SCMA 669
Forecasting Methods

Take-at-Home Exam
Due May 11, 2021

SCMA-669-902-2021Spring
Bryce Bowles

Instructions:

1. You may not discuss this test or general topics which may significantly apply to the test with anyone except the instructor.

2. You may use passive support materials (notes, text, internet, etc.), but you may not use any active sources, that is, either human or electronic sources that answer specific questions.

3. A Word copy of the test is posted on Blackboard under Assignments. You may insert your answers in the Word document.

4. An Excel document (Data File '21) containing data for the exam is also posted on Blackboard. You can download the file. You do not need to include the data or your Excel worksheets with the test, just the results requested.

5. **The completed test is due May 11.** Please e-mail your completed exam to my VCU e-mail (swcuster@vcu.edu). I will acknowledge receipt of your test within 24 hours.

6. If you have questions call (702-526-8154) or e-mail (swcuster@vcu.edu).

I pledge to comply with the above instructions and will neither give or receive any help on this test:

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1. Briefly discuss the differences and the relationship between forecasting, planning, and goal/objective setting.
    a. Goals should always be taken into consideration and most of the time promote forecasting and planning. Forecasting will help with planning but should be adjusted to reflect proper goals. Planning relies on the accuracy of a forecast while you may choose a particular forecast based on goal setting. A goal without a plan is a dream.

2. Nat Silver reviewed a large number of professional forecasts. He found that less than 50% of the future values fell within the forecasted 95% confidence intervals. Why is this?
    a. Because you cannot be sure that forecasting is accurate. Your confidence has been misplaced or you're lying/ignorant if you trust the confidence intervals. Forecasting underestimates the margin of Error. Statistical error from random variation in a series explain the majority of wrong predictions. Unanticipated unknown events may happen.

3. You are on the staff of the District Manager for the Mid-Atlantic Region of a major company. Over the last year, working with the District Manager and his sales managers, you've developed a time-series forecasting system for the District. Previously, sales had been forecast based on the sales managers' judgment. Your system has greatly improved forecasting. The Corporate Vice President of Sales asks you to implement a similar system in the other Districts. How do you response to the Vice President?
    a. I would respond to the Vice President and let him know that 1. Yes, I'd be glad to help and appreciate him for the opportunity and 2. I can develop the forecasts but I am not in position to implement it (I do not know that district well enough). I would advise him to first go to the subordinate managers of the other districts and let them know he'd like for them to improve. Mention the success that this district has had. Offer to them this district is willing to help if needed and reach out as they please. If they can do it themselves, great. If they need assistance, they will reach out that way they are responsible for the burden of the results (In this case I am the monkey on their back) and the resources needed.

4. You are doing a monthly production forecast for a manufacturer using classical decomposition and exponential smoothing. The historical production data shows three consecutive months with zero production. Checking with management you find the data is correct; the plant was closed those months due to a labor dispute.

Must you adjust for these three months? (You may adjust either the data or the forecast model. The question is not how you should adjust, but, given that the data is correct, should you adjust.)

a. I would first ask for the status of the labor dispute and the probability that it will happen again. Then, yes, I would try to adjust with the typical seasonality for that time period. However, with exponential smoothing, may not be affected as much depending on how far back the zero data was.

If you said you should adjust, what would the consequences be for your forecast if you had not adjusted?

b. Depending on how recent the labor dispute was, there could be a significant drop in the series if the zero production was in a more recent time frame therefore leading to not enough being produced – leading to lost sales. What are we manufacturing? It may be better to produce more if the product does not go bad. Probably need to catch up on production if it was stopped for so long. If it was not so recent, then you may be better off not adjusting as there would be less weight placed on those low values due to using exponential smoothing.

If you said you should not adjust, what would the consequences be for your forecast if you had adjusted?

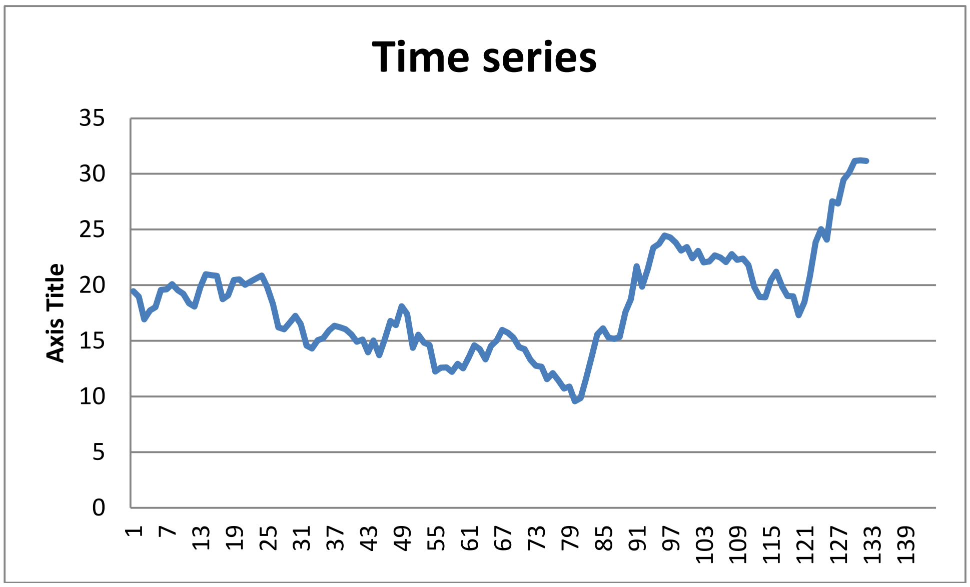
c. Possibility of overpredicting the data and having too much inventory to sell that could possibly expire or go bad.

5. You are creating a forecasting system for monthly demand of parts. A number of the part numbers have intermittent demand, that is, no demand most months and significant demand in those months where there is a demand. Both the quantity of the demand and the time between months with demand appear random. What is the best approach for forecasting these intermittent demand parts?
   a. Using Croston's method. Forecast the demand as the demand level (when there is an occurrence) multiplied by the weighted probability or intervals of having an occurrence.

6. You are developing a forecast for the time series shown below. You use Holt's Exponential Smoothing with a starting value equal to the first data point for L_1, and 0 for b_1. When you minimize the MSE to find α and β, you get α = 1.00, and β = 0.00.
   a. What does this tell you about the series?
      1. Using a 0 for b1 with a beta of 0 and alpha of 1 would have the series using a Naïve forecast. There must be a lot of variation in the dataset causing big errors.
      2. ES is a weighted moving average of all of the data. Alpha is how much we correct or adjust by the percentage of the

error. You are weighting the beginning of the data the same as the more recent data. ALPHA equal 1 sets the current smoothed point to the current point (i.e., the smoothed series is the original series).

b. What is your best forecast for the next 6 periods?
   1. Using the parameters described above such as Holt's Exponential Smoothing with a starting value equal to the first data point for L1, and 0 for b1 with alpha = 1.00, and beta = 0.00, I'd say my best guess forecast for the next 6 would be 31, 31, 31, 31, 31, 31



7. Series 1 on the Final Exam Worksheet (Data File '21) gives 56 months of monthly data. Calculate the 12 month multiplicative seasonal indexes (or factors) for the series and the seasonal adjusted series. You do not need to create a forecast. Multiplicative seasonal factors are usually appropriate when there is a meaningful zero for the data series. For example revenue, sales or production quantities. We used multiplicative factors for most of the examples we did in class.
   a. 12-month multiplicative seasonal indexes (or factors)
   b. seasonal adjusted series

a)

	0	1	2	3	4		Averages	Month	Adj factors
Jan		100.31	93.98	88.28	109.33		97.9750	Jan	0.8596
Feb		89.27	82.40	94.67	108.90		93.8100	Feb	0.8231
Mar	88.54	88.39	107.19	105.86	109.44		99.8840	Mar	0.8764
Apr	78.93	85.67	93.96	92.65	98.13		89.8680	Apr	0.7885
May	82.70	91.33	89.31	92.46	102.94		91.7480	May	0.8050
Jun	88.04	94.63	95.72	97.61	97.12		94.6240	Jun	0.8302
Jul	91.53	100.82	102.01	106.66	115.73		103.3500	Jul	0.9068
Aug	119.30	121.68	112.35	130.73	143.50		125.5120	Aug	1.1012
Sep	117.94	149.17	149.24	139.84	171.64		145.5660	Sep	1.2772
Oct	169.53	160.18	176.46	175.27	178.12		171.9120	Oct	1.5083
Nov	144.12	154.75	154.60	146.94			150.1025	Nov	1.3170
Dec	103.19	94.58	108.75	106.93			103.3625	Dec	0.9069
	1083.82	1330.78	1365.97	1377.90	1234.85	Sum	1367.7140		12.0000
						Ajdfac(Sum)	0.008773764		

b)

t	Month	data	CMA (12) Adj	Season Ratio	Adj Factors	Seasonal Adj Series
1	March	88.54			0.8764	\$101.03
2	April	78.93			0.7885	\$100.10
3	May	82.70			0.8050	\$102.74
4	June	88.04			0.8302	\$106.05
5	July	91.53			0.9068	\$100.94
6	Aug.	119.30			1.1012	\$108.34
7	Sept.	117.94	\$106.11	\$1.11	1.2772	\$92.35
8	Oct.	169.53	\$106.39	\$1.59	1.5083	\$112.40
9	Nov.	144.12	\$107.03	\$1.35	1.3170	\$109.43
10	Dec.	103.19	\$107.66	\$0.96	0.9069	\$113.79
11	Jan.	100.31	\$108.32	\$0.93	0.8596	\$116.69
12	Feb.	89.27	\$108.81	\$0.82	0.8231	\$108.46
13	March	88.39	\$110.21	\$0.80	0.8764	\$100.86
14	April	85.67	\$111.12	\$0.77	0.7885	\$108.65
15	May	91.33	\$111.17	\$0.82	0.8050	\$113.46
16	June	94.63	\$111.26	\$0.85	0.8302	\$113.98
17	July	100.82	\$110.63	\$0.91	0.9068	\$111.19
18	Aug.	121.68	\$110.08	\$1.11	1.1012	\$110.50
19	Sept.	149.17	\$110.58	\$1.35	1.2772	\$116.80
20	Oct.	160.18	\$111.71	\$1.43	1.5083	\$106.20
21	Nov.	154.75	\$111.97	\$1.38	1.3170	\$117.51
22	Dec.	94.58	\$111.93	\$0.84	0.9069	\$104.29
23	Jan.	93.98	\$112.03	\$0.84	0.8596	\$109.33
24	Feb.	82.40	\$111.69	\$0.74	0.8231	\$100.11

25	March	107.19	$111.30	$0.96	0.8764	$122.31
26	April	93.96	$111.98	$0.84	0.7885	$119.17
27	May	89.31	$112.66	$0.79	0.8050	$110.95
28	June	95.72	$113.24	$0.85	0.8302	$115.30
29	July	102.01	$113.59	$0.90	0.9068	$112.50
30	Aug.	112.35	$113.87	$0.99	1.1012	$102.02
31	Sept.	149.24	$114.32	$1.31	1.2772	$116.85
32	Oct.	176.46	$114.21	$1.55	1.5083	$116.99
33	Nov.	154.60	$114.29	$1.35	1.3170	$117.39
34	Dec.	108.75	$114.50	$0.95	0.9069	$119.92
35	Jan.	88.28	$114.77	$0.77	0.8596	$102.70
36	Feb.	94.67	$115.73	$0.82	0.8231	$115.02
37	March	105.86	$116.11	$0.91	0.8764	$120.80
38	April	92.65	$115.66	$0.80	0.7885	$117.50
39	May	92.46	$115.30	$0.80	0.8050	$114.86
40	June	97.61	$114.90	$0.85	0.8302	$117.57
41	July	106.66	$115.70	$0.92	0.9068	$117.63
42	Aug.	130.73	$117.17	$1.12	1.1012	$118.71
43	Sept.	139.84	$117.91	$1.19	1.2772	$109.49
44	Oct.	175.27	$118.29	$1.48	1.5083	$116.20
45	Nov.	146.94	$118.96	$1.24	1.3170	$111.57
46	Dec.	106.93	$119.37	$0.90	0.9069	$117.91
47	Jan.	109.33	$119.73	$0.91	0.8596	$127.19
48	Feb.	108.90	$120.64	$0.90	0.8231	$132.31
49	March	109.44	$122.50	$0.89	0.8764	$124.88
50	April	98.13	$123.94	$0.79	0.7885	$124.45
51	May	102.94			0.8050	$127.88
52	June	97.12			0.8302	$116.98
53	July	115.73			0.9068	$127.63
54	Aug.	143.50			1.1012	$130.31
55	Sept.	171.64			1.2772	$134.39
56	Oct.	178.12			1.5083	$118.09

8. Series 2 on the Final Exam Worksheet gives 132 months of monthly data. Create a 12 month forecast using Holt's Exponential Smoothing. Do not adjust the series for seasonality. For starting value of L and b use the first series value and the difference of the first two series values respectively. That is $L_1 = 5922$ and $b_1 = -281$. Determine α and β by minimizing MSE using all the data.
    a. What are α and β?

Alpha	Beta
0.338	0.1928

b. What are the final values for L and b?

L_t	b_t
$5,551.33	(42.7553)

c. What is the 12 month forecast?

Month	Holt's Exp Smooth FC
June	$5,508.58
July	$5,465.82
August	$5,423.06
September	$5,380.31
October	$5,337.55
November	$5,294.80
December	$5,252.04
January	$5,209.29
February	$5,166.53
March	$5,123.78
April	$5,081.02
May	$5,038.27

9. Series 2 (the same series you used on the previous problem) on the Final Exam Worksheet gives 132 months of monthly data. Create a 12 month forecast using Holt's Exponential Smoothing with a Damped Trend. Use a Damping Coefficient ϕ of 0.95.

As in the previous problem do not adjust the series for seasonality. For starting value of L and b use the first series value and the difference of the first two series values respectively. That is $L_1 = 5922$ and $b_1 = -281$. Determine α and β by minimizing MSE using all the data.

a. What are α and β?

Alpha	Beta
0.333	0.1523

b. What are the final values for L and b?

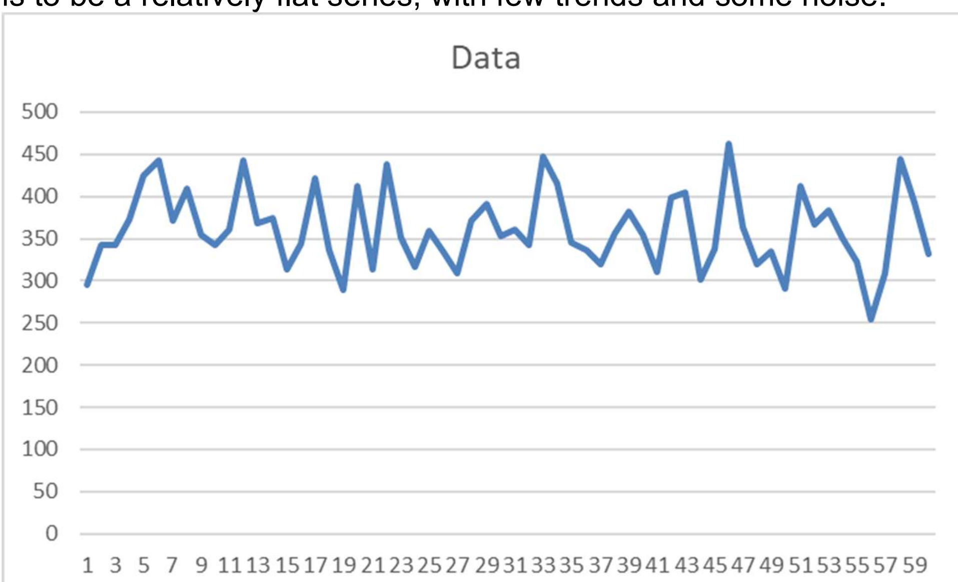
L_t	b_t
$5,562.35	-$32.68

c. What is the 12 month forecast?

Month	Holt's Exp Smooth Damp FC
June	$5,529.68
July	$5,497.00
August	$5,464.33
September	$5,431.65
October	$5,398.97
November	$5,366.30
December	$5,333.62
January	$5,300.95
February	$5,268.27
March	$5,235.60
April	$5,202.92
May	$5,170.24

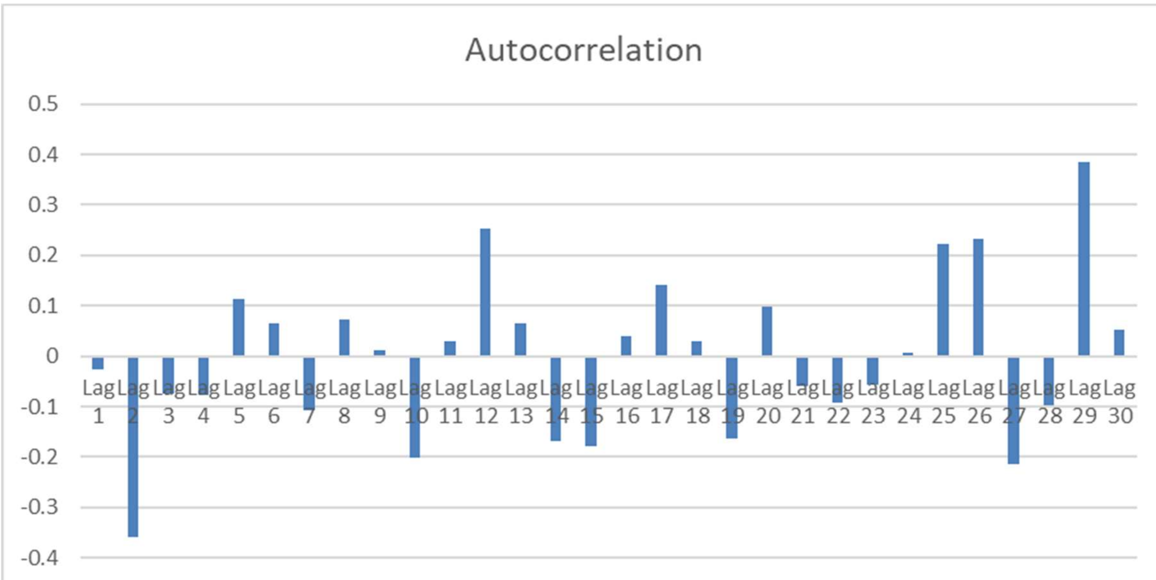
10. Series 3 on the Final Exam Worksheet gives 60 periods of data.
   a. Show the Autocorrelation chart for this data.

This seems to be a relatively flat series, with few trends and some noise.

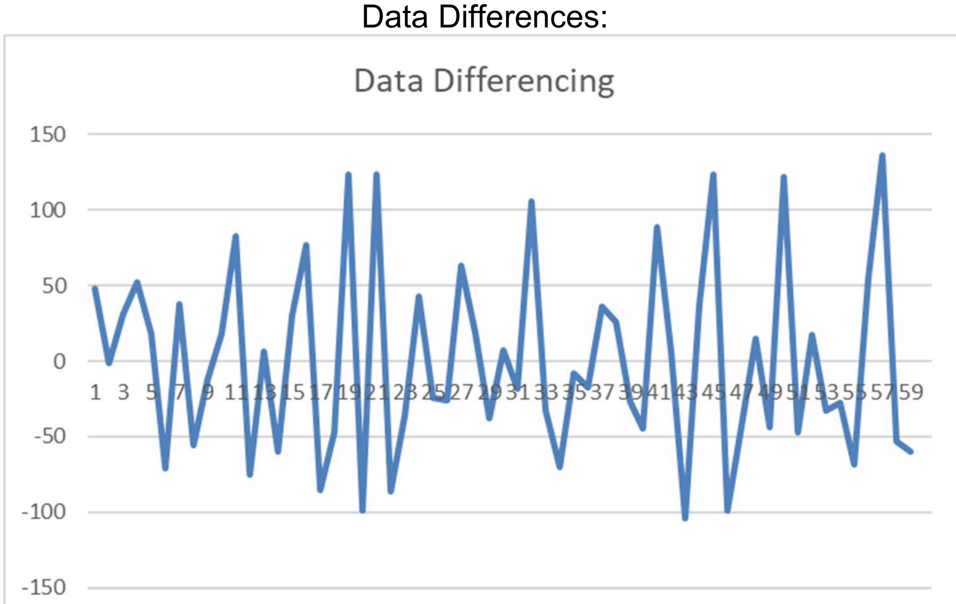


a. Does the chart indicate seasonality? If so, what is the period (length) of the seasonality?

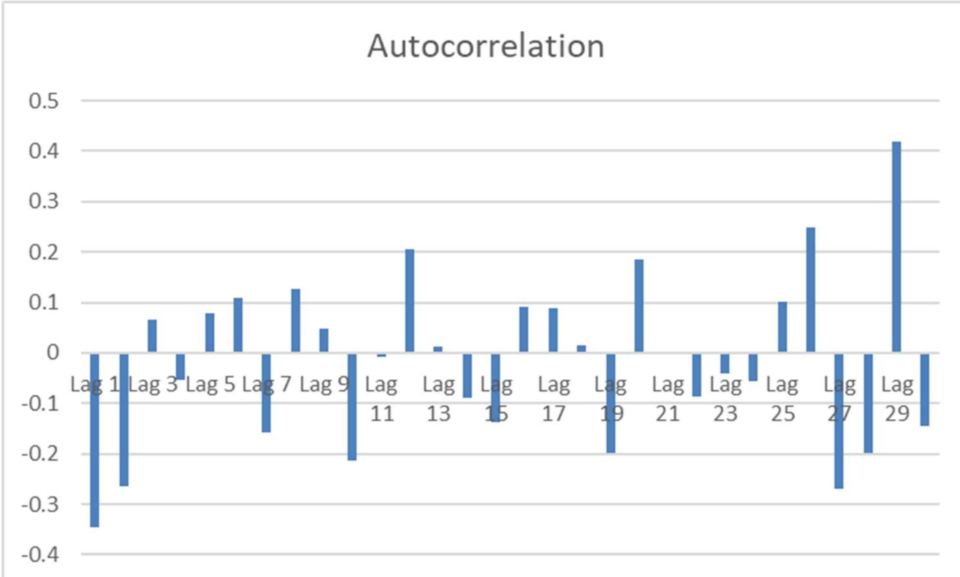
Correlation Chart: I extended the lag out to 30 to try to find some correlation but there does not appear to be any consistency in seasonality.



Data Differences:



Data Difference Autocorrelation chart:



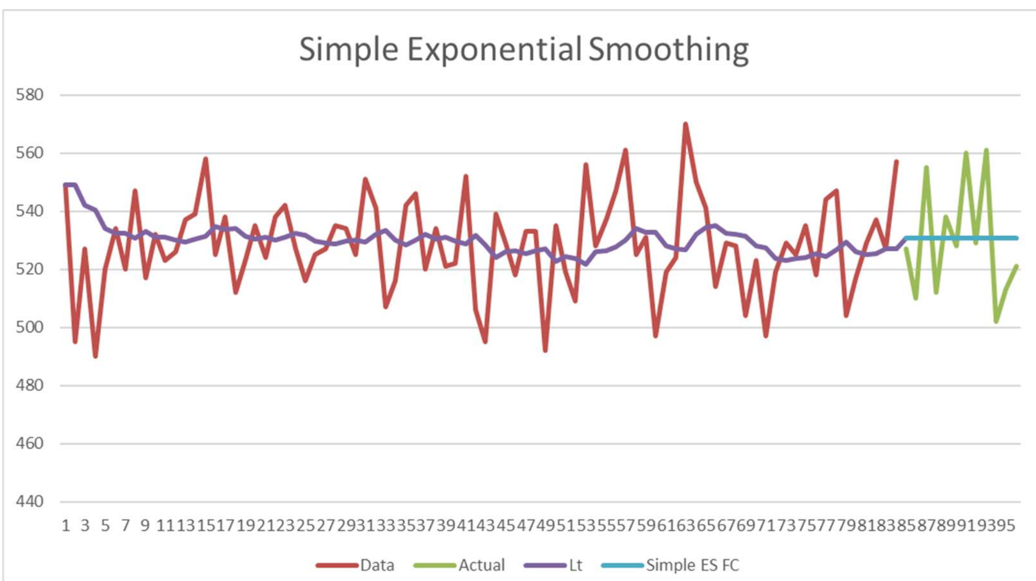
A Linear function may be the best we can do with this set of data.

11. Series 4 on the Final Exam Worksheet gives 60 periods of data. Make the last 12 periods out-of-sample data (periods 85 – 96). The first 84 periods are training data. Do not adjust for the seasonality.
    a. Using the training data, create a 12-period simple Exponential Smoothing forecast. Use the first data point as your starting value. Use MSE for all the training data to obtain α.
        i. α=0.1253

	FC:
85	530.75
86	530.75
87	530.75
88	530.75
89	530.75
90	530.75
91	530.75
92	530.75
93	530.75
94	530.75
95	530.75
96	530.75

b. Using the out-of-sample data do a Quick & Dirty Analysis of the goodness of fit for your forecast. Use MAPE as your measure of fit

Diff	ABS
3.75	0.71%
20.75	4.07%
-24.25	4.37%
18.75	3.66%
-7.25	1.35%
2.75	0.52%
-29.25	5.22%
1.75	0.33%
-30.25	5.39%
28.75	5.73%
17.75	3.46%
9.75	1.87%
MAPE	3.06%



12. Using the same data as the previous problem (Series 4) and your Simple Exponential Smoothing model, perform a complete analysis with your out-of-sample data. Use take-off points periods 84, 87 and 90. Make your forecasting horizons 2, 4, 6 & 8 periods. Show the MAPE for each take-off point and forecasting horizon.

		F/C Horizon		
F/C Takeoff Point	**2 Mo.**	**4 Mo.**	**6 Mo.**	**8 Mo.**
84	4.07%	3.66%	0.52%	10.42%
87	1.31%	5.18%	5.35%	3.50%
90	0.10%	5.49%	1.64%	
Average:	1.83%	4.78%	2.50%	6.96%

			Errors	**ABS(%**	**Errors)**
Period	Data	F/C	F/C	F/C	
82	537				
83	527	**Takeoff**	Alpha		
84	557	**84**	0.1253		
85	527	530.75	3.75	0.71%	
86	510	530.75	20.75	4.07%	2
87	555	530.75	(24.25)	4.37%	
88	512	530.75	18.75	3.66%	4
89	538	530.75	(7.25)	1.35%	
90	528	530.75	2.75	0.52%	6
91	560	530.75	(29.25)	5.22%	
92	529	530.75	1.75	0.33%	8
93	561	530.75	(30.25)	5.39%	
94	502	530.75	28.75	5.73%	
95	513	530.75	17.75	3.46%	
96	521	530.75	9.75	1.87%	
		Average	1.08	**3.06%**	
			=MAX(Q	5.73%	
			=MIN(Q(	0.33%	

			Errors	**ABS(%**	**Errors)**
Period	Data	F/C	F/C	F/C	
82	537				
83	527	**Takeoff**	Alpha		
84	557	**87**	0.1188		
85	527				
86	510				
87	555				
88	512	530.97	18.97	3.71%	
89	538	530.97	(7.03)	1.31%	2
90	528	530.97	2.97	0.56%	
91	560	530.97	#####	5.18%	4
92	529	530.97	1.97	0.37%	
93	561	530.97	#####	5.35%	6
94	502	530.97	28.97	5.77%	
95	513	530.97	17.97	3.50%	8
96	521	530.97	9.97	1.91%	
			1.64	**3.07%**	
			=MAX(V	5.77%	
			=MIN(W	0.37%	

			Errors	**ABS(%**
Period	Data	F/C	F/C	F/C
82	537			
83	527	**Takeoff**	Alpha	
84	557	**90**	0.1140	
85	527			
86	510			
87	555			
88	512			
89	538			
90	528			
91	560	529.55	(30.45)	5.44%
92	529	529.55	0.55	0.10%
93	561	529.55	(31.45)	5.61%
94	502	529.55	27.55	5.49%
95	513	529.55	16.55	3.23%
96	521	529.55	8.55	1.64%
			(1.45)	**3.58%**
			=MAX(A(	5.61%
			=MIN(AC	0.10%

I pledge that I have neither given or received on this test:

Bryce Bowles