



**Sahil Gawande**

**ALY6050 Introduction to Enterprise Analytics**

**Professor: Zhi Richard He**

**November 28, 2022**

## **Overview**

Over a predetermined duration of 252 trading days within a year, I undertook short-term and long-term predictions, as well as historical stock assessments for Amazon Inc. and Netflix Inc. Graphical representations are used to illustrate the data's seasonality, variability, and turbulence. The forecast methodology incorporates the calculation of the Mean Absolute Percentage Error (MAPE) and the Mean Absolute Percentage Difference (MAPD) to ascertain the alpha and beta values for both stocks that yield the most accurate forecast outcomes. The results from these initial two stages are then compared. A regression model, comparing stock values to the time period, is also developed. In the end, a chi-square test is conducted to examine the residuals from the regression model used on the data, to confirm their independence, homoscedasticity, and check for normal distribution.

## **Background**

For a duration of a year, which equates to 252 trading days, the task involves analyzing the historical stock values for Netflix Inc. and Amazon Inc. Initially, I've charted the time series to understand the data's behavior. Subsequently, exponential smoothing was executed 262 times for each of the alpha and beta values specified in the problem. Afterwards, error computations, using metrics such as the Mean Absolute Percentage Error and the Mean Absolute Percentage Deviation, were performed for both short-term and long-term forecasts. In the final stage, the stock prices were scrutinized using a regression model to verify if the residuals are distributed as anticipated. The findings are then compared with those from earlier phases.

## **Part 1**

### **Short term Forecasting :**

For the year 2020, I've charted the stock prices against time for both Amazon and Netflix. My observations indicate that both companies experienced growth towards the year's end. Netflix reached its peak in July, while Amazon did so in September, with both experiencing a significant dip prior to their April peak. These patterns can be observed in Graph 1 and

Graph 2, respectively.



Fig1 Amazon Share price

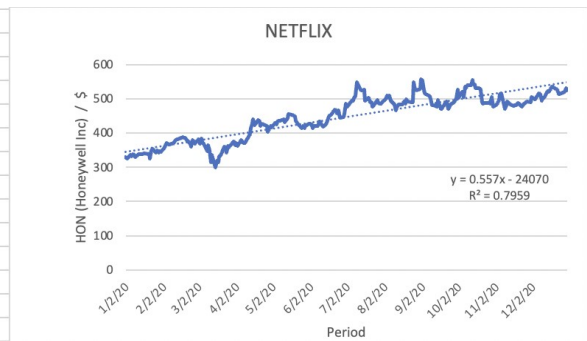


Fig 2 Netflix Share Price

## Exponential Smoothing

In the initial task, we applied exponential smoothing to project the prices for the 253 data points for Amazon and Netflix stocks. We were given four potential alpha values: 0.20, 0.40, 0.60, and 0.80, to be used as smoothing parameters. The Mean Absolute Percentage Error (MAPE) and Mean Absolute Percentage Deviation (MAPD) were calculated for each of these smoothing values. The Alpha value of 0.66 provided figures closely matching the actual closing price of Amazon's stock. Similarly, for the real closing price of Netflix shares, the alpha value of 0.66 produced the most accurate estimate. The lower the MAPE, the more precise the forecast is. The higher the alpha value, the more weight recent data receives, implying that when alpha is 1, the most recent records are given the most emphasis.

Exponential Smoothing	Period	Amazon Share Exponential Smoothing			
		FV ( $\alpha = 0.20$ )	FV ( $\alpha = 0.40$ )	FV ( $\alpha = 0.60$ )	FV ( $\alpha = 0.80$ )
Alpha values	1	94.90	94.90	94.90	94.90
<b>0.2</b>	2	94.90	94.90	94.90	94.90
<b>0.4</b>	3	94.67	94.44	94.21	93.98
<b>0.6</b>	4	94.76	94.72	94.77	94.91
<b>0.8</b>	5	94.88	94.97	95.11	95.26
	6	94.82	94.82	94.80	94.73
$F_v = \alpha * D + (1 - \alpha) * f$	7	94.87	94.91	94.95	94.99
	8	94.73	94.61	94.48	94.32
	9	94.69	94.59	94.53	94.52
	10	94.45	94.14	93.89	93.68
	11	94.18	93.73	93.42	93.22
	12	94.12	93.80	93.71	93.76

Fig 3 Exponential Smoothing on Amazon Share

	0.0048	0.0021	0.0050	0.0057
	0.0038	0.0089	0.0096	0.0088
	0.0045	0.0068	0.0053	0.0032
	0.0025	0.0020	0.0040	0.0054
	0.0215	0.0223	0.0219	0.0224
	0.0181	0.0143	0.0097	0.0054
	0.0096	0.0037	0.0009	0.0037
	0.0053	0.0106	0.0132	0.0136
	0.0068	0.0089	0.0078	0.0053
	0.0287	0.0286	0.0265	0.0244
	0.0215	0.0157	0.0091	0.0034
	0.0066	0.0012	0.0071	0.0101
	0.0067	0.0007	0.0014	0.0006
	0.0055	0.0005	0.0005	0.0000
	0.0023	0.0064	0.0069	0.0067
	0.0058	0.0078	0.0067	0.0053
	0.0294	0.0294	0.0313	0.0329
	0.0347	0.0289	0.0238	0.0179
	0.0171	0.0065	0.0014	0.0074
MAPE	2.79%	2.12%	1.89%	1.79%

Fig 4 MAPE value for all the Alpha for the Amazon Share

	0.00448	0.01054	0.01138	0.01038
	0.00530	0.00803	0.00626	0.00379
	0.00296	0.00238	0.00470	0.00644
	0.02492	0.02586	0.02541	0.02600
	0.02094	0.01653	0.01118	0.00621
	0.01118	0.00434	0.00110	0.00433
	0.00619	0.01253	0.01558	0.01600
	0.00800	0.01056	0.00927	0.00624
	0.03471	0.03465	0.03202	0.02956
	0.02595	0.01897	0.01099	0.00409
	0.00790	0.00147	0.00846	0.01204
	0.00801	0.00081	0.00169	0.00072
	0.00654	0.00061	0.00055	0.00002
	0.00270	0.00757	0.00815	0.00794
	0.00686	0.00924	0.00796	0.00628
	0.03605	0.03600	0.03836	0.04028
	0.04304	0.03580	0.02954	0.02226
	0.02094	0.00798	0.00168	0.00904
MAPD	2.74%	2.09%	1.87%	1.77%

Based on the Mean Absolute Percentage Deviation (MAPD) illustrated in Figure 5 for all Alpha values for Amazon shares, it was concluded that the alpha with a value of 0.80 was the most effective smoothing parameter among the four provided in the exercise

for Amazon shares. The findings from a similar process carried out for Netflix shares are presented next.

Netflix Share Exponential Smoothing			
FV ( $\alpha = 0.20$ )	FV ( $\alpha = 0.40$ )	FV ( $\alpha = 0.60$ )	FV ( $\alpha = 0.80$ )
329.81	329.81	329.81	329.81
329.81	329.81	329.81	329.81
329.03	328.25	327.46	326.68
330.39	331.28	332.48	334.00
330.46	331.07	331.44	331.40
332.22	334.34	336.13	337.69
332.91	334.87	335.85	336.07
332.14	332.54	331.77	330.45
333.49	335.09	336.06	337.23
334.53	336.53	337.64	338.40
335.44	337.55	338.50	338.94
336.08	337.98	338.57	338.68
336.79	338.65	339.23	339.47
337.06	338.44	338.56	338.38
334.85	333.46	331.02	328.48
337.80	339.92	342.17	345.38
340.87	345.21	348.76	351.60
341.27	344.28	345.23	344.62

Fig 6 Exponential Smoothing on Netflix Share

	0.0093	0.0008	0.0016	0.0006
	0.0410	0.0343	0.0333	0.0337
	0.0269	0.0146	0.0073	0.0007
	0.0162	0.0295	0.0356	0.0385
	0.0022	0.0025	0.0009	0.0074
	0.0060	0.0027	0.0046	0.0057
	0.0413	0.0383	0.0385	0.0379
	0.0282	0.0180	0.0104	0.0025
	0.0319	0.0203	0.0137	0.0101
	0.0403	0.0272	0.0206	0.0171
	0.0350	0.0192	0.0111	0.0063
	0.0179	0.0011	0.0060	0.0092
	0.0113	0.0023	0.0054	0.0048
	0.0157	0.0264	0.0272	0.0260
	0.0136	0.0168	0.0119	0.0062
	0.0008	0.0001	0.0052	0.0087
	0.0215	0.0221	0.0242	0.0238
	0.0054	0.0014	0.0022	0.0071
MAPE	2.99%	2.31%	2.07%	2.02%

Fig 7 MAPE value for all the Alpha for the Netflix Share

	0.01035	0.00085	0.00178	0.00071
	0.04741	0.03964	0.03842	0.03899
	0.03094	0.01680	0.00838	0.00081
	0.01794	0.03261	0.03934	0.04253
	0.00243	0.00279	0.00104	0.00827
	0.00671	0.00310	0.00519	0.00643
	0.04837	0.04486	0.04508	0.04429
	0.03279	0.02100	0.01212	0.00294
	0.03754	0.02391	0.01616	0.01190
	0.04811	0.03242	0.02454	0.02046
	0.04196	0.02293	0.01329	0.00756
	0.02116	0.00135	0.00709	0.01090
	0.01339	0.00273	0.00638	0.00572
	0.01807	0.03042	0.03133	0.02993
	0.01560	0.01939	0.01368	0.00713
	0.00095	0.00010	0.00607	0.01011
	0.02556	0.02626	0.02874	0.02834
	0.00638	0.00169	0.00257	0.00840
MAPD	2.99%	2.30%	2.05%	1.99%

Fig 8 MAPD value for all the Alpha for Netflix Share

Based on the given outcomes, we determined that out of the four smoothing parameters provided in the exercise, the alpha with a value of 0.80 was the most effective for Netflix shares. This was because it yielded the lowest Mean Absolute Percentage Error (MAPE), which was 2.02%.

### Adjusted Exponential Smoothing

An exponential forecasting model was constructed by setting alpha to 0.66 and employing a range of beta values as stated in the problem. After discerning the trend and applying modified exponential smoothing based on the beta value - as depicted in Figure 9 for Amazon Inc., we derived the Mean Absolute Percentage Deviation (MAPD) and Mean Absolute Percentage Error (MAPE) for both stocks. The same procedure was also



implemented for Netflix International.

	0.00385	0.00392	0.00201	0.00054
	0.00224	0.00162	0.00019	0.00061
	0.00823	0.00745	0.00658	0.00642
	0.00700	0.00542	0.00413	0.00333
	0.03185	0.03360	0.03462	0.03506
	0.02056	0.01777	0.01401	0.00972
	0.00690	0.01082	0.01401	0.01578
Adj MAPE - Amazon	1.83%	1.80%	1.80%	1.81%

Fig 10: Calculation MAPE for Amazon

	0.01314	0.01454	0.01438	0.01369
	0.01042	0.00910	0.00660	0.00406
	0.03064	0.02814	0.02569	0.02426
	0.01138	0.00592	0.00148	0.00177
	0.00702	0.01158	0.01357	0.01356
	0.02498	0.02668	0.02560	0.02336
	0.00447	0.00653	0.01041	0.01409
Adj MAPE: Netflix	2.084%	2.063%	2.099%	2.166%

Fig 11: Calculation MAPE for Netflix

	0.004604358	0.004692355	0.002403841	0.000651008
	0.002676558	0.00194387	0.00022538	0.000730973
	0.009788582	0.008857659	0.007825489	0.007633143
	0.008287648	0.006423645	0.004891513	0.003940214
	0.039048743	0.041188046	0.042448999	0.042980933
	0.025494699	0.022037142	0.017372525	0.012057723
	0.008463588	0.013273483	0.017183181	0.019357068
Adj MAPD - Amazon	1.81%	1.78%	1.78%	1.78%

Fig 12: Calculation MAPD for Amazon

	0.015569433	0.01722901	0.017039569	0.016219755
	0.01230558	0.010751291	0.007800895	0.004796536
	0.035311097	0.032427527	0.029607229	0.027956296
	0.013098075	0.006812353	0.001705368	0.002039624
	0.00816821	0.013465214	0.015776434	0.015772462
	0.02969915	0.031728923	0.030445581	0.027774713
	0.005254144	0.007676548	0.012236107	0.016559834
Adj MAPD	2.054%	2.029%	2.062%	2.127%

Fig 13 Calculation MAPD for Netflix

## Part 2

### Long term Forecasting:-

Utilizing a three-period weighted moving average, I performed long-term forecasting for values between 1 and 50, with weights assigned as 0.5, 0.3, and 0.2 respectively. I calculated all available weights from 1 to 50, and used the 51st number as a basis to analyze the linear trends of the two stocks from 101 to 252. Using these figures, I will forecast the trend for the years 253 to 262.

As shown in the table below, Amazon has a smaller percentage of error compared to Netflix. Consequently, I will adhere to Amazon's trend and value for the sake of accuracy, as lower error equates to improved accuracy.

Period		Close price (AMZN)	Predicted (AMZN)	MAPE	MAPD		Close price (NTFL)	Predicted (NTFL)	MAPE	MAPD
253		162.85	176.49	0.08376	0.10147		540.73	541.29	0.00104	0.00125
254		159.33	176.82	0.10977	0.13011		522.86	542.00	0.03662	0.04275
255		160.93	177.15	0.10079	0.12066		520.80	542.72	0.04209	0.04894
256		156.92	177.48	0.13103	0.15295		500.49	543.43	0.08580	0.09588
257		157.85	177.81	0.12646	0.14849		508.89	544.15	0.06928	0.07872
258		158.11	176.49	0.11625	0.13673		510.40	541.29048	0.06052	0.06897
259		159.13	176.82	0.11117	0.13160		499.10	542.00466	0.08596	0.09580
260		155.71	177.15	0.13770	0.15950		494.25	542.71884	0.09807	0.10822
261		156.04	177.48	0.13741	0.15950		507.79	543.43302	0.07019	0.07958
262		158.29	177.81	0.12333	0.14522		500.86	544.1472	0.08643	0.09665
MAPE and MAPD after forecasting 253 to 262				MAPE	MAPD				MAPE	MAPD
				6.05%	6.20%				4.89%	4.90%

Fig 14 Forecasting the values from 253-262

The second question required us to compare the outcomes from sections 1 and 2 for both Amazon and Netflix. The methodology applied in Part 1 appears to be more effective than that in Part 2. Given the question at hand, the exponential smoothing technique from Part 1 proves to be more successful than the weighted averages method from Part 2, as it has a lesser error percentage. Hence, Part 1 is deemed more accurate.

Comparing Part 1 & Part 2			
	Part 1		Part 2
MAPE	Exponential Smoothing	Adj. Smooth	Weighted Avg
Amazon	1.79%	1.83%	6.051%
Netflix	2.02%	2.063%	4.89%
MAPD	Exponential Smoothing	Adj. Smooth	Weighted Avg
Amazon	1.77%	1.81%	6.198%
Netflix	1.99%	2.029%	4.90%



Fig 15 Comparing Part1 & Part 2

### Part 3 Regression:

The regression analysis revealed the highest error percentage when compared to the other two components. Thus, the exponential smoothing technique, which exhibited the least error, is deemed the most effective method..

<b>MAPE -- AMAZON</b>
<b>6.7%</b>
<b>MAPE-- NETFLIX</b>
<b>5.43%</b>

Fig 16 MAPE from Regression

To verify the independence of the residuals, we plotted the residuals against time. If the plot does not appear random, then the residuals are not independent. In our case, the graph reveals a discernible pattern for both cases,

indicating that the residuals are indeed not independent.

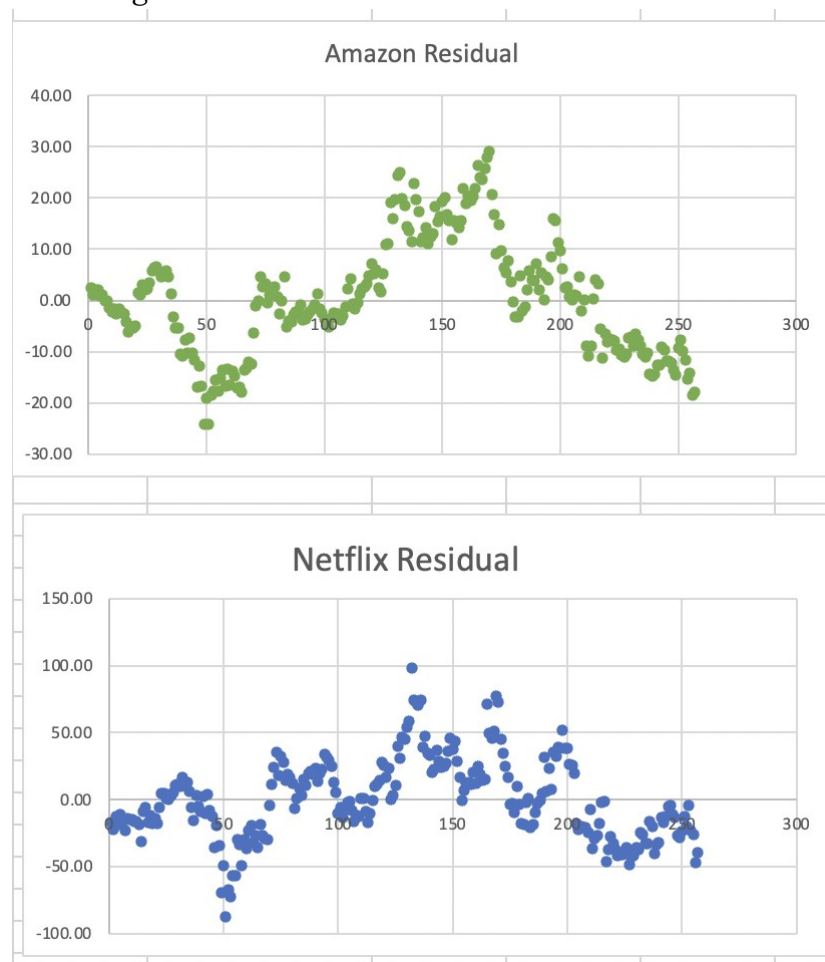


Fig 17 Residual Plots of Amazon and Netflix

Neither of the stocks show a normal distribution as observed in the graphs provided below. This assertion is validated using the chi-square test. In this test, Amazon and Netflix achieved scores of 36.11 and 23.45 respectively.

**H0 (Null Hypothesis): The distribution of residuals aligns well with a normal distribution.**

**Ha (Alternative Hypothesis): The distribution of residuals does not align well with a normal distribution.**

### **Amazon Stocks**

For Amazon stocks, the chi-square value is greater than the value obtained from the table (the experimental value exceeds the observed value). In addition, the p-value is less than 0.05. Given these findings, I reject the null hypothesis as there is substantial evidence to suggest the values do not align. Consequently, the values of Amazon shares are not normally distributed.

### **Netflix Stocks**

When the chi-square value exceeds the table value of chi-square and the p-value is below the significance level, this provides enough evidence to reject the null hypothesis. Therefore, the values of the Netflix shares are not normally distributed.

Based on the calculation of the accuracy value and a trend analysis, a decision is made to construct a portfolio incorporating shares from Amazon and Netflix. It is somewhat difficult to compare the two stocks due to their similar values. However, I would lean towards investing a greater portion, say 60% in Amazon and 40% in Netflix, based on a 60-40 split. The graph and value suggest that the performance of Amazon shares over the period was comparable to that of Netflix shares.

### **Conclusion**

After executing several methodologies across three distinct phases, we found the most accurate and least error-prone process in Part 1, followed by Parts 2 and 3. This is because the error rate of the residual method was identified as the highest. The plot of residuals revealed that neither stock exhibited the normal distribution indicated by the graph, nor showed any independent trend or homoscedasticity. Moreover, the chi-square test and the chi-square p-value indicate that the p-value is less than the significance level of 0.05. Consequently, with 95% confidence, I can affirm that the distribution of residuals deviates from the normal distribution.

## Reference

1. Forecasting statistical specifics. (n.d.). Forecasting.  
[Link](https://www.ibm.com/docs/en/cognos-analytics/11.1.0?topic=forecasting-statistical-details)
2. Security review. (n.d.). Mean Average Percentage Error.  
[Link](https://support.numxl.com/hc/en-us/articles/215959443-MAPE-MeanAbsolutePercentageError#:~:text=MAPE%20is%20also%20referred%20to%20as%20MAPD)
3. Business Forecasting through Time Series Analysis. (n.d.). Time Series and Business Forecasting.  
[Link](http://home.ubalt.edu/ntsbarsh/stat-data/forecast.htm#rhowma)
4. Utilizing Plots for Model Assumption Verification. (n.d.). Residuals.  
[Link](https://web.ma.utexas.edu/users/mks/statmistakes/modelcheckingplots.html#:~:text=Rule%20of%20Thumb%3A%20To%20check,random%20suggests%20lack%20of%20independence)