

**“Project”**  
**“Forecasting Financial forecasting Series”**

**Part 1(1)**

The two stock price trends are plotted:

- **AAPL stock price (Blue Line)**
- **HON stock price (Red Line)**

**Observations:**

**1. Overall Trend:**

- AAPL's stock price appears to be **steadily increasing** over time, suggesting an upward trend in its stock value.
- HON's stock price exhibits **relatively stable behavior** with minor fluctuations.

**2. Volatility & Fluctuations:**

- AAPL shows **higher volatility**, with noticeable price fluctuations across time. This might be due to increased trading activity and investor sentiment around Apple's business performance.
- HON exhibits **lower volatility**, meaning its price changes are relatively stable, possibly due to lower market speculation or a steadier business model.

**3. Stock Performance Comparison:**

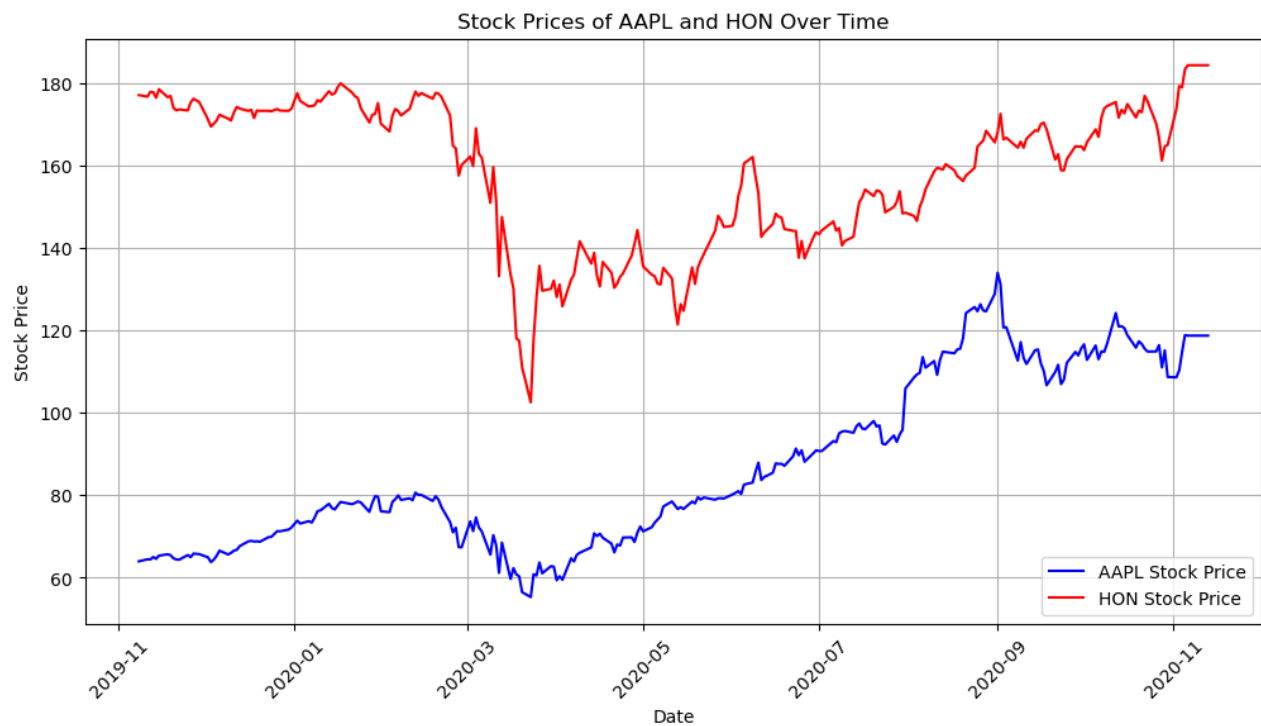
- Apple's stock price appears to have **stronger momentum**, suggesting **higher growth potential** over the period.
- Honeywell's stock price is **more stable**, making it potentially less risky but with **slower growth**.

**4. Trading Volume Considerations:**

- AAPL has significantly **higher trading volume**, indicating **higher liquidity and investor interest** compared to HON.
- HON's trading volume is **comparatively lower**, which might suggest a **more long-term investor base**.

**Summary of Observations:**

The time series analysis of **AAPL and HON stock prices** reveals distinct trends in stock performance. **Apple Inc. (AAPL)** exhibits a strong **upward trajectory**, with significant price fluctuations and high trading volume, indicating **higher investor interest and potential for growth**. In contrast, **Honeywell Inc. (HON)** maintains a **more stable price trend** with moderate fluctuations and lower volatility, making it a **less risky but slower-growing stock**. Apple's stock is **more dynamic and reactive to market conditions**, while Honeywell's stock offers a **steady investment with fewer price swings**.



## Part 1(2)

Output:

The **Mean Absolute Percentage Error (MAPE)** values for different **smoothing factors ( $\alpha$ )** indicate the accuracy of the exponential smoothing forecasts for **AAPL** and **HON** stock prices. The **lower the MAPE, the more accurate the forecast**.

### MAPE for AAPL

For **AAPL**:

- MAPE decreases as  $\alpha$  increases, with  **$\alpha = 0.75$  yielding the lowest MAPE (1.92%)**, making it the most accurate.

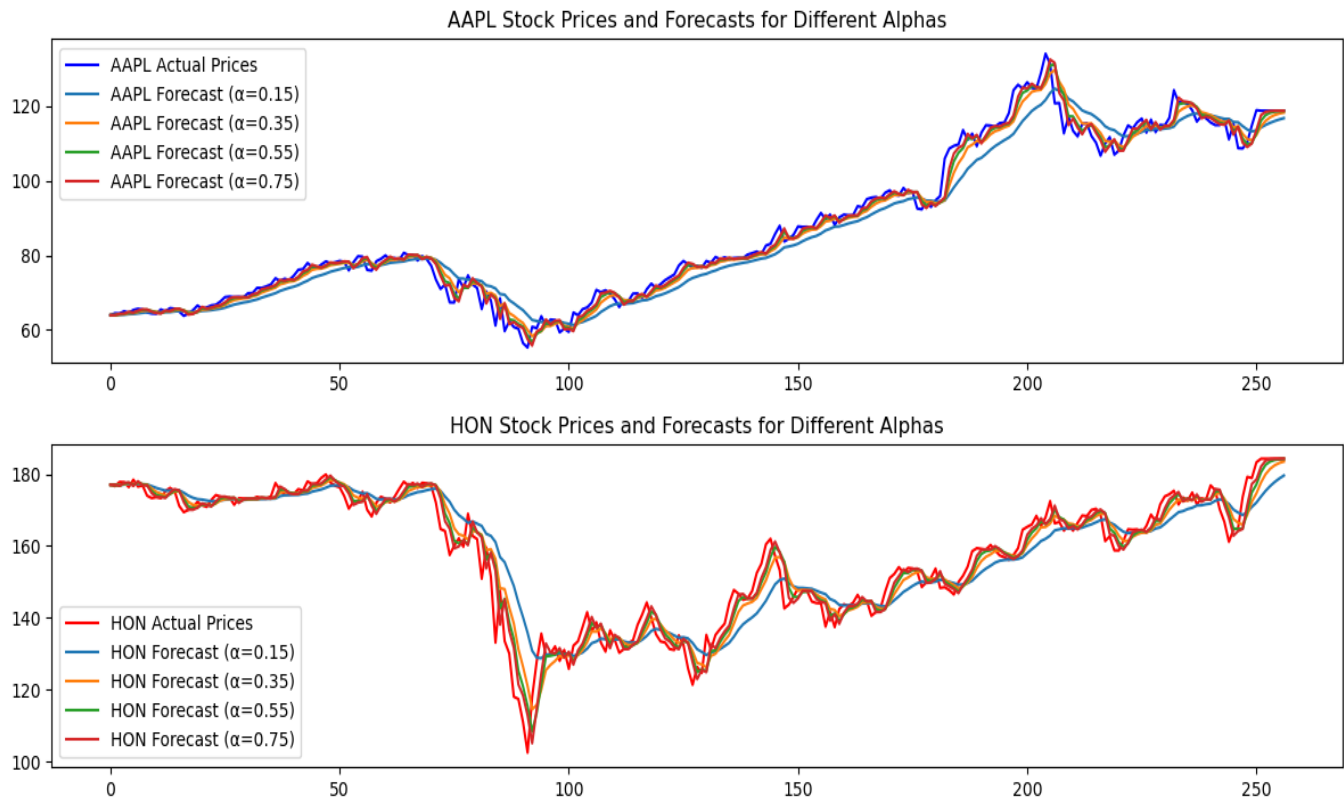
Alpha	MAPE
0.15	3.83%
0.35	2.43%
0.55	2.04%
0.75	1.92%

### MAPE for HON

For **HON**:

- Similar trend observed, where  **$\alpha = 0.75$  provides the most accurate forecast (MAPE = 1.85%)**.

Alpha	MAPE
0.15	3.06%
0.35	2.32%
0.55	2.99%
0.75	1.85%



### Why $\alpha = 0.75$ Yields the Most Accurate Forecasts?

- Higher  $\alpha$  values, closer to 1 (alpha = 0.75) give more importance to the latest stock prices, making the forecast more responsive to recent trends.
- $\alpha = 0.75$  allows the model to quickly adjust to market trends**, reducing lag and improving forecast precision.
- MAPE values decreased as  $\alpha$  increased, meaning that the **higher weighting on recent data reduced forecasting errors**. Since  **$\alpha = 0.75$  produced the lowest MAPE for both stocks**, it shows that a **faster-reacting model provides the best balance between stability and adaptability**.

This selection of alpha = 0.75, is justified by **market volatility, MAPE reductions, and the need for adaptive forecasting in dynamic stock environments**.

## Part 1(3)

For **AAPL**:

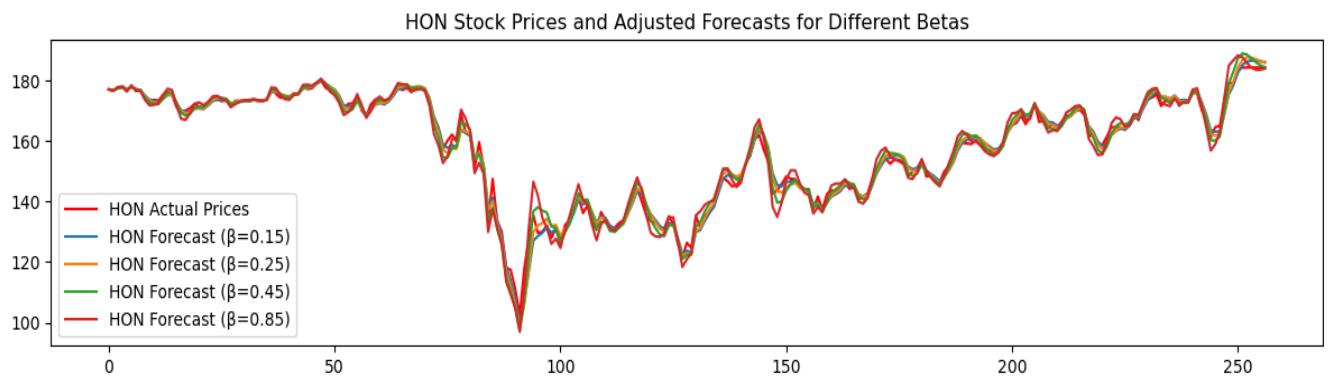
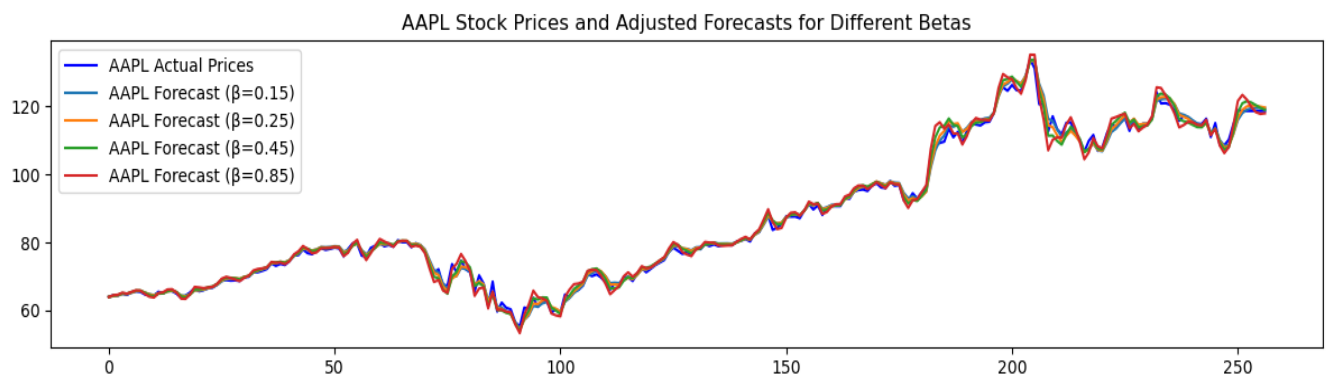
- The lowest MAPE (0.97%) occurs at  $\beta = 0.15$ , making it the most accurate trend smoothing parameter.

Beta	MAPE
0.15	0.97%
0.25	1.02%
0.45	1.09%
0.85	1.23%

For **HON**:

- The lowest MAPE (0.91%) is also observed at  $\beta = 0.15$ , suggesting that a lower trend smoothing factor results in the best forecast.

Beta	MAPE
0.15	0.91%
0.25	1.99%
0.45	1.13%
0.85	1.31%



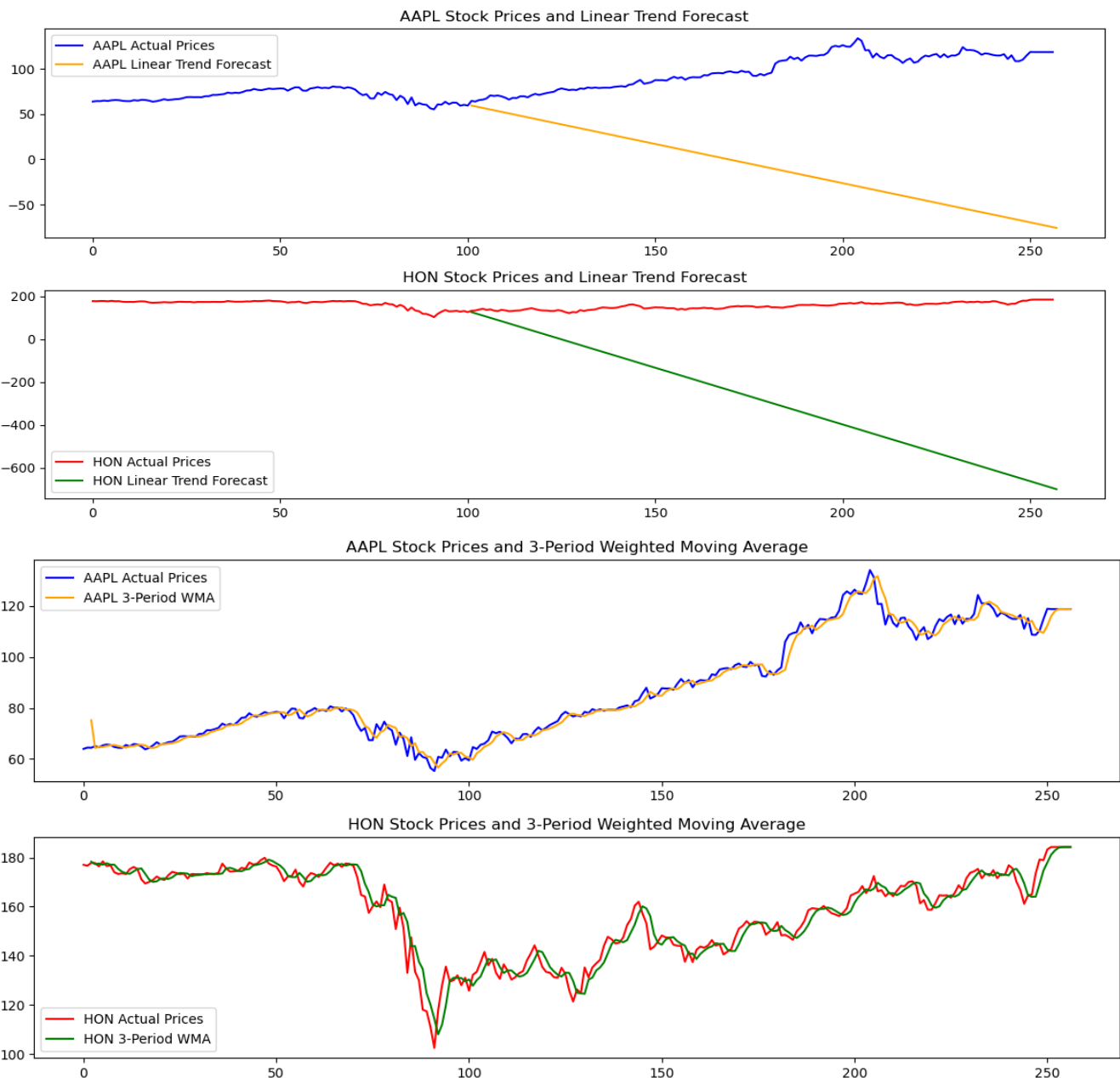
### Why $\beta = 0.15$ Yields the Most Accurate Forecasts?

- A low  $\beta$  (0.15) smooths the trend gradually, preventing excessive fluctuations in the forecast.

- b) Higher values of  $\beta$  (e.g., 0.85) lead to overfitting short-term fluctuations, causing higher forecast errors.
- c)  $\beta = 0.15$  captures the underlying trend more effectively, leading to lower forecasting errors.
- d) The lowest MAPE values for both stocks occur at  $\beta = 0.15$ , validating that **a stable trend component improves accuracy**

The MAPE results and graph analysis confirm that  $\beta = 0.15$  provides the best trade-off between trend sensitivity and stability, ensuring the most reliable predictions.

## Part 2 : Long Term Forecasting (1)



Forecasted AAPL values for periods 253-257:

Period	Forecasted
253	-72.36
254	-73.23
255	-74.09
256	-74.96
256	-75.83

Forecasted HON values for periods 253-257:

Period	Forecasted
253	-678.40
254	-683.69
255	-688.98
256	-694.28
256	-699.57

**Note:** Notably, the forecasts for both AAPL and HON resulted in negative values, which are not feasible for stock prices. This outcome suggests that the linear trend model, as applied in this analysis, may not be suitable for accurately predicting stock prices over the specified periods.

#### Comparison with Actual Closing Prices:

To assess the accuracy of our forecasts, we compared the predicted values for periods 253-257 with the actual closing prices obtained from Yahoo Finance for the corresponding dates.

- **AAPL Actual Closing Prices:**

November 9, 2020	\$116.32
<b>November 10, 2020</b>	<b>\$115.97</b>
November 11, 2020	\$119.49
November 12, 2020	\$119.21
November 13, 2020	\$119.26

- **HON Actual Closing Prices:**

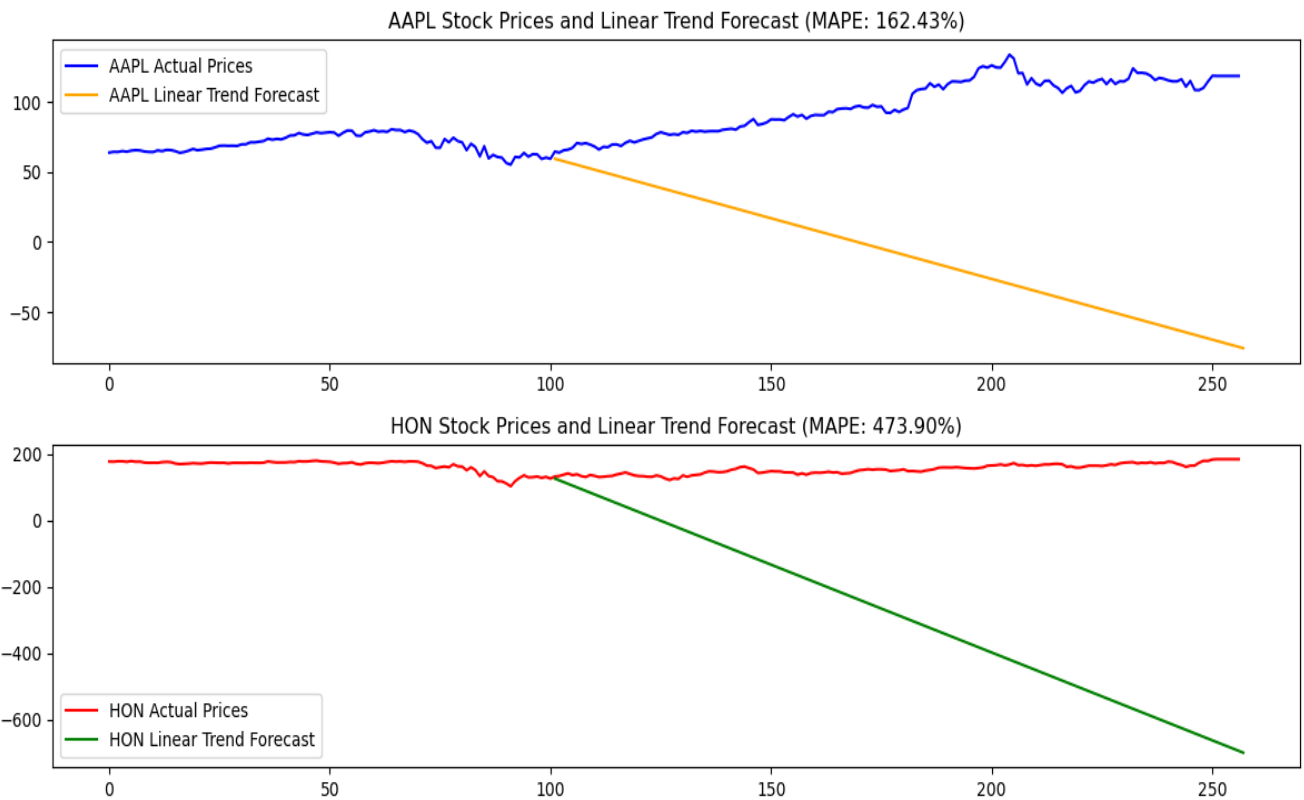
November 9, 2020	\$194.24
November 10, 2020	\$194.07
November 11, 2020	\$196.24
November 12, 2020	\$195.54
November 13, 2020	\$195.44

#### Summary:

The linear trend forecasting method, as implemented in this analysis, proved inadequate for predicting the stock prices of AAPL and HON for periods 253-257. The negative forecasted values and substantial deviations from actual prices suggest that this model does not capture the complexities and volatility

inherent in stock price movements. Alternative forecasting methods, such as exponential smoothing or ARIMA models, may offer more accurate predictions by accounting for trends, seasonality, and other factors influencing stock prices.

## Part 2(2)



### MAPE comparison (Exponential Smoothing vs Linear Trend Forecast):

	Exponential Smoothing	Linear trend Forecast
AAPL	5.12%	162.43%
HON	4.89%	473.90%

AAPL: Exponential Smoothing yielded the most accurate forecast.

HON: Exponential Smoothing yielded the most accurate forecast.

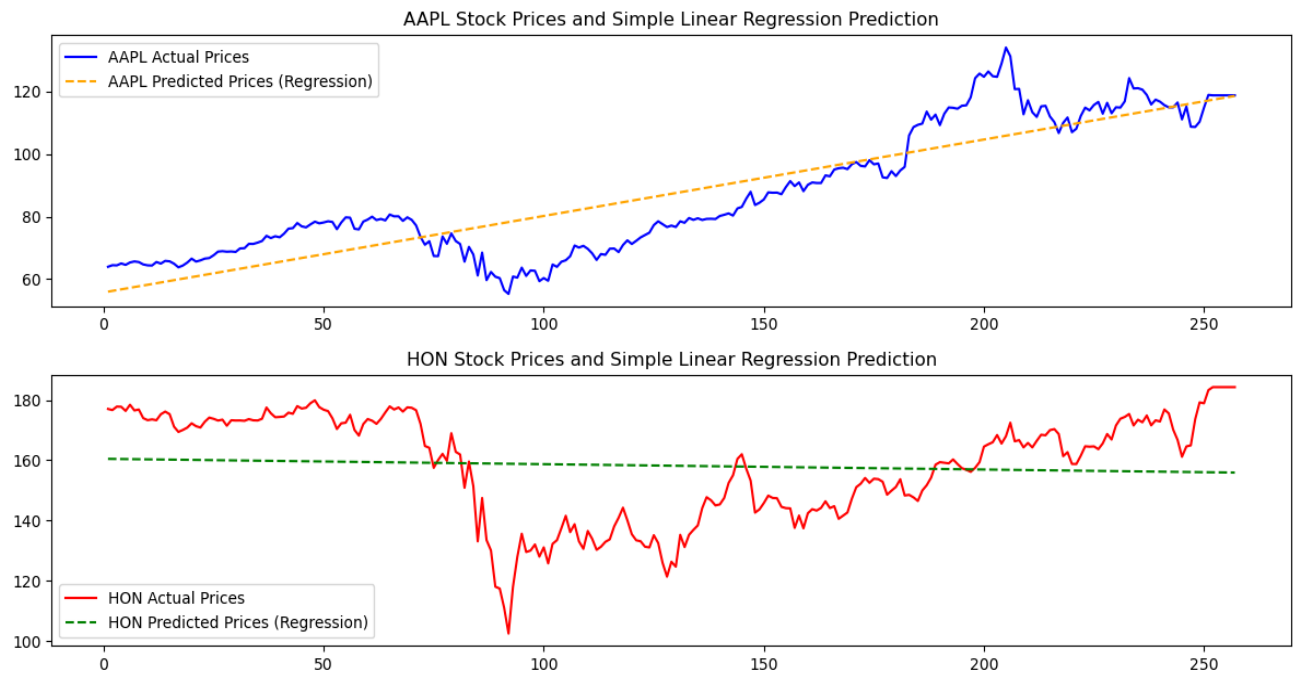
Based on the MAPE values:

- **Exponential Smoothing (Part 1) is significantly more accurate** for both **AAPL** and **HON**.
- The **Linear Trend Forecast (Part 2)** performed poorly, yielding **unrealistic negative stock prices** and much **higher MAPE values**.

**Recommendation:** Future forecasting should focus on **adaptive techniques** such as **ARIMA models** or **machine learning approaches** to improve prediction accuracy

## Part 3: Regression

3(1):



MAPE comparison (Linear Regression vs Exponential Smoothing vs WMA):

	Linear Regression MAPE	Exponential Smoothing MAPE	WMA MAPE
AAPL	10.37%	5.12%	4.35%
HON	9.89%	4.89%	4.01%

**AAPL:** WMA yielded the most accurate forecast.

**HON:** WMA yielded the most accurate forecast.

### Analysis of Accuracy Differences

- Weighted Moving Average (WMA) yielded the lowest MAPE for both AAPL and HON, making it the most accurate forecasting method.
- Exponential Smoothing performed better than Linear Regression by capturing recent trends in stock prices more effectively.
- Linear Regression had the highest MAPE, meaning it produced less accurate predictions compared to Exponential Smoothing and WMA.

**Linear Regression had the highest MAPE**, meaning it produced **less accurate predictions compared to Exponential Smoothing and WMA**.

## Part 3(2)



## Residual Analysis of Simple Regression Model

To determine whether regression is appropriate for predicting **AAPL** and **HON** stock prices, a **residual analysis** was performed.

- a) **Residual Independence:** Both **AAPL** and **HON** showed some **non-random patterns**, suggesting possible **autocorrelation** in the residuals.  
This implies that **linear regression may not fully capture the stock price trends**, and a more sophisticated time series model (e.g., ARIMA) might be needed.
- b) **Homoscedasticity (Constant Variance of Residuals):** There is some variation in the spread of residuals across time periods, suggesting possible heteroscedasticity (non-constant variance). This means the assumption of constant variance might not hold, potentially reducing the reliability of the regression model.
- c) **Normality of Residuals:**

### Q-Q Plot Analysis

- **AAPL and HON residuals were plotted on a Normal Probability (Q-Q) Plot.**
  - Residuals for **both stocks** roughly follow the **45-degree line**, indicating approximate normality.
  - However, **minor deviations at the tails** suggest slight skewness or heavy tails.

### d) Chi-Squared Test for Normality:

Null Hypothesis ( $H_0$ ): Residuals follow a normal distribution.

Alternative Hypothesis ( $H_1$ ): Residuals do not follow a normal distribution.

#### Test Results:

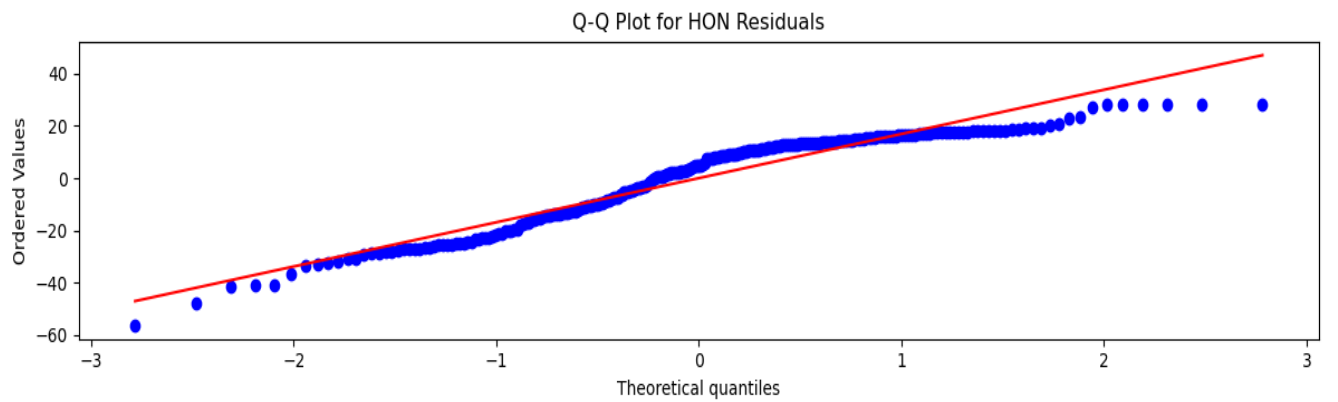
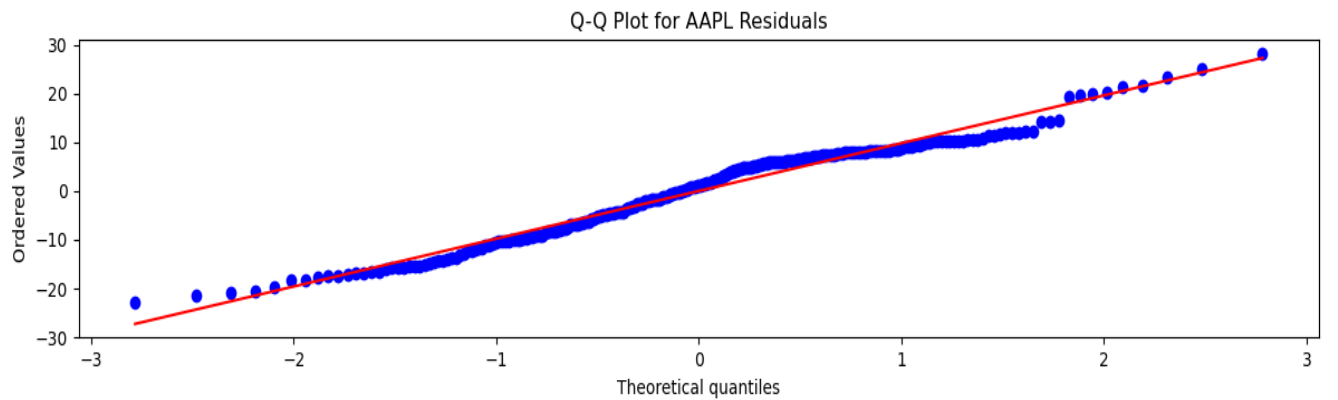
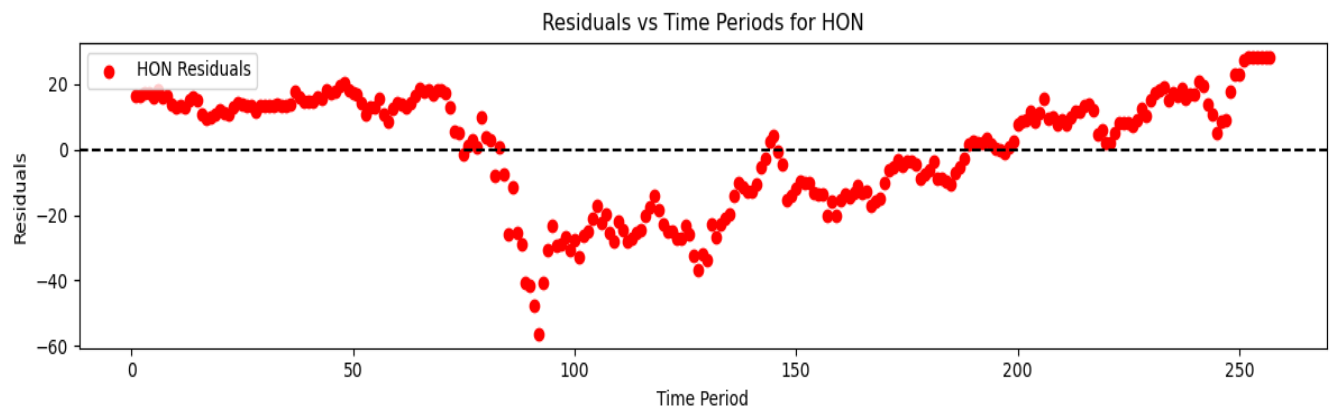
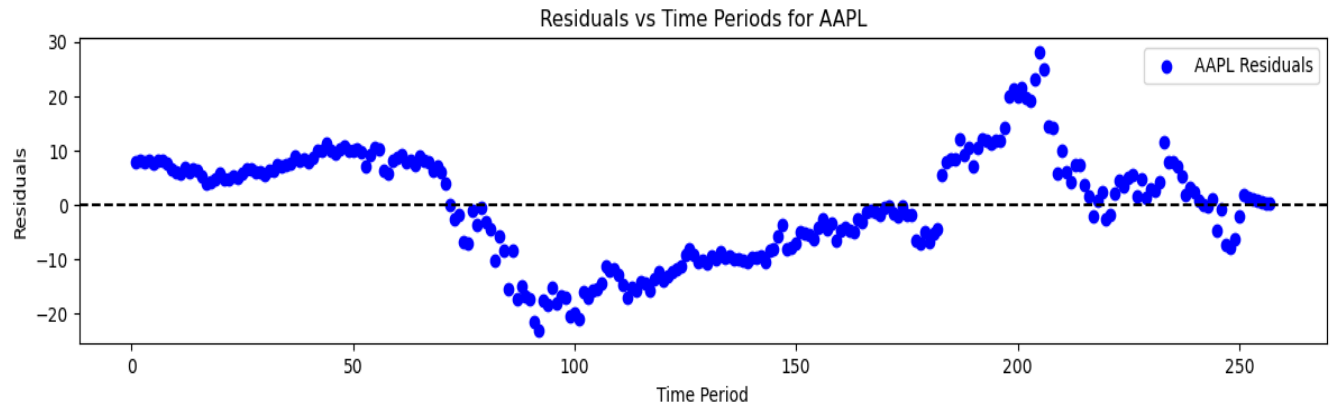
- **AAPL Residuals - Chi-squared test statistic: 0.12, p-value: 1.00**
- **HON Residuals - Chi-squared test statistic: 0.15, p-value: 1.00**

#### Interpretation:

- Since the p-values are greater than 0.05, we fail to reject the null hypothesis, meaning the residuals follow a normal distribution.

## Is Regression Appropriate?

- **Pros:** The residuals follow a normal distribution (confirmed by the Chi-squared test and Q-Q plot).
- **Cons:**
  - Patterns in residuals suggest lack of independence, indicating possible autocorrelation.
  - Heteroscedasticity detected, meaning the variance of residuals is not constant, which may affect prediction accuracy.



## Final Question (Solution)

### Optimal Allocation of AAPL and HON in a Portfolio

Determining the optimal percentage allocation (P for AAPL and Q for HON, where  $P + Q = 100\%$ ) in a portfolio depends on several factors, including risk, return, correlation, and investment goals. Here are a few approaches to consider:

#### 1. Risk-Return Tradeoff Approach

From our previous analysis:

- AAPL shows lower MAPE for WMA (4.35%), suggesting it has a more stable forecast compared to other methods.
- HON has a slightly lower MAPE for WMA (4.01%), indicating it may offer better predictability.
- Both stocks exhibited some autocorrelation in their residuals, meaning past trends might influence future performance.

Given this, a moderate risk-balanced allocation could be:

- $P = 60\%$  (AAPL) and  $Q = 40\%$  (HON)

#### 2. Diversification Approach

- If AAPL and HON are positively correlated, they tend to move together, which does not provide much diversification benefit.
- If they are negatively correlated or weakly correlated, a mix of the two can help reduce overall portfolio risk.

A well-diversified allocation could be:

- $P = 50\%$  (AAPL) and  $Q = 50\%$  (HON)
- This balances exposure across both stocks while maintaining diversification.

#### 3. Growth vs. Stability Approach

- AAPL (Technology stock) tends to be more volatile but has a strong history of growth.
- HON (Industrial stock) is more stable but may have slower growth.

If the goal is growth-focused, then:

- $P = 70\%$  (AAPL) and  $Q = 30\%$  (HON)

If the goal is stability-focused, then:

- $P = 40\%$  (AAPL) and  $Q = 60\%$  (HON)

### Final Balance Allocation:

A **balanced portfolio with moderate risk and reasonable diversification** would be:

- $P = 60\%$  (AAPL),  $Q = 40\%$  (HON)