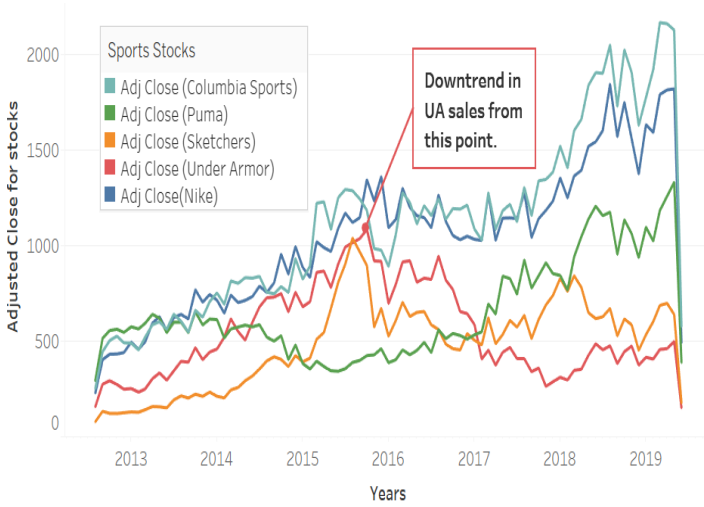


Fig 2: Comparison of Stock Prices (*aggregated by month)

It is hard to understand and learn patterns for each company's from fig.1.

So, we decide to explore each company separately. Graphs and inference are present below:

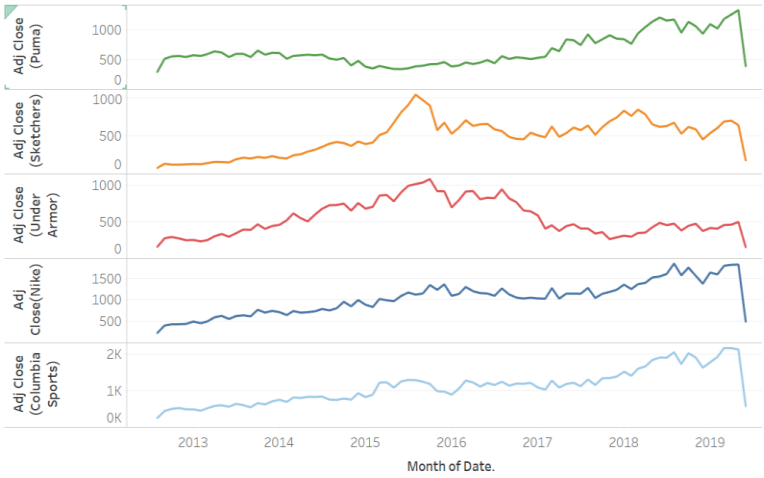


Fig 3: Comparison of Stock Prices (*aggregated by month)

We can observe that Puma, Nike and Columbia Sports have had a consistent increase in the stock Prices over the years whereas Sketchers experienced a fall towards the year 2016 but recovered well and continued to stay strong in the face of competition. However, looking at Fig 2 we notice that the major reason for this decline is most strongly attributed to market share gained by Sketchers and Puma instead of the growing trend in Nike.

Most people would argue that this fact is due to Nike/Puma/Columbia Sports, however, we notice that a market share shift is more predominant by studying Fig 2 and Fig 3 in conjunction.

Models

OLS Model

At first, we check the OLS model to check the impact that each stock has on UA.

```
> M1 = lm(data=DF,UA_Adj.Close ~ Nike_Adj.Close+SK_Adj
.Close+Puma_Adj.Close+COL_Adj.Close)
> summary(M1)

Call:
lm(formula = UA_Adj.Close ~ Nike_Adj.Close + SK_Adj.Cl
ose + Puma_Adj.Close +
    COL_Adj.Close, data = DF)

Residuals:
     Min       1Q   Median       3Q      Max
-13.6604  -3.7446   0.2086   2.6071  21.0858

Coefficients:
                Estimate Std. Error t value Pr(>|t|)
(Intercept)       3.1800     0.4400   7.228 1.58e-12 **
*
Nike_Adj.Close    0.9985     0.0402  24.841  < 2e-16 **
*
SK_Adj.Close      0.1652     0.0480   3.441 0.000622 **
*
Puma_Adj.Close    -0.2749     0.0221 -12.440  < 2e-16
***
COL_Adj.Close    -0.2742     0.0520  -5.273 1.91e-07 **
*
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0
.1 ‘ ’ 1

Residual standard error: 5.463 on 571 degrees of freed
om
Multiple R-squared:  0.822,    Adjusted R-squared:  0.
8208
F-statistic: 659.3 on 4 and 571 DF,  p-value: < 2.2e-1
6
```

The model depicts that the Nike and Sketchers share price has a positive impact on the shares of Under Armour whereas the share prices of Puma and Columbia has negative impact on the share price of Under Armour.

Checking for OLS Assumptions

As the data much relates to be dependent on the historic values of the stock prices we are keen to check on the auto correlation of the values of the Under Armour Stock Price and here are some of the results for the check for auto correlation:

```
> acf(DF$UA_Adj.Close, plot=FALSE)$acf[2
]
[1] 0.9948214
```

From the above test of ACF we can conclude that that the values of the Under Armour stock prices are highly correlated.

Correlation Vs Causation

It is very evident from the model tests that the beta coefficients are a result of an auto Correlation and we cannot arrive at the conclusion that neither the decrease in the prices

of the stocks of Puma and Columbia will cause an increase in the price of UA stocks nor the increase 10 | P a g e in the stock prices of Nike and Sketchers are causing an increase in the stock price of UA.

Time Series Analysis

The most important assumption in implementing the time series is that the series must be stationary. So, to make a timeseries stationary we need to differentiate the timeseries. The above graph suggests that after applying differentiation the zero conditional mean condition is satisfied. In other words, we can conclude that the time series is made stationary by applying differentiation on the log transformed variable of the Adj.close

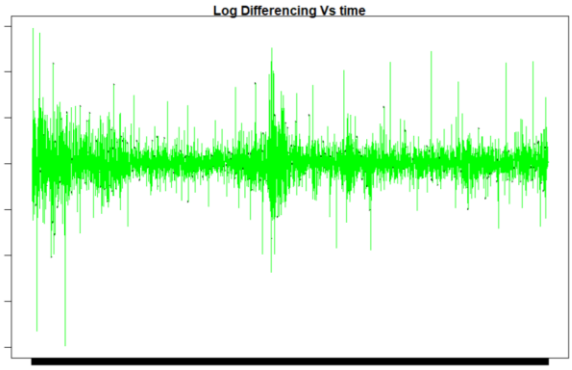


Fig : Log Differencing with Time(Satisfying Stationarity)

ARIMA

Arima stands for Auto Regressive Integrated Moving Average. The Model works by employing a lag variables P,D and Q which are :

P: Auto-Regressive Parameter

D: Differencing Parameter

Q: Moving Average Parameter

We have studied ACF and PACF plots and generated below:

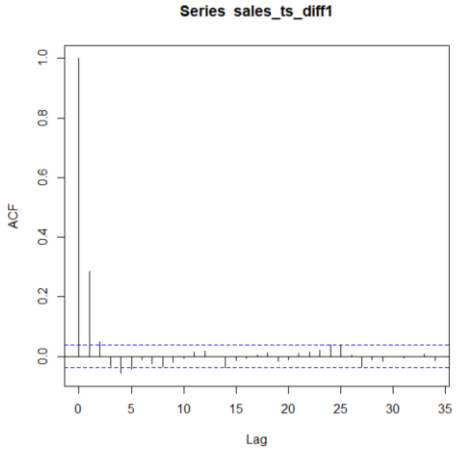


Fig: ACF Plot

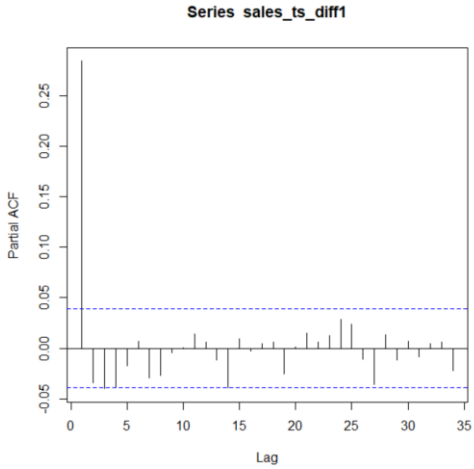


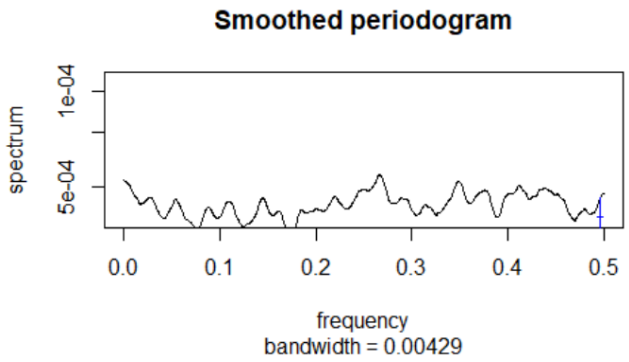
Fig : PACF Plot

The acceptable values of ACF and PACF should be between the blue lines and should change its sign.

Keeping this in mind we have an Auto Regressive part of 3 after which it changes sign and Moving Average part of 1 after which it changes sign and falls in the permissible range. (P = 3, Q =1)

Seasonality

We study the Periodogram using the Spectrum command in R which upon adjusting frequency bandwidth gives the below figure.



From the smoothed periodogram, we can see that there is no significant dominant frequency, which means there is no significant cycles . Although there are some small peaks in the spectrum, but when we move the crossbar to each peak along the estimated spectrum, it gives pointwise 95% confidence intervals, and we can see that all the peaks are insignificant. This is not contrary to our common sense that the stock price and return is a kind like random walk, one can hardly find cycles in such a few years.

Model

We have determined the p,d and q values which need to be passed to our ARIMA model for studying the summary.

```
> sales_model<-arima(sales_ts,order=
c(3,1,1))
> sales_model

Call:
arima(x = sales_ts, order = c(3, 1, 1))

Coefficients:
          ar1      ar2      ar3      ma1
      0.7792  -0.0496  -0.0296  -0.7344
s.e.  0.1308   0.0231   0.0204   0.1301

sigma^2 estimated as 0.4403:
log likelihood = -3306.96,  aic = 6623.91
```

From the above model we can infer that the auto regressive coefficients of 0.7792(ar1), -0.496(ar2) and -0.0296 (ar3) with a standard errors of 0.130 8,0.0231 and 0.0204 and Moving Average coefficient of -0.7344. Upon testing various models, we observe that this model has the lowest AIC value of 6623.91. However, such a high Value suggests that there are multiple factors apart from the lagged value of variable which are responsible for this.

Justification

The infographic created has to be bound by a certa in standard, which would explain why a certain te chnique, layout, style or color is
Used and the intent it serves.

TECHNIQUES:

The purpose an infographic serves is to spell out a visual story. Visualizations play a very vital role in this story depiction. The story here is the study of Under Armour's declining trend and the reasons for it, we have placed a visualization on the right of the infographic which explains the stock behavior of Under Armour from 2013 to 2019. The downtrend in sales has been pin-marked and pointed out clearly. Next to this, we have a visualization for market shares of 2011 and 2019. It is pointed out that the negative Impacting companies are puma and Columbia Sports. We can see that sketchers increased their Market share from 2011 to 2019 while every other company is almost constant.

The extreme left of the infographic shows us the Stock trends. It is seen that Nike, Columbia and Puma have a positive growth while Sketchers and Under Armour has a downfall. Although initially Sketchers did have a downfall, it is seen in the Stock behavior visualization they later managed To pick themselves up compared to Under Armour which continued to lose its stocks.

LAYOUT:

The layout has been created with the help of an Online tool called Venngage. The tool seemed to have a lot of options to edit the infographic and consists of a variety of graphs and charts which could be used while creating an infographic. The stock behaviour visualization and market share visualization was taken from tableau to laptop in .png format and later loaded into the infographic. Venngage has a lot of layout settings to set up These images according to our need in the

Infographic. The different types of headers available to term the visualizations helped a lot. The layout was edited to fit the A3 to meet the size requirements.

STYLE:

Paytone one is the font selected for the title. Since my topic is related to stocks, I needed A font style that is not fancy and yet something w hich show out the title to capture the attention of the viewer. The font size of Under Armour is bigger to suggest that we will be Focusing on this particular company. Bangers Is the font used to explain the story statement which is placed next to the title and also for the analysis of stock behavior. This has been done because the bold italic feature seems to attract the viewer to read it right after seeing the title and then read the stock behavior analysis immediately after seeing the visualization.

Icons have been used to make the infographic more attractive, in stock trends at the extreme left of the infographic, icons explain whether the company's stocks are increasing with time or decreasing. The net sales of Under Armour has been shown in the infographic and the different sections like apparel, footwear, fitness has been depicted by respective icons found in the tool.

COLOUR:

Colour plays a very important role in making Infographic more attractive. I have split the Infographic in three tones of colour – Maroon, Orange and dark grey. This combination separates the title from the visualization part in a very soft manner. The red color used in the icons of stock trend depict the downfall of the stocks.

Sub headers are shown in black to contrast to the orange background and also to make the infographic visually appealing.

Technologies Used

Below is the list of all technologies inculcated Into the infographic which could make it Complete.

VENNGAGE:

A web-based application called Venngage was used to create the infographic. It is a simple to use online tool which consists of a lot of features that was helpful in the making of the infographic. Info graphic been a visual depiction of the story that is to be told, Venngage provides a lot of charts and maps and coloring options which seemed to be very useful for creating my infographic. It has a huge collection of templates to choose from and this is helpful and the apt template can be chosen or even created according to the situation. In my infographic, a lot of information had to shown in a precise format so I chose the format which can accommodate text easily.

TABLEAU:

Tableau has been used for all visualization purposes. I found it to be the best tool for comparing stock prices collectively and also individually. I used tableau because it can be directly aligned with the database and the drag and drop feature makes it very easy and user-friendly to visualize data. The visualization needs no or very less explanation as the image is self-explanatory.

R:

R is used for developing the models. It felt easier in R to test the hypothesis and help in validation of the statistical methods. I deployed OLS model for checking on the impact of other company stocks on Under Armor. Arima model is employed later for analyzing the summary and also, to make sure of any presence of other factors additional to lagged value of variable responsible for the lowest "aic" value.

Reflection

The most challenging part while creating the infographic was to ascertain what to present and what to omit. Since, the project statement undertaken is study the effect of Stock Prices, it is important to compile a report which is indicative of the reasons that relate directly to the problem statement. A lot of unforeseen analytics that con veys, for example, Stock Price prediction just shows the graph of the same without giving the entire code behind it.Development of these models in R and visualization in Tableau required integration of both these technologies and required significant learning and exploration. This integration is of immense importance as we apply analytics on real world problems which always require integration of various technologies.

This project overall gives sense of end to product delivery which is an essential component going in the market as a seasoned analyst.

We infer that the stock prediction is not only dependent on studying the Time Series of the Lagged variables but on the overall influence of multiple stocks. The OLS scheme suggests that what factors could have contributed to the downfall in the Market Share of Under Armor.

OLS model suggests that the Under Armour prices are correlated with the Puma and Columbia sports and from the inspection of market we can infer that the marketing strategies adopted by these two companies should be considered by the marketing team of Under Armour while coming up with new products and pricing.

References

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Chatterjee, . (2019). *Time Series Analysis Using ARIMA Model In R*. [online] DataScience+. Available at: https://datascienceplus.com/time-series-analysis-using-arima-model-in-r/ [Accessed 21 Jul. 2019].

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Dataset Links

https://finance.yahoo.com/quote/NKE/history?p=NKE

https://finance.yahoo.com/quote/PUM.DE/history?p=PUM.DE

https://finance.yahoo.com/quote/UA/history?p=UA

https://finance.yahoo.com/quote/COLM/history?p=COLM

https://finance.yahoo.com/quote/SKX/history?p=SKX