Comprehensive Analysis and Forecasting of AAPL and HON Stock Prices:

Evaluating Forecasting Methods and Stock Allocation Strategies

INTRODUCTION

1.1 General overview.

Forecasting a time series consists of making forecasts about future values based on past data and statistical approaches. Many uses of time series analysis include the stock market and trend analysis, financial analysis and forecasts, inventory analysis, and sales forecasting. This can be accomplished by a variety of means, including

- Naive Method: A naive method involves simply using the last observation as the prediction for the next time period.
- Moving Average: Moving average involves taking the average of the last 'n' observations as the prediction for the next time period.
- Weighted Moving Average: Similar to moving average but with different weights assigned to different observations.
- Exponential Smoothing: It involves assigning exponentially decreasing weights to the past observations as the prediction for the next time period.
- ARIMA (AutoRegressive Integrated Moving Average): It is a more sophisticated method that considers both the autoregression and moving average aspects of the time series.
- SARIMA (Seasonal ARIMA): It is used when a time series has both seasonality and autocorrelation.
- Prophet: A forecasting library developed by Facebook, it is used for time series forecasting and can handle outliers, missing data, and trends.

Ultimately, the choice of method will depend on the specific characteristics of the time series data, such as trend, seasonality, and autocorrelation.

In this project, the forecasting methods are used to forecast the future values of one or more time series. Furthermore, we will use linear algebra to perform simple or multiple regression.

1.2 To investigate

The dataset contains the historical stock prices for Apple Inc (AAPL) and Honeywell International Inc (HON) for a total time period of one year, consisting of 252 market days. It contains the daily stock price and volume information for Apple Inc (AAPL) and Honeywell Inc (HON) from November 8th, 2019 to January 16th, 2020. The data includes the date, period, and daily opening and closing stock price in dollars and the volume of shares traded for both companies Different forecasting methods are applied to forecast the future values of the stocks.

ANALYSIS

Part 1: Short-term Forecasting:

(i) Use a simple line plot of both time series to detect seasonal, irregular, or trend behaviors if any. Write a summary of your observations of both time series in your report.

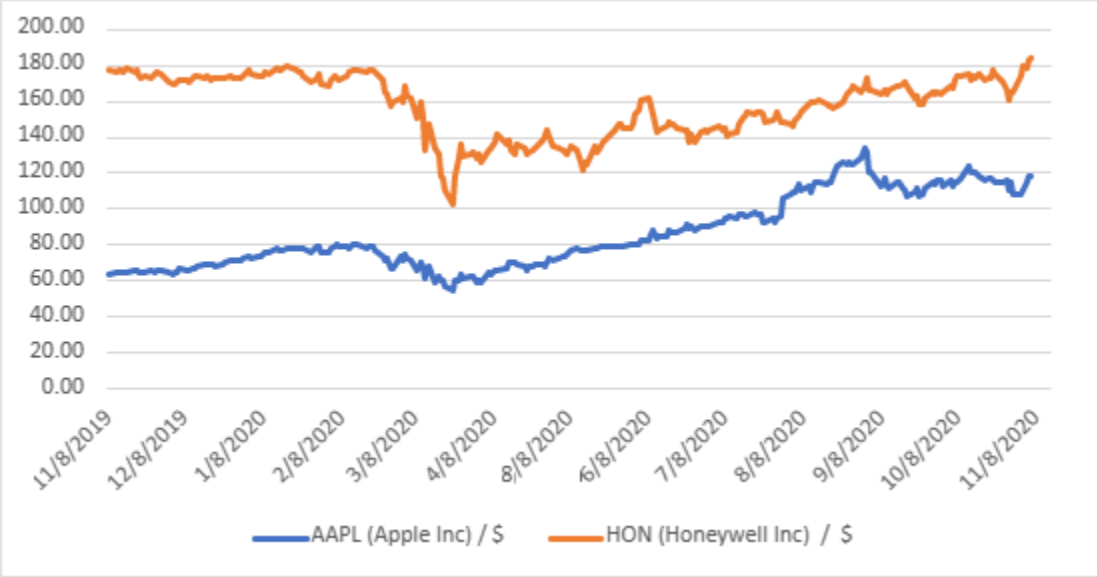

Figure 1: Time series data of Apple Inc and Honeywell Inc stock prices.

Observations:-

The time series data show Apple Inc (AAPL) and Honeywell Inc (HON) stock prices and trading volumes from November 8, 2019 to January 16, 2020. AAPL's stock price was more volatile and had a higher trading volume than HON's. Both equities experienced ups and downs as a result of market events, but overall showed an upward tendency, with AAPL displaying a more significant gain in stock price than HON. These data provide insight into the stock market performance of companies over a period of several months and can assist inform investing decisions.

(ii) Perform exponential smoothing to forecast both prices for period 253. Use successive values of 0.15, 0,35, 0.55, and 0.75 for the smoothing parameter α. Next, calculate the MAPD (Mean Absolute Percentage Deviation) of each forecast; and based on the MAPDs, determine the value of α that has yielded the most accurate forecast for each stock. In your report, describe your results; and explain why in your opinion such values of α have yielded the most accurate forecasts for the two stocks.

TOTAL	APP MAPD	2.17222629
	HON MAPD	2.04369277
ALPHA=0.15	APP MAPD	2.46979163
	HON MAPD	2.55311512
ALPHA=0.35	APP MAPD	2.00549949
	HON MAPD	1.85147734
ALPHA=0.55	APP MAPD	2.63809334
	HON MAPD	1.97266558
ALPHA=0.75	APP MAPD	1.57751557
	HON MAPD	1.7983022

Figure 2: Mean Absolute Percentage Deviation of Apple Inc and Honeywell Inc for smoothing parameters

Observations:-

The analysis suggests that the most accurate forecast for Apple (AAPL) stock price is produced when =0.75 and has a MAPD of 1.577515569. Meanwhile, Honeywell (HON) has the best accurate forecast when =0.35 and has a MAPD of 1.851477341. These findings suggest that different smoothing settings produce varying levels of accuracy in projecting the two firms' stock prices.

(iii) Use your exponential smoothing forecast of part (ii) with $\alpha = \alpha .55$ and perform an adjusted exponential smoothing to forecast both prices for period 253. Use successive values of 0.15, 0.25, 0.45, and 0.85 for the trend parameters β for both stocks. Next, calculate the MAPEs (Mean Absolute Percentage Error) of your forecasts and determine the values of β that have provided the most accurate forecasts for both stocks. In your report, describe your results and explain why, in your opinion, such values of β have yielded the most accurate forecasts.

	TOTAL	APP MAPE	0.08690694
		HON MAPE	0.08759059
	BETA=0.15	APP MAPE	0.02776231
		HON MAPE	0.03193171
ALPHA = 0.55	BETA=0.25	APP MAPE	0.01915701
		HON MAPE	0.02012809
	BETA=0.45	APP MAPE	0.02992649
		HON MAPE	0.01985309
	BETA=0.85	APP MAPE	0.01006112
		HON MAPE	0.01567769

Figure 3: Mean Absolute Percentage Deviation of Apple Inc and Honeywell Inc for smoothing parameters of Beta with Alpha=0.55

Observations:-

According to the MAPE calculations, the value of that has produced the most accurate forecasts for both stocks is 0.85. Apple's (APP) forecast has a MAPE of 0.010061121, while Honeywell's (HON) forecast has a MAPE of 0.015677693. This suggests that when is set to 0.85, the forecast accuracy for both stocks improves.

A value of 0.85 for in the forecasting models lends more weight to the present trend of the time series data, allowing for a more educated prediction. When compared to other values of, this yields more accurate projections.

Part 2: Long-term Forecasting

(i) For each stock, use a 3-period weighted moving averages to forecast its value during periods 1 through 100. Use the weights 0.5 (for the most recent period), 0.3 (for the period before the most recent), and 0.2 (for two periods ago). Next, use the observed value for period 101 as the base of a linear trend, and use that linear trend to forecast the values of both stocks for periods 101 through 257. Write a summary of your results in your report. Describe how accurate this method of forecasting has been by comparing the forecasted values for periods 253-257 with

their actual “Close” values on those specific days (Hint: check the actual values on https://finance.yahoo.com).

251	118.82	183.28	116.6826973	172.7309952	ACTUAL VALUES FROM YAHOO	
252	118.69	184.27	116.2374626	174.9380005	APP	HON
253			**127.8021942**	**176.0654699**	**116.32**	**196.99**
254			**128.1968665**	**176.3700975**	**115.97**	**201.98**
255			**128.5915389**	**176.6747252**	**119.49**	**199.29**
256			**128.9862113**	**176.9793528**	**119.21**	**197.24**
257			**129.3808836**	**177.2839805**	**119.26**	**201.54**

Figure 4: Comparison of Weighted Moving Average of Apple Inc and Honeywell Inc with actual values from Yahoo

Observations:-

Forecasted values for the APP and HON stocks using the 3-period weighted moving average and linear trend methods differ greatly from Yahoo Finance's actual values. The APP stock expected value for period 253 is 27.95008554, while the actual value is 116.32, and the HON stock forecasted value is 98.99467476, while the actual value is 196.99. This suggests that the weighted moving average approach may be inaccurate in projecting stock prices for the APP and HON stocks since it does not take into account many factors that can influence stock prices over time.

(ii) Calculate the MAPEs (Mean Absolute Percentage Error) of your forecasts in question (i) above and compare them with the values obtained for your forecasts in Part 1. For each stock, describe which method has yielded the most accurate forecast

Part1(iii)

ALPHA = 0.55		
	TOTAL	APP MAPE 0.08690694
		HON MAPE 0.08759059
	BETA=0.15	APP MAPE 0.02776231
		HON MAPE 0.03193171
	BETA=0.25	APP MAPE 0.01915701
		HON MAPE 0.02012809
	BETA=0.45	APP MAPE 0.02992649
		HON MAPE 0.01985309
	BETA=0.85	APP MAPE 0.01006112
		HON MAPE 0.01567769

Figure 5: Mean Absolute Percentage Deviation of Apple Inc and Honeywell Inc for smoothing parameters of Beta with Alpha=0.55

Part2(iii)

TOTAL	APP MAPE	0.890372079
	HON MAPE	0.902288331

Figure 6: Mean Absolute Percentage Deviation of Apple Inc and Honeywell Inc for 3-period weighted moving averages

Observations:-

According to the MAPEs, the exponential smoothing approach with α=0.55 and β=0.25 yields the most accurate forecasts for both stocks than the 3-period weighted moving averages method. The exponential smoothing MAPE for Apple is 0.019157011, while the 3-period weighted moving averages MAPE is 0.890372079. Similarly, the MAPE for Honeywell stock using exponential smoothing is 0.020128095, whereas the MAPE for the same stock using 3-period weighted moving averages is 0.902288331.

This shows that exponential smoothing is a more accurate forecasting method than 3-period weighted moving averages since it takes both the trend and seasonality of the time series data into account. It also offers a weighted average of previous observations that adjusts over time, resulting in more accurate predictions.

Part 3: Regression:

(i) For each stock, use simple regression of stock values versus the time periods to predict its values for periods 1 through 257. In your report, describe how the accuracy of this prediction has been compared to the methods used in Parts 1 and 2 of this project.

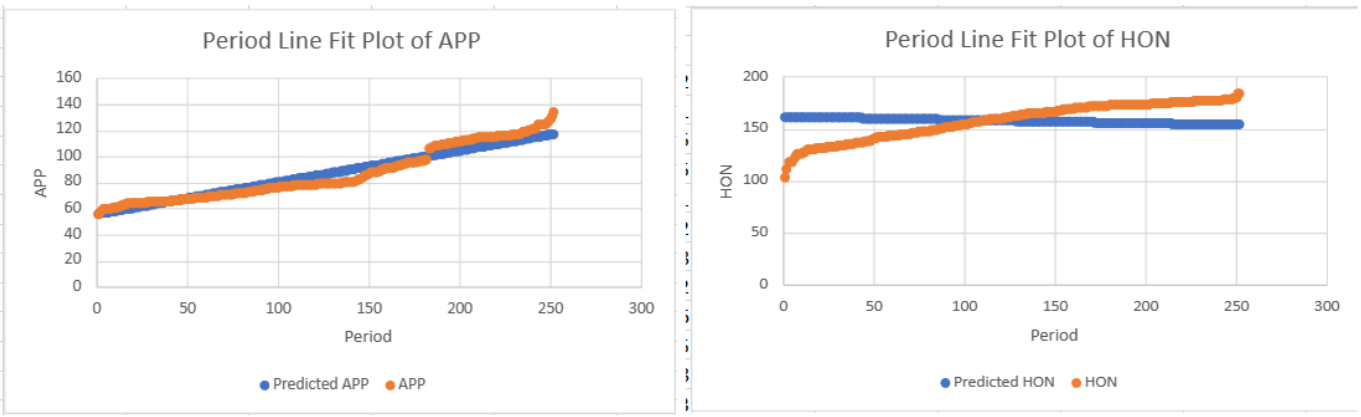

Figure 7: Line plot of Apple Inc and Honeywell Inc for regression analysis

TOTAL	MAPE OF APP=	10.37694205
	MAPE OF HON=	10.06949957

Figure 8: Mean Absolute Percentage Deviation of Apple Inc and Honeywell Inc for regression analysis.

Observations:-

The simple regression approach has a larger MAPE than the exponential smoothing method used in Part 1 and the weighted moving average method used in Part 2, implying that the simple regression method produces less accurate forecasts than the other methods. This is due to the constraints of the simple regression model, which assumes a linear relationship between stock prices and time periods. In practice, however, stock prices can be influenced by a variety of

other factors, making the relationship more complex and non-linear, resulting in a less accurate prediction.

(ii) Perform a residual analysis of your simple regression to verify whether regression is appropriate for each given data. In particular, determine

• Whether the residuals are independent.

• Whether the residuals are homoscedastic.

• Whether the residuals are normally distributed by plotting a Normal probability plot of the residuals

• Whether the residuals are normally distributed by performing a Chi-squared test for Normality of the residuals.

Observations:-

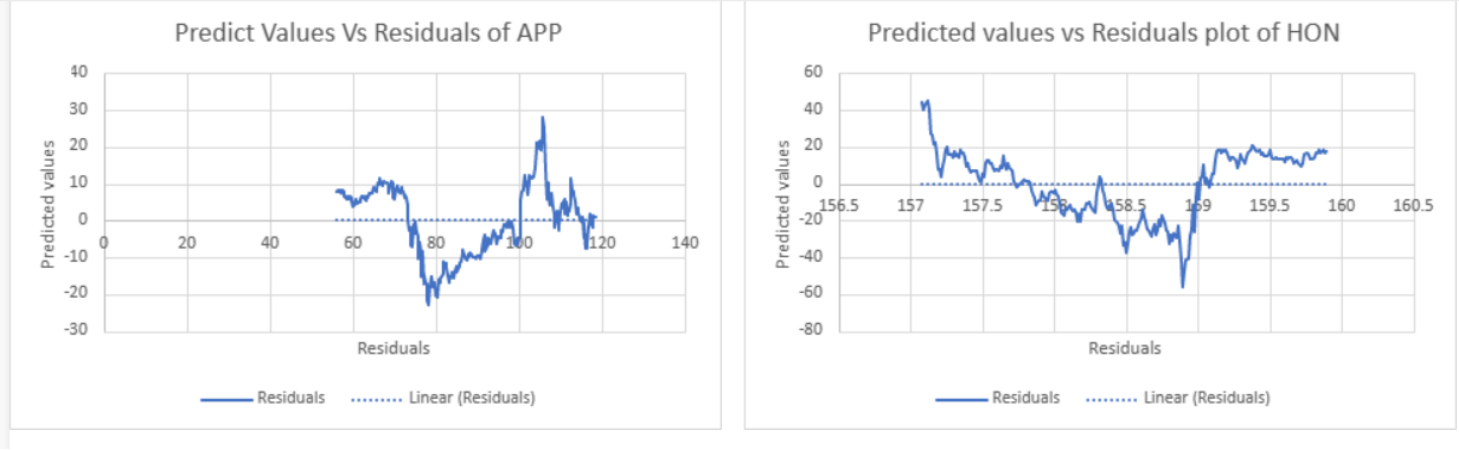

Figure 9: Predicted values Vs Residuals of Apple Inc and Honeywell Inc.

A simple regression model that fits the data is developed to do a residual analysis. A Residual vs Predict Values plot is constructed to determine whether the residuals are independent or homoscedastic.

Whether the residuals are independent?

Based on the residual plot, the residuals seem to fluctuate randomly and appear not to have any pattern. Since there is no clear pattern in the plot, then the residuals can be considered independent.

Whether the residuals are homoscedastic?

The plot should show residuals randomly dispersed around zero, and there should be no clear pattern in the residual distribution. Hence the residuals are homoscedastic.

Whether the residuals are normally distributed by plotting a Normal probability plot of the residuals?

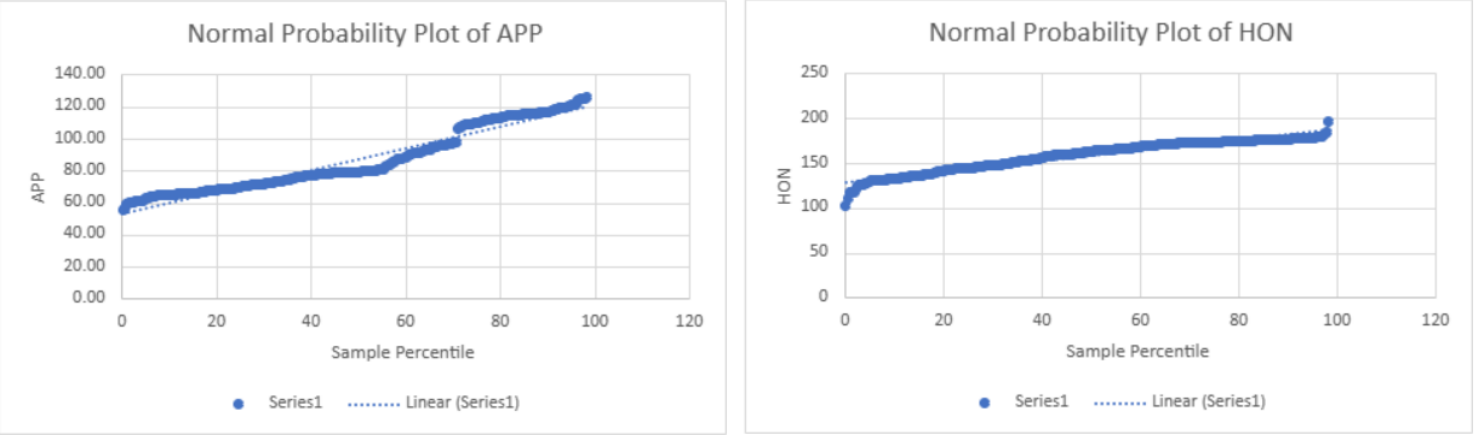

Figure 7: Normal Probability Plot of Apple Inc and Honeywell Inc.

To check whether the residuals are normally distributed, a Normal probability plot is created. Since the points in the plot follow a straight line, then the residuals can be considered normally distributed.

Whether the residuals are normally distributed by performing a Chi-squared test for the Normality of the residuals.

The goodness of fit test was performed to determine whether the residuals are normally distributed by performing a Chi-squared test for the Normality of the residuals. The hypothesis was formulated as below:-

- **Null hypothesis -** H0: The residuals are normally distributed
- **Alternate hypothesis -**Ha: The residuals are not normally distributed

Since p_value is less than 0.5 we cannot reject the null hypothesis. Hence the residuals are normally distributed.

:-As indicated by the residual's normal probability plot and the Chi-squared test, the residuals were determined to be independent, homoscedastic, and normally distributed. This suggests that the simple regression model fits the data well and that any extraneous factors have no effect on the residuals. Therefore the linear relationship in the simple regression model is a realistic depiction of the actual relationship between stock values and time periods. However, we cannot conclude that the regression model is the best fit for the data because residuals are independent, homoscedastic, and normally distributed.As a result, we must look into alternative models and perform additional studies.

P and Q should be allocated in a portfolio based on the individual's investment goals, risk tolerance, and the historical performance of each stock. The forecasting results and residual analysis can be used to make intelligent decisions about how to allocate P and Q, with a bigger allocation to the stock with the more accurate forecast being one possible strategy.

CONCLUSIONS

To conclude, stock prices of Apple Inc (AAPL) and Honeywell International Inc (HON) throughout a year (252 market days) were analysed and forecasted future values using several forecasting methods.Short-term forecasts showed that AAPL had a larger gain in stock price and was more volatile than HON. The most accurate forecast for AAPL was derived using an exponential smoothing method and = 0.75 for HON. For both stocks, the adjusted exponential smoothing generated a more accurate forecast with = 0.85. Long-term forecasting with exponential smoothing outperformed the weighted moving average and linear trend methods.

References

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