ALY6050: Introduction to Enterprise Analysis

Module 3: Forecasting a Time Series

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Introduction

This following report includes a thorough analysis on the Historical Data of two stocks wiz. Netflix, Inc. (NFLX) and Amazon.com, Inc. (AMZN) over a period of 252 financial market days. The data from the financial days of 01/02/2020 to 01/14/2021. The stock prices are predicted by using Short-Term Forecasting, Long-Term Forecasting, Regression and Baseline Model for the period of 10 financial days from 12/31/20 to 01/14/2021. These predicted values are then compared with the actual values to check the accuracy of the model. Overall, the Mean Absolute Percentage Error (MAPE) is calculated for every Forecasting method to get the efficient value in terms of prediction.

Analysis

Part 1: Short-Term Forecasting

1. Line Plot

In Figure 1, the Line Plot is visualized for both the Amazon and Netflix Stock Price with respect to the 252 Market Days. The trend seems to be in the gradually increasing position for Amazon as well as Netflix. The stock price of Amazon was nearly $95, which reached its yearly-high of $176 after around 169 days. The stock price of Amazon was $164 after the 252nd financial day. The trend line of Amazon stock represents the slope of 0.342, which is a positive slope and lies in the first quadrant. The stock price of Netflix was nearly $330, which reached its yearly-high of $556 after around 169 days. The stock price of Netflix was $525 after the 252nd financial day. The trend line of Netflix stock represents the slope of 0.8, which is a positive slope and lies in the first quadrant.

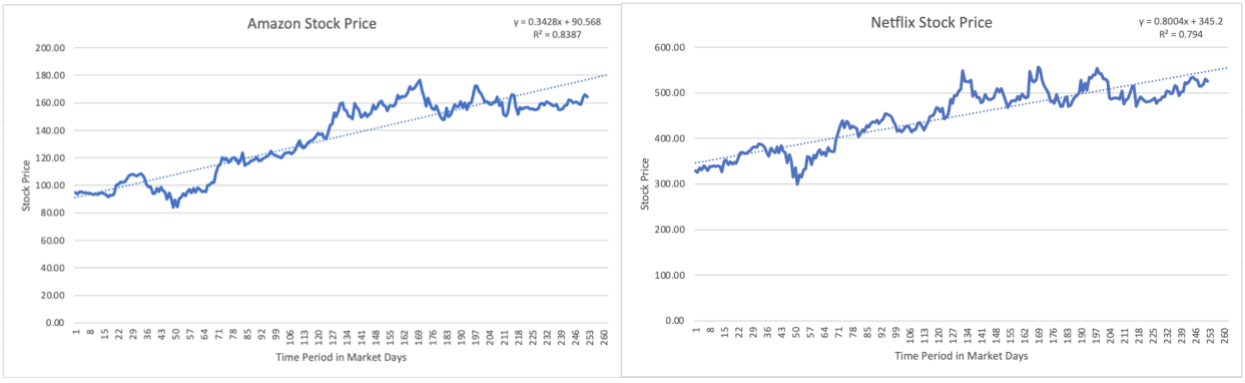

Fig. 1: Line Plot

2. Exponential Smoothing

As a part of Short-Term Forecasting, Exponential Smoothing is performed in the data to predict the 253rd Market Day with the corresponding Exponential Smoothing value (α), which is chosen to be (0.2, 0.4, 0.6 and 0.8). After obtaining the Exponential Smoothing value, the MAPEs are calculated for both the stocks of Amazon and Netflix. As the MAPE is a form of error, lower the

MAPE value, better the result is to be expected. In figure 2, the MAPE value at $\alpha = 0.8$ is the lowest for both Amazon and Netflix. For $\alpha = 0.8$, the MAPE value is 1.79 for Amazon and 2.02 for Netflix. Thus, for the 253rd Market Day, the $\alpha = 0.8$ values are considered to be more efficient at the Amazon Stock Price at 164.53 while that of Netflix would be 525.34 respectively.

Period 253		Period 253	
α = 0.20	162.05	α = 0.20	522.31
α = 0.40	163.65	α = 0.40	524.14
α = 0.60	164.38	α = 0.60	525.05
α = 0.80	164.53	α = 0.80	525.34
Average MAPE		**Average MAPE**	
α = 0.20	2.79	α = 0.20	2.99
α = 0.40	2.12	α = 0.40	2.31
α = 0.60	1.89	α = 0.60	2.07
α = 0.80	1.79	α = 0.80	2.02

Fig. 2: Exponential Smoothing

3. Adjusted Exponential Smoothing

Like the Exponential Smoothing, Adjusted Exponential Smoothing is also performed to predict the stock price at 253rd financial day. Adjusted Exponential Smoothing is denoted by β and also states if the β values is lower, better will be the accuracy of Adjusted Exponential Smoothing. In figure 2, the MAPE value at $\beta = 0.6$ is the lowest for Amazon and $\beta = 0.4$ for Netflix. For $\beta = 0.6$ in Amazon, the MAPE value is 1.80 and for $\beta = 0.4$ in Netflix, the MAPE value is 2.096. Thus, for the 253rd Market Day, the $\beta = 0.6$ values are more efficient at the Amazon Stock Price at 165.13, while $\beta = 0.4$ values are considered to be more efficient that of Netflix Stock Price at 524.91.

Period 253		Period 253	
β = 0.20	162.52	β = 0.20	523.27
β = 0.40	164.51	β = 0.40	524.91
β = 0.60	165.13	β = 0.60	526.36
β = 0.80	164.27	β = 0.80	524.64
Average MAPE		**Average MAPE**	
β = 0.20	2.57	β = 0.20	2.79
β = 0.40	1.91	β = 0.40	2.10
β = 0.60	1.80	β = 0.60	2.10
β = 0.80	2.02	β = 0.80	2.53

Fig. 3: Adjusted Exponential Smoothing

Part 2: Long-Term Forecasting

At the period 1 to 100, the 5-period weighted moving average is used to predict the values till 100th Financial Day. At 101st period, the {=TREND} function is utilized to predict the values till the 262nd Financial Day. The scatterplot in figure 4 represents the Actual vs. Predicted Values, where the Predicted Values in Yellow are found out in the linear pattern.

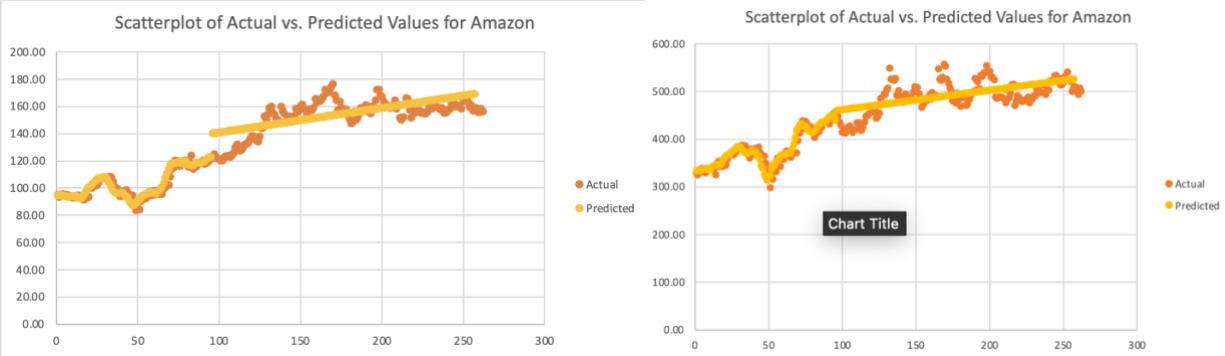

Fig. 4: Scatterplot of Actual vs. Predicted Values for Amazon and Netflix

Figure 5 represents the Actual Values as well as the Predicted Values at the period of 253 to 262. The MAPEs of the period 253 to 262 is also calculated in figure 5.

	Amazon					Netflix			
Date	Period	Actual Values	Predicted Values	MAPE	Date	Period	Actual Values	Predicted Values	MAPE
12/31/20	253	162.85	167.59	2.91	12/31/20	253	540.73	522.51	3.37
1/4/21	254	159.33	167.78	5.30	1/4/21	254	522.86	522.92	0.01
1/5/21	255	160.93	167.96	4.37	1/5/21	255	520.80	523.33	0.49
1/6/21	256	156.92	168.14	7.15	1/6/21	256	500.49	523.74	4.64
1/7/21	257	158.11	168.32	6.46	1/7/21	257	508.89	524.15	3.00
1/8/21	258	159.13	168.50	5.89	1/8/21	258	510.40	524.56	2.77
1/11/21	259	155.71	168.68	8.33	1/11/21	259	499.10	524.96	5.18
1/12/21	260	156.04	168.86	8.21	1/12/21	260	494.25	525.37	6.30
1/13/21	261	158.29	169.04	6.79	1/13/21	261	507.79	525.78	3.54
1/14/21	262	156.37	169.22	8.22	1/14/21	262	500.86	526.19	5.06

Fig. 5: Predicted Values

Part 3: Regression

1. Simple Regression

The Figure 6 represents the Stock Price of Amazon and Netflix with Trendline showing a positive slope of 0.325 for Amazon and 0.766 for Netflix.

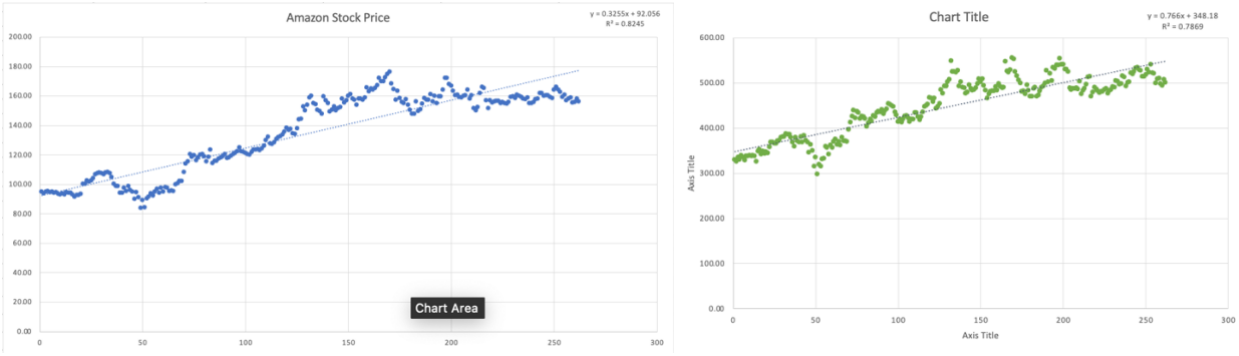

Fig. 6: Stock Price and Trendline

The Figure 7 represents the Actual vs. Predicted Values of Amazon and Netflix. The Predicted Values are observed to be in linear increasing.

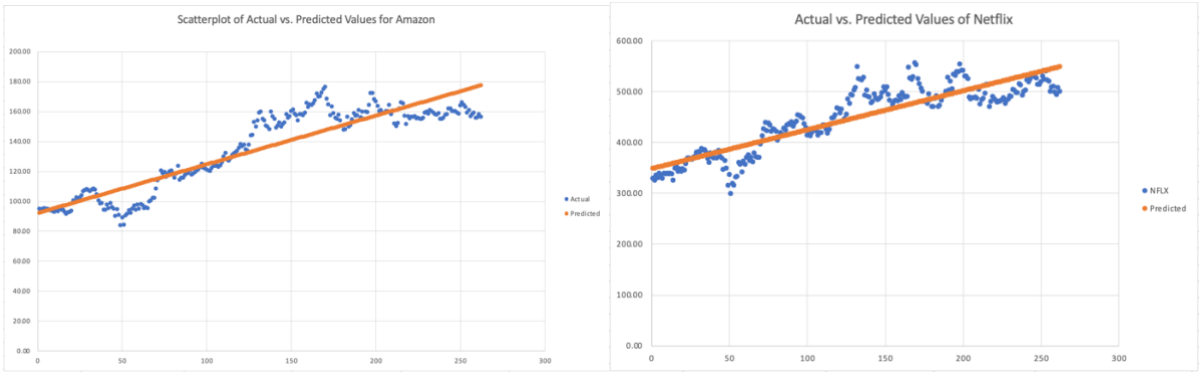

Fig. 7: Actual vs Predicted Values

The MAPE values are calculated for period 253 to 262 of financial days. The Average MAPE for Amazon was 6.70 and for Netflix was 5.40.

12/31/20	253	162.85	174.41	7.10	12/31/20	253	540.73	541.97	0.23
1/4/21	254	159.33	174.74	9.67	1/4/21	254	522.86	542.73	3.80
1/5/21	255	160.93	175.06	8.78	1/5/21	255	520.8	543.50	4.36
1/6/21	256	156.92	175.39	11.77	1/6/21	256	500.49	544.26	8.75
1/7/21	257	158.11	175.71	11.13	1/7/21	257	508.89	545.03	7.10
1/8/21	258	159.13	176.04	10.63	1/8/21	258	510.4	545.80	6.94
1/11/21	259	155.71	176.36	13.26	1/11/21	259	499.1	546.56	9.51
1/12/21	260	156.04	176.69	13.23	1/12/21	260	494.25	547.33	10.74
1/13/21	261	158.29	177.02	11.83	1/13/21	261	507.79	548.09	7.94
1/14/21	262	156.37	177.34	13.41	1/14/21	262	500.86	548.86	9.58
			Average MAPE	**6.70**				**Average MAPE**	**5.40**

Fig. 8: MAPE values for Period 253 to 262

The comparison of Residuals and Time Period showing a pattern in them resulting that the residuals are not independent in nature.

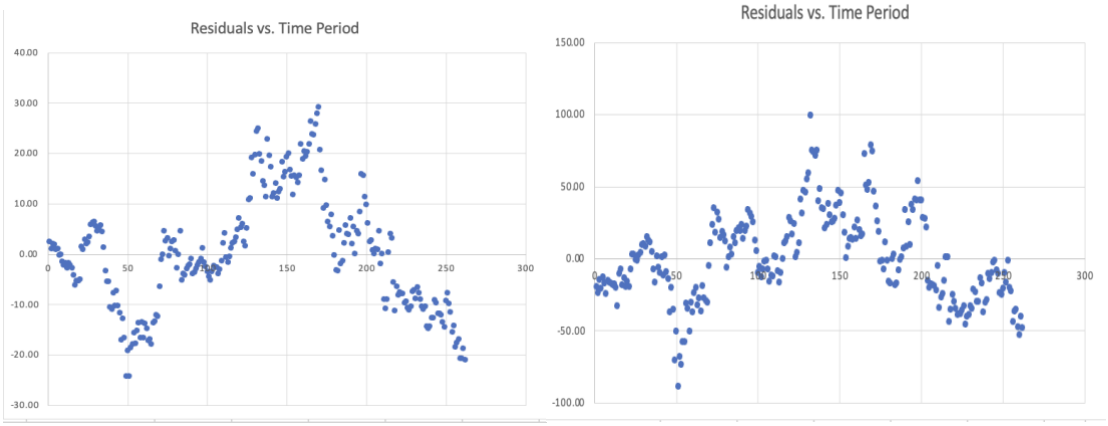

Fig. 9: Residuals vs. Time Period in Days

The Residuals follow a pattern, hence they are not homoscedastic in nature.

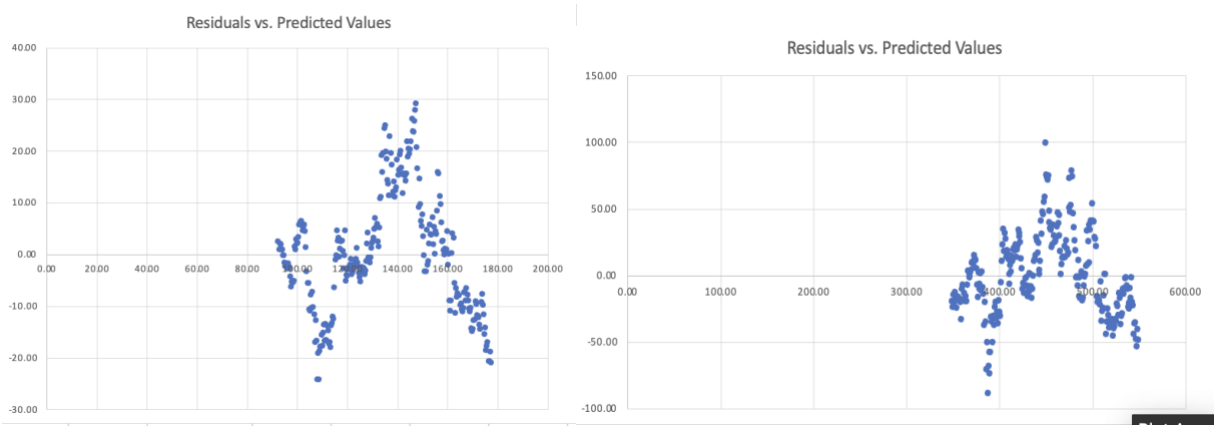

Fig. 10: Residuals vs. Predicted Values

The Histogram of Netflix follows a bell-shaped pattern while that of Amazon does not follow a bell-shaped pattern, resulting in Histogram of Netflix to be normally distributed while that of Amazon is not normally distributed.

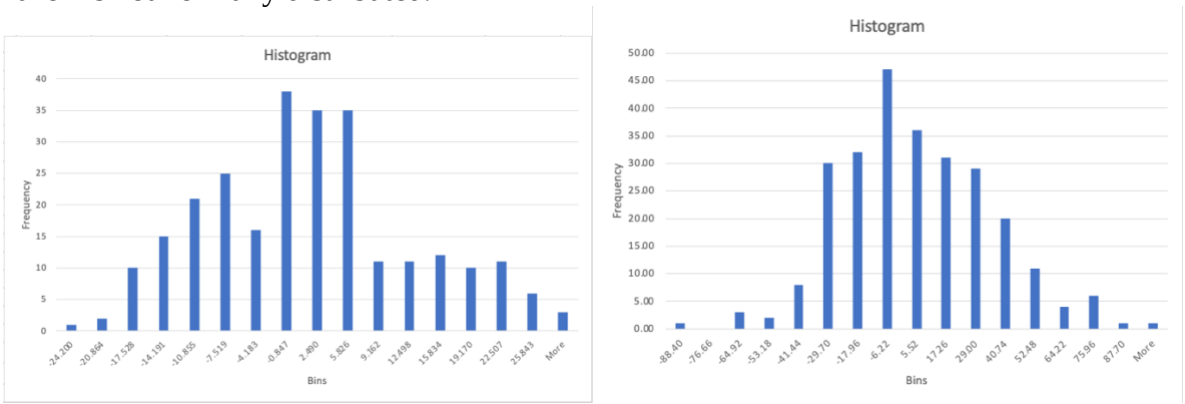

Fig. 11: Histograms

The residuals follow an irregular pattern for Amazon, and therefore it is not normally distributed, while that Netflix, it follows a linear pattern and is considered to be normally distributed.

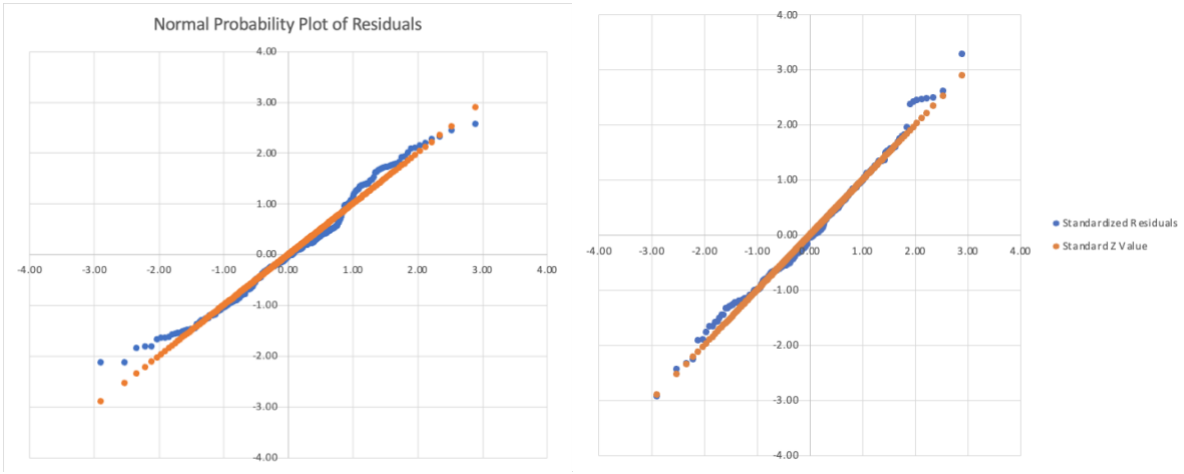

Fig. 12: Comparison of Standard Z values with Residuals

The Chi-Square Statistic Value for Amazon is 31.77 whereas of Netflix is 21.33. The degree of freedom is 16 for both Amazon and Netflix. The p-value for Amazon is 0.01 which is less than the alpha value of 0.05, hence Null Hypothesis is rejected which results in Residuals to be not normally distributed. The p-value for Netflix is 0.16 which is more than the alpha value of 0.05, hence Alternative Hypothesis is rejected which results in Residuals to be normally distributed.

Null Hypothesis (H0): The residuals are normally distributed

Alternative Hypothesis (Ha): The residuals are not normally distributed

Chi-Squared Statistic Value	31.71
Degree of Freedom	16
P-Value	0.010899831

Chi-Squared Statistic Value	21.33
Degree of Freedom	16
P-Value	0.1660356

Fig. 13: Chi-Square Statistic

Part 4: Baseline Model

1. MAPE Calculations & Actual vs Predicted graphs.

Figure 14 depicts the predicted values and MAPE values of Period 253 – 262 for Amazon data on the left and Netflix data on the right. The most recent value is used as the predicted value for the following periods in the baseline model. The MAPE values are calculated by dividing the difference between the actual values and the predicted values by the actual values, and then multiplying by 100. Average MAPE value is calculated using AVERAGE () function. From the figure it is observed that the average MAPE value for Amazon is 1.77 and for Netflix is 2.10.

Date	Period	AMZN	Predicted Values	MAPE
12/31/20	253	162.85	164.29	0.89
1/4/21	254	159.33	162.85	2.21
1/5/21	255	160.93	159.33	0.99
1/6/21	256	156.92	160.93	2.56
1/7/21	257	158.11	156.92	0.75
1/8/21	258	159.13	158.11	0.64
1/11/21	259	155.71	159.13	2.20
1/12/21	260	156.04	155.71	0.21
1/13/21	261	158.29	156.04	1.42
1/14/21	262	156.37	158.29	1.23
			Average MAPE	1.77

Date	Period	NFLX	Predicted Values	MAPE
12/31/20	253	540.73	524.59	2.98
1/4/21	254	522.86	540.73	3.42
1/5/21	255	520.80	522.86	0.40
1/6/21	256	500.49	520.80	4.06
1/7/21	257	508.89	500.49	1.65
1/8/21	258	510.40	508.89	0.30
1/11/21	259	499.10	510.40	2.26
1/12/21	260	494.25	499.10	0.98
1/13/21	261	507.79	494.25	2.67
1/14/21	262	500.86	507.79	1.38
			Average MAPE	2.10

Fig. 14: MAPE values for Amazon and Netflix

The baseline model's comparison of the actual and predicted values for both Amazon and Netflix is shown in Figure 15. The figure makes it obvious that the actual and predicted values coincide with each other.

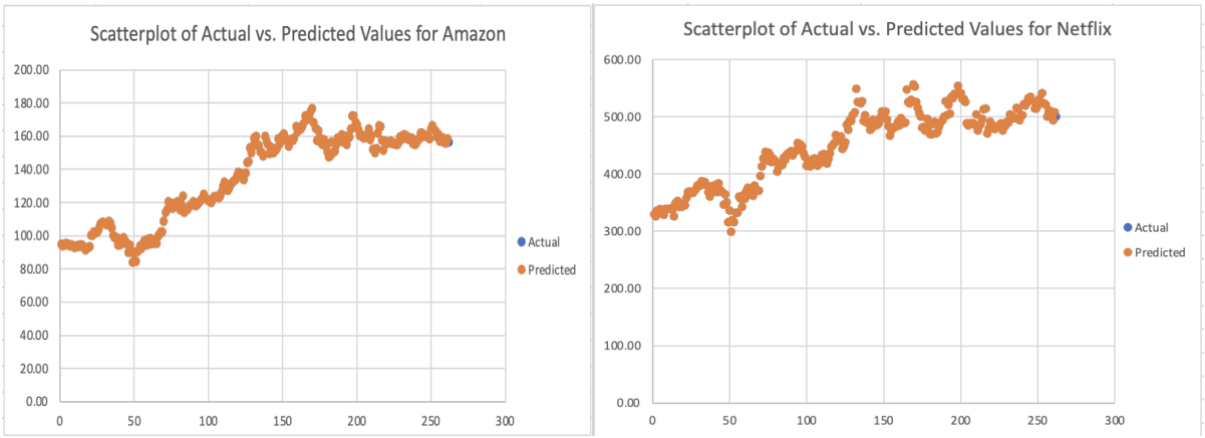

Fig. 15: Scatter plots of Actual vs Predicted Values for Amazon and Netflix

2. Comparison of different Forecasting Methods

Figure 16 compares the MAPE values for Amazon and Netflix for short-term forecasting, long-term forecasting, regression, and the baseline model. From the below table it is observed that for Amazon the Base Line Forecasting has the lowest MAPE value of 1.77 and for Netflix the Short-Term (Exponential Smoothing) Forecasting is having the lowest MAPE value of 2.02. Thus, it can be concluded that Baseline Forecasting Method can be beneficial for Amazon to forecast values and Short-Term (Exponential Smoothing) Forecasting Method can be beneficial for Netflix to forecast values.

	AMAZON	
Forecasting Methods		**MAPE**
Short-term	**Exponential Smoothing**	**1.79**
	Adjusted exponential smoothing	**1.80**
Long-term		**4.25**
Regression		**6.70**
Base line		**1.77**

	NETFLIX	
Forecasting Methods		**MAPE**
Short-term	**Exponential Smoothing**	**2.02**
	Adjusted exponential smoothing	**2.10**
Long-term		**3.68**
Regression		**5.40**
Base line		**2.10**

Fig. 16: Comparison of different Forecasting Method

Question:

As compared to the Analysis, the Amazon (P) would be a better deal than Netflix (Q). Hence, P would be around 70%, while Q would be around 30%.

References

How to Calculate Mean Absolute Percentage Error in Excel? - GeeksforGeeks. (2021, July 2). GeeksforGeeks. https://www.geeksforgeeks.org/how-to-calculate-mean-absolute-percentage-error-in-excel/

Normality Test Chi Square Goodness of fit MS Excel. (2017, November 6). YouTube. https://www.youtube.com/watch?v=Zs8IA3K1-4I

How to calculate probability in Excel - Excelchat | Excelchat. (2019, June 9). Excelchat. https://www.got-it.ai/solutions/excel-chat/excel-tutorial/probability/how-to-calculate-probability-in-excel