Module 3 Assignment | Project: Forecasting Financial Time Series

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Analysis and Interpretation

Part 1: Short-term Forecasting

The two graphs below depict the historical time series of Amazon (AMZN) and Toyota (TM)

stock prices over a span of six years. These graphs provide insights into the behavior of the two

stocks over time. Figure 1 demonstrates the price movement of Amazon stock, which exhibits

considerable volatility. The graph displays a dramatic increasing trend from period 199 to period

221, where the stock price rises from $90 to $170, as well as downtrends from period 111 to

period 133 and from period 276 to period 300. In contrast, Toyota's prices demonstrate a more

stable pattern over the six-year period. The graph illustrates consistent prices ranging from $100

to $200, suggesting relative stability in Toyota's stock price over time.

Figure 1: Time series of Amazon stock prices

Figure 2: Time series of Toyota stock price
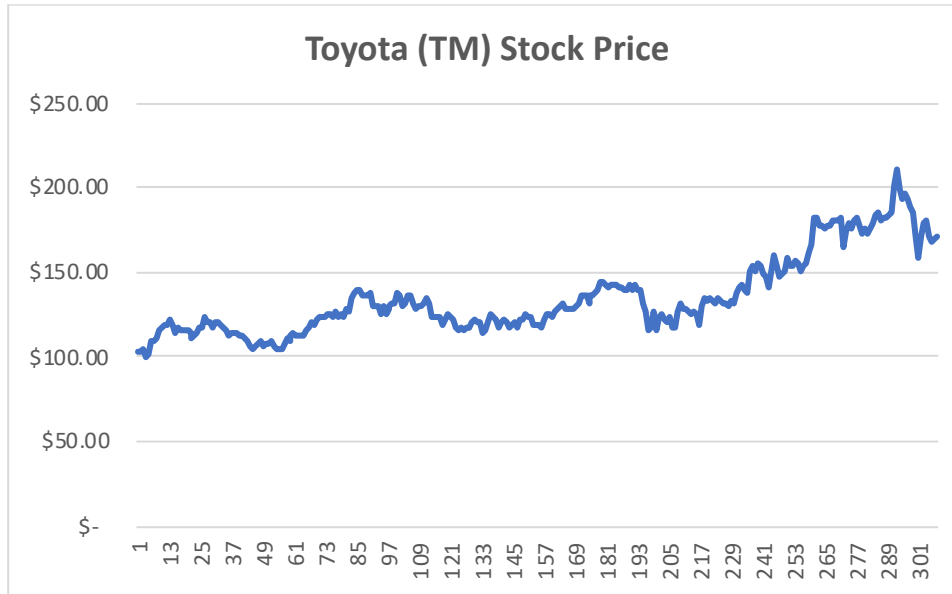
The MAPEs (Mean Absolute Percentage Errors) for different values of α (Alpha) for Amazon

and Toyota stocks are as follows:

Table 1: MAPEs with different alpha values

Alpha (α)	MAPE (Amazon)	MAPE (Toyota)
0.15	**5.39%**	**3.49%**
0.35	**3.76%**	**2.49%**
0.55	**3.19%**	**2.21%**
0.75	**2.96%**	**2.12%**

In terms of MAPEs indicators, it can be observed that the value of α that has yielded the most

accurate forecast (minimized the errors in the forecasts) for Amazon stock is 0.75, and for

Toyota stock is also 0.75. So, the α value of 0.75 has resulted in the most accurate forecasts for

both stocks because it strikes a balance between reacting quickly to recent changes in the time

series data due to higher α values tend to be more responsive to recent observations and

providing a stable forecast by considering a reasonable portion of the historical data.

The MAPEs (Mean Absolute Percentage Errors) for different values of Beta (β) for Amazon and

Toyota stocks are as follows:

Table 2: MAPEs with different beta values

Beta (β)	MAPE (Amazon)	MAPE (Toyota)
0.15	**3.06%**	**2.22%**
0.25	**3.01%**	**2.21%**
0.45	**2.94%**	**2.19%**
0.85	**2.85%**	**2.13%**

Based on these results, it can be observed that for both Amazon and Toyota stocks, the lowest

MAPE is obtained when β is 0.85. This suggests that a β value of 0.85 has yielded the most

accurate forecasts for both stocks. In my opinion, a β value of 0.85 has resulted in the most

accurate forecasts for both stocks because it balances between capturing the underlying trend in

the data and adapting to recent changes. A higher β value allows the forecast to be more

influenced by recent observations, which can help capture short-term fluctuations. However, it

also takes into account the overall trend by considering a suitable portion of the previous trend.

In this case, a β value of 0.85 appears to have achieved the best trade-off for both Amazon and

Toyota stocks based on the MAPEs.

Part 2: Long-term Forecasting

Based on the retrieved data from Yahoo Finance for Amazon and Toyota stock prices during

periods 309-313, we can now compare the actual values with the corresponding predicted values

to evaluate the accuracy of the forecasting method in this long-term forecasting. It appears that

the forecasting methods of 3-period weighted moving averages & linear trend used in this part

did not accurately predict the stock values for periods 309-313. There is a noticeable deviation between the predicted and actual values for both Amazon and Toyota stocks.

Table 3: Actual vs Predicted values from period 309 to 313

Date	Period	Actual Amazon	Predicted Amazon	Actual Toyota	Predicted Toyota
5/2/22	309	114.77	155.06	173.30	187.52
5/9/22	310	113.06	154.75	161.33	187.90
5/16/22	311	107.59	154.44	158.66	188.29
5/23/22	312	115.15	154.13	166.83	188.67
5/30/22	313	122.35	153.81	164.81	189.05

- MAPE (Amazon): 3.99%

- MAPE (Toyota): 2.93%

The MAPEs of both predicted stocks in this part are higher than most of the MAPEs in part 1, showing that this method has less accuracy than those in the previous part. For Toyota stock, the MAPE of 2.93% indicates a slightly higher level of accuracy compared to Amazon. The forecasted values for Toyota stock deviated from the actual values by an average of 2.93%. This implies that the forecasting method was relatively more accurate in predicting Toyota stock prices than Amazon's during the given periods.

- Exponential smoothing with $\alpha = 0.75$: the most accurate forecast for Toyota stock prices.

- Adjusted exponential smoothing with $\beta = 0.85$: the most accurate forecast for Amazon stock prices.

Part 3: Regression on Amazon stock prices

- The forecasting method used in part 3 yielded the least accuracy for *Amazon stock prices*.

5/2/22		1	309	$	114.77	177.36
5/9/22		1	310	$	113.06	177.85
5/16/22		1	311	$	107.59	178.35
5/23/22		1	312	$	115.15	178.85
5/30/22		1	313	$	122.35	179.35

- Homoscedasticity and Independence assumption of residuals:

Residuals vs Predicted Y
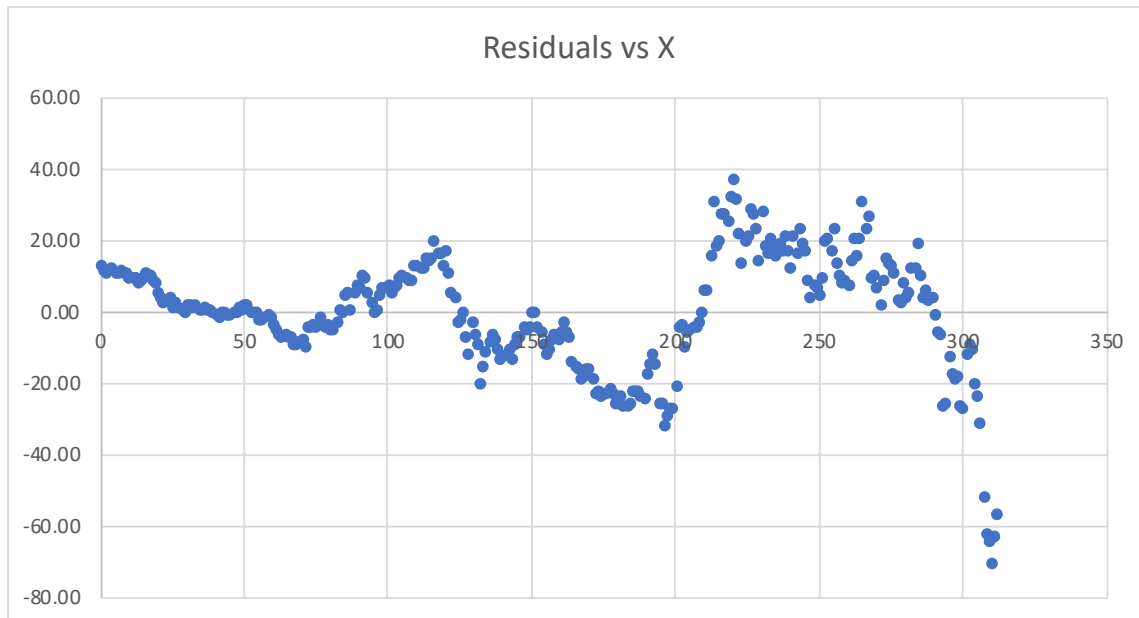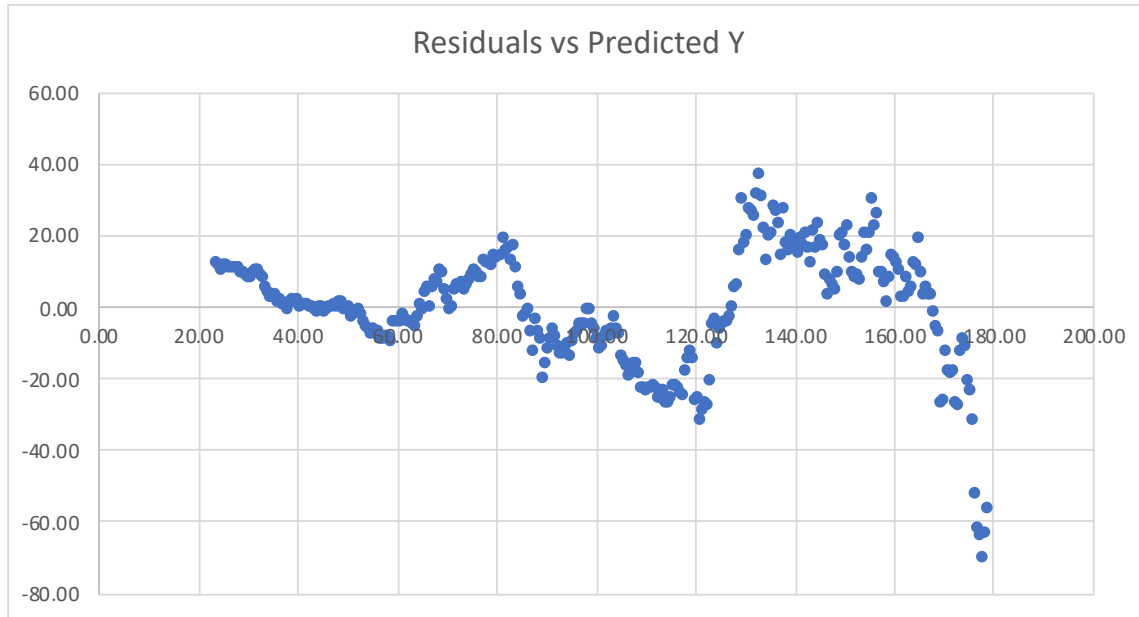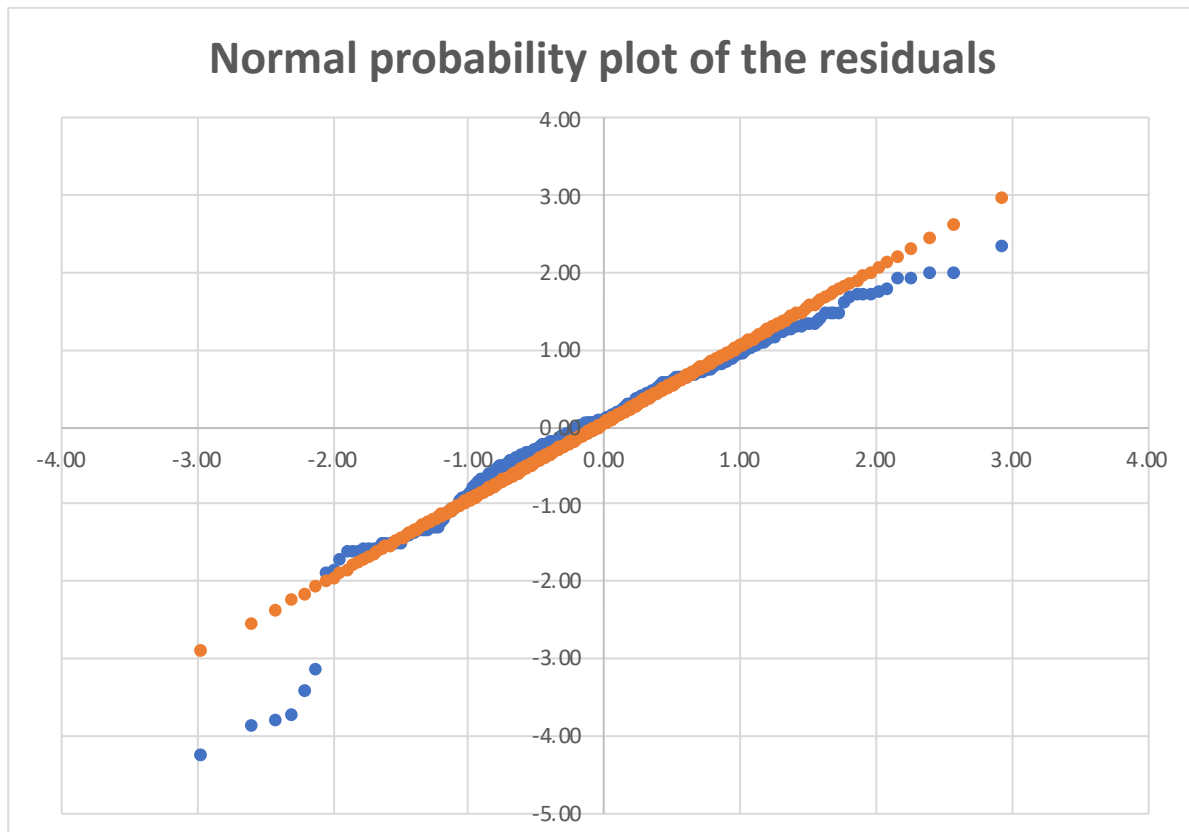

Residuals vs X

The residual plots above show that they do not meet the assumptions of Homoscedasticity and
Independence in the regression method. There are significant patterns within the residuals.

- Whether the residuals are normally distributed?
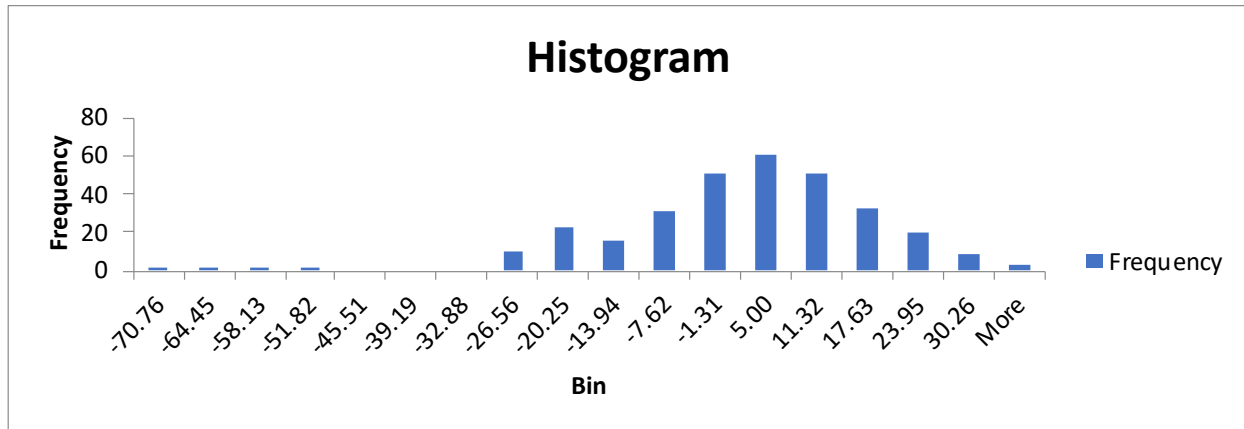
The fitted value of standardized z values and residual values of Amazon stocks in the normal
probability plot indicates that the residuals are not in a normal distribution.

- Chi-squared test for Normality of the residuals:

H0 (null hypothesis): Residuals are from a normally distributed population.

H1 (alternative hypothesis): Residuals are not from a normally distributed population.

Since the p-value is much less than a 0.5 significance level, we reject the null hypothesis and conclude that residuals are not normally distributed with a 95% confidence level.

- Whether regression is appropriate to use for each of the given data?

The assumptions of regression analysis, such as independence of observations, homoscedasticity, and normality of residuals, are not met for the given data. The residual analysis indicated significant patterns within the residuals and deviations from normality, suggesting potential issues with using regression in this case.

References

Evans, J. R. (2013). Statistics, data analysis, and decision modeling. Pearson Education.