A

Project

On

"FORECASTING DATA USING MOVING AVERAGE METHOD & WINTER'S METHOD FOR CAR SALES & ANALYSING DISCREPANCY IN A CERTAIN TIME PERIOD"

Being Submitted in Partial Fulfilment of the Degree of MBA (Tech)

For the Course

MARKETING ANALYTICS & STRATEGIC DECISION MAKING

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Introduction

In this report, we will be sharing our results after thorough analysis and forecasting possible data of Tata motors car sales in India. We briefly discuss about the data obtained , the interpretations and the evident discrepancies. After this, we show the procedure and results of our forecasting and state our remarks about the seasonality and trend of the same.

At First Glance

The number of cars sold in a given month for five consecutive years are taken and analysed. Data is taken from October 2012 & ends on September 2017. As evident the trend is basically same for the month of October and the trend is steady till December i.e. Decreasing steadily. In January, the sales trend increases upwards and this is mostly accredited to the launch of new cars in the beginning of the year. Although this trend is not the same in January 2013, reasons for this are stated in the discrepancy analysis

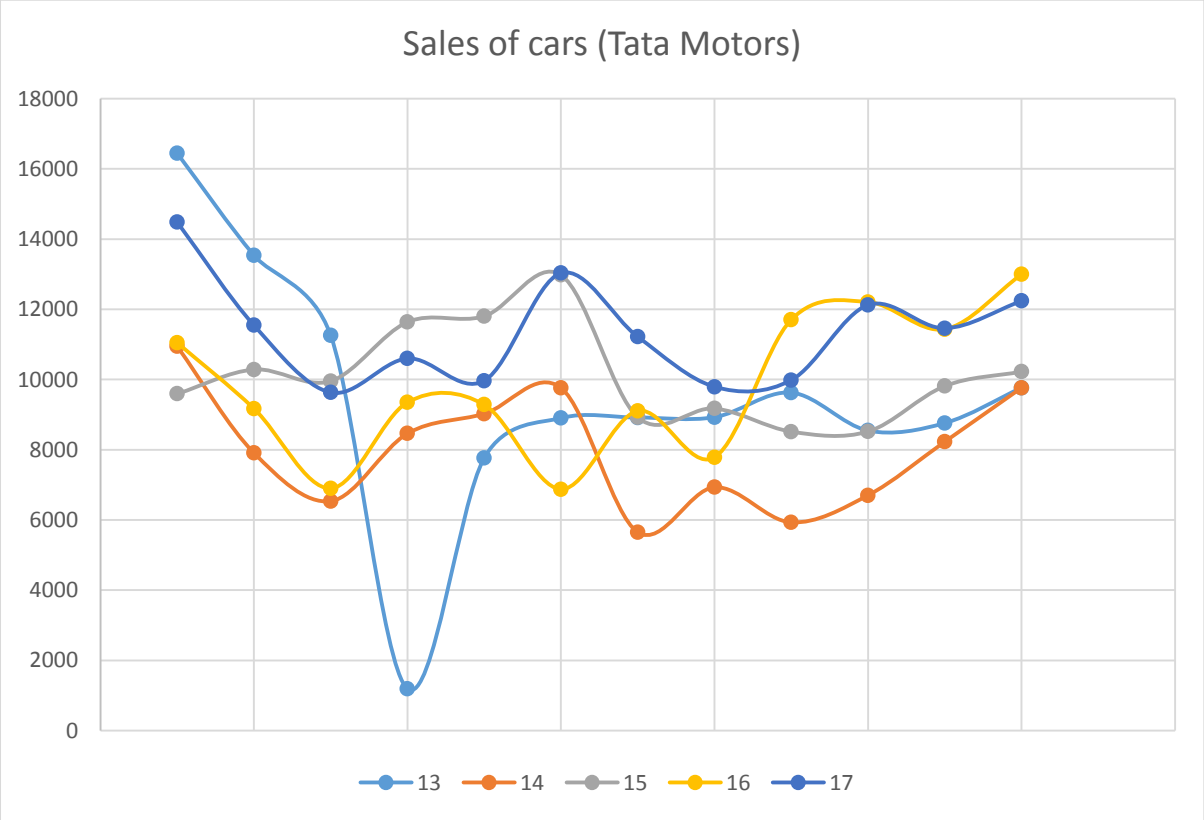

Fig. 1 - Sales of cars

	A	B	C	D	E	F
1		13	14	15	16	17
2	OCT	16444	10944	9594	11049	14483
3	NOV	13538	7910	10286	9172	11546
4	DEC	11257	6537	9956	6900	9632
5	JAN	1192	8463	11637	9350	10,600
6	FEB	7769	9026	11805	9284	9,967
7	MAR	8903	9761	12977	6876	13,032
8	APR	8918	5653	8925	9106	11220
9	MAY	8927	6932	9176	7787	9,794
10	JUN	9628	5933	8516	11705	9,985
11	JUL	8546	6703	8520	12209	12,125
12	AUG	8761	8229	9814	11435	11,462
13	SEP	9766	9765	10226	12997	12,238

Fig.2 - Sales of Cars Data

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Next, the trend observed in the months of February & March show steady increase and later in the months of April ,May and June a decrease in the sales trend is observed. In the months of July, August and September the sales increase and increase significantly compared to July.Although this trend is not observed in 2016,we can assume that the trend is fairly constant in comparison to the other years.

The data suggests that the years 2014,2015,2016 & 2017 are fairly seasonal but the year 2013 shows discrepancies. Therefore, using Winter's method to forecast data while the data is volatile will give incorrect forecasts. A better alternative would be using method of moving averages to forecast such volatile data.

Hence, to forecast the data, we analyse the data based on multiplicative trend and use moving averages and winter analysis to forecast data for the coming year.

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Initial Analysis

The data shows that buyers buy cars during February - March. This is mainly because of the festival discounts at that time. Sales then decrease till June and again increases during July. The reason being pre Diwali sales and other festive sales during this time period.

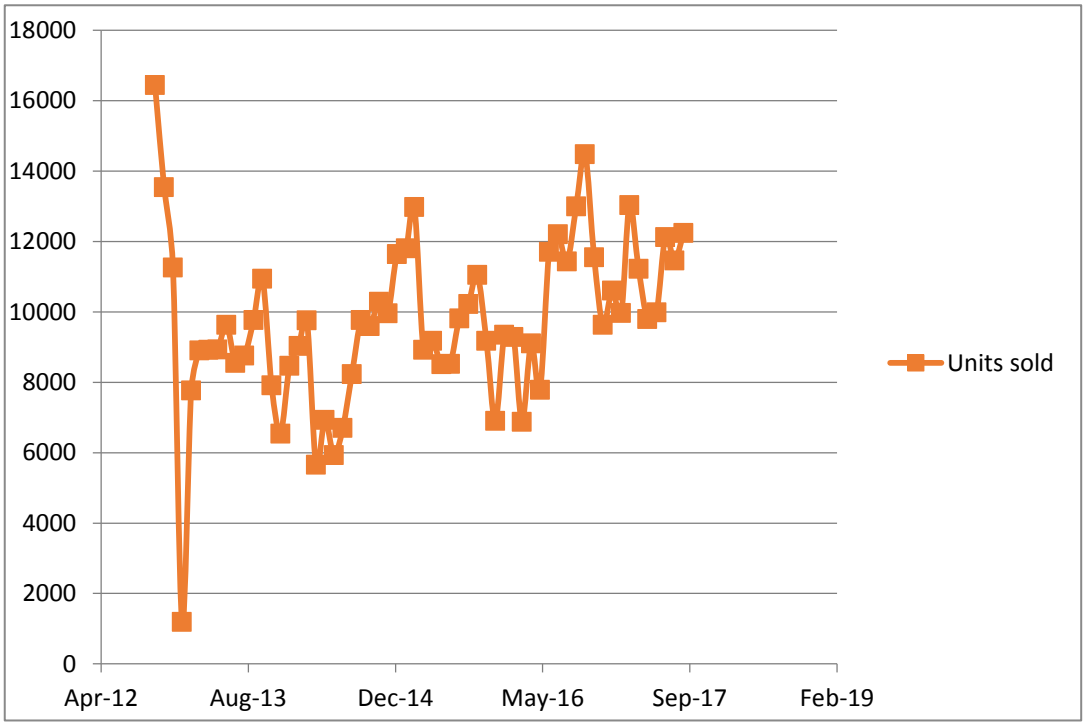


Fig.3 - Units sold

Apart from the dip in sales in 2013, the seasonality is fairly constant and therefore becomes an outlier as the highest and lowest values of sales fall in the same time period.

Discrepancy Analysis

As observed in the graph, in January 2013 the sales fell from approximately 12000 to approximately 1900. This drop in the number of units sold can be traced back to the Inflation in 2012 and 2013.

In 2012, Interest rates were lowered by the government to pump money into the economy. This changed buyer sentiment at that time and encouraged people to take loans or borrow money at very low interest rates. This ensured that buyers could take a car loan and easily obtain the required capital to buy a car. Therefore the sales in year 2012 increased.

Due to the increased flow of money in the economy, inflation became a concern and the government had to take steps to ensure that the CPI (Consumer Price Index) was lower than the previous year. To ensure the same, the government had to increase the interest rates which discouraged people from taking loans and stopped the money in the economy.

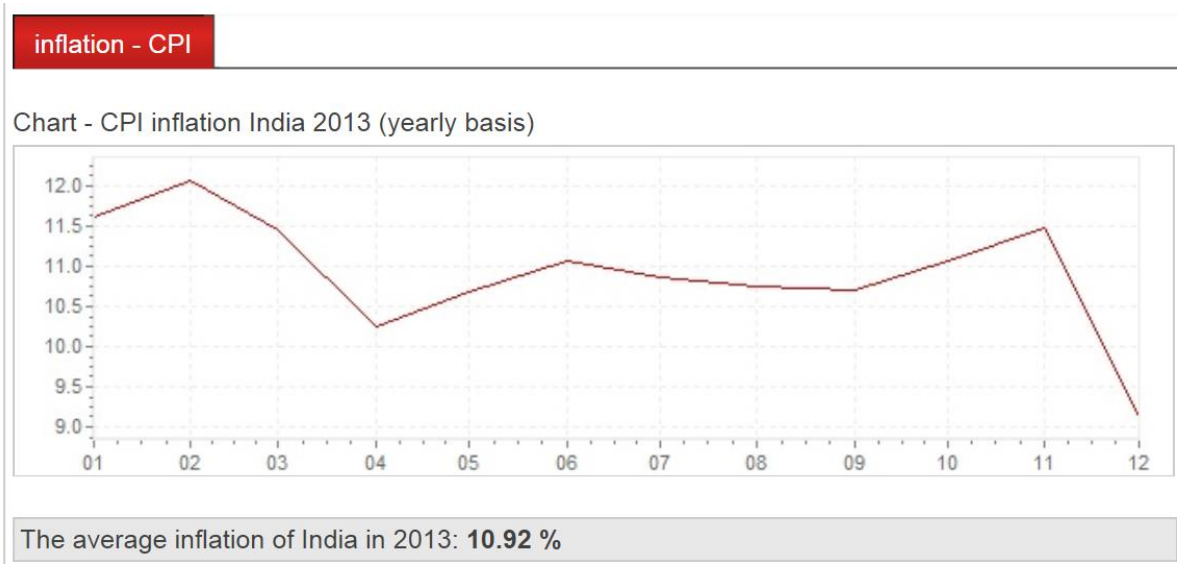


Fig.4 - CPI in 2013 compared to 2012

Other factors like labour unrest causing factory shutdowns, fall of rupee with respect to dollar and brokerages downgrading stocks were also reasons for the biggest decline in sales.

Multiplicative Trend

Multiplicative trend is a prerequisite to winter analysis and is basically used to forecast for the future. In this case we forecast the data for 2017-2018.To forecast the future sales, we use the formula "Predicted Period t Sales = Base * (Trend^t) * (Seasonal Index for Month t)"

Since the largest and smallest values of sales were in the same time period, we remove them as they are outliers. Because of these outliers only data for four years has been considered for the multiplicative trend analysis.

base	8.00494								
trend	1.008141988								
								stddeverrors	1.356909591
1	1.033046913							RSQ	0.547632639
2	1.020761152							SSE	86.54
3	1.082092087							86.54	
4	0.894884774	MonthNumber	Month	Month	Sales (in thousands)	Forecast	Error	Sq Error	
5	0.845893397	1	Oct-13	10	10.944	9.90842917	1.04	1.07	
6	0.908715804	2	Nov-13	11	7.91	8.361283297	-0.45	0.20	
7	0.9906934	3	Dec-13	12	6.537	7.073921395	-0.54	0.29	
8	1.006122624	4	Jan-14	1	8.463	8.542104958	-0.08	0.01	
9	1.099828726	5	Feb-14	2	9.026	8.509238492	0.52	0.27	
10	1.227792736	6	Mar-14	3	9.761	9.093948427	0.67	0.44	
11	1.027712137	7	Apr-14	4	5.653	7.581883166	-1.93	3.72	
12	0.86245625	8	May-14	5	6.932	7.225157308	-0.29	0.09	
		9	Jun-14	6	5.933	7.824947931	-1.89	3.58	
mean	1	10	Jul-14	7	6.703	8.600314803	-1.90	3.60	
		11	Aug-14	8	8.229	8.805371761	-0.58	0.33	
		12	Sep-14	9	9.765	9.70383813	0.06	0.00	
		13	Oct-14	10	9.594	10.92107143	-1.33	1.76	

Fig.5 – Multiplicative trend sheet

1		
2	base	8.00494
3	trend	1.008141988
4		
5	1	1.033046913
6	2	1.020761152
7	3	1.082092087
8	4	0.894884774
9	5	0.845893397
10	6	0.908715804
11	7	0.9906934
12	8	1.006122624
13	9	1.099828726
14	10	1.227792736
15	11	1.027712137
16	12	0.86245625
17		
18	mean	1

Fig.6 – Base, Trend and Seasonal Indices

The base is the best estimate of the level (without seasonality) of monthly car sales at the beginning of the observed time period or simply the lowest value under consideration.

The multiplicative trend suggests that the trend is increasing since the trend value is 1.008. The increase is 0.008% per month.

Seasonal indices are a type of forecasting tool used to determine demand for various commodities or goods in a given marketplace over the course of a typical year (or a shorter time period).

Seasonal Indices show how the demand will vary in comparison to an average season. In case of Car sales, in the 10^{th} month the seasonal index is 1.22 which indicates that the variation in demand is 22% when compared to an average season.

Next, we go on to use the winter's method to predict future sales values. The outliers are not considered for this method either.

Winter's Method of Forecasting

The Winter's method to forecast data is used to smoothen the constantly changing parameters that affect the forecast. In simpler words, it levels the irregularities. Exponential smoothing methods update time series parameters by computing a weighted average of the estimate of the parameter from the current observation with the prior estimate of the parameter.

Winter's Method is an exponential smoothing method that updates the base, trend, and seasonal indices after each equation:

1. Lt = Level of series
2. Tt = Trend of series
3. St = Seasonal index for current month

The smoothing parameters are given as:

(1) $Lt = alp(x_t) / (s_{t-c}) + (1-alp)(L_{t-1} * T_{t-1})$

(2) $Tt = bet(L_t / L_{t-1}) + (1-bet)T_{t-1}$

(3) $St = gam(x_t / L_t) + (1-gam)s_{(t-c)}$

	A	B	C	D	E	F	G	H	I	J
1	Dates	Sales						alpha	beta	gamma
2	Oct-13	10.944						0.466251071	0	0
3	Nov-13	7.91								
4	Dec-13	6.537								
5	Jan-14	8.463								
6	Feb-14	9.026								
7	Mar-14	9.761								
8	Apr-14	5.653								
9	May-14	6.932								
10	Jun-14	5.933								
11	Jul-14	6.703								
12	Aug-14	8.229								
13	Sep-14	9.765								
14	Oct-14	9.594						1.227792736		
15	Nov-14	10.286						1.027712137		
16	Dec-14	9.956						0.86245625		
17	Jan-15	11.637						1.033046913		
18	Feb-15	11.805						1.020761152		
19	Mar-15	12.977						1.082092087		
20	Apr-15	8.925						0.894884774		
21	May-15	9.176				SSE	37.81877584	0.845893397		
22	Jun-15	8.516				stderr		0.908715804		
23	Jul-15	8.52						0.9906934		
24	Aug-15	9.814	BASE	TREND	FORECAST	ERROR	SQ.ERR	1.006122624		
25	Sep-15	10.226	9.29781134	1.008141988				1.099828726		
26	Oct-15	11.049	9.19893184	1.008141988	11.50873242	-0.459732415	0.211353893	1.227792736		
27	Nov-15	9.172	9.11103725	1.008141988	9.530827067	-0.358827067	0.128756864	1.027712137		
28	Dec-15	6.9	8.6327987	1.008141988	7.92184971	-1.02184971	1.04417683	0.86245625		
29	Jan-16	9.35	8.86525316	1.008141988	8.990696995	0.359303005	0.129098649	1.033046913		
30	Feb-16	9.284	9.01098028	1.008141988	9.122985376	0.161014624	0.025925709	1.020761152		
31	Mar-16	6.876	7.8114868	1.008141988	9.830100633	-2.954100633	8.726710551	1.082092087		

Fig.7 – Initializing Winter's Method

We minimize the sum of squared errors and make sure that the values of the parameters lie between 0 and 1.

The smoothing parameters smoothen the curve obtained and sales is better predicted.

1.227792736
1.027712137
0.86245625
1.033046913
1.020761152
1.082092087
0.894884774
0.845893397
0.908715804
0.9906934
1.006122624
1.099828726

Fig.8 – Seasonal Indices Winter's Method

The forecast is obtained based on these values. The forecasted values are sales from October 2017 to September 2018.

	forecast	
1	Oct-17	14.21686854
2	Nov-17	11.99698392
3	Dec-17	10.14984401
4	Jan-18	12.25643148
5	Feb-18	12.20927383
6	Mar-18	13.04823066
7	Apr-18	10.8786806
8	May-18	10.36684118
9	Jun-18	11.22743617
10	Jul-18	12.33995246
11	Aug-18	12.63417345
12	Sep-18	13.92331606
	total	145.2480324

Fig.9 – Forecasted Values Winter's Method

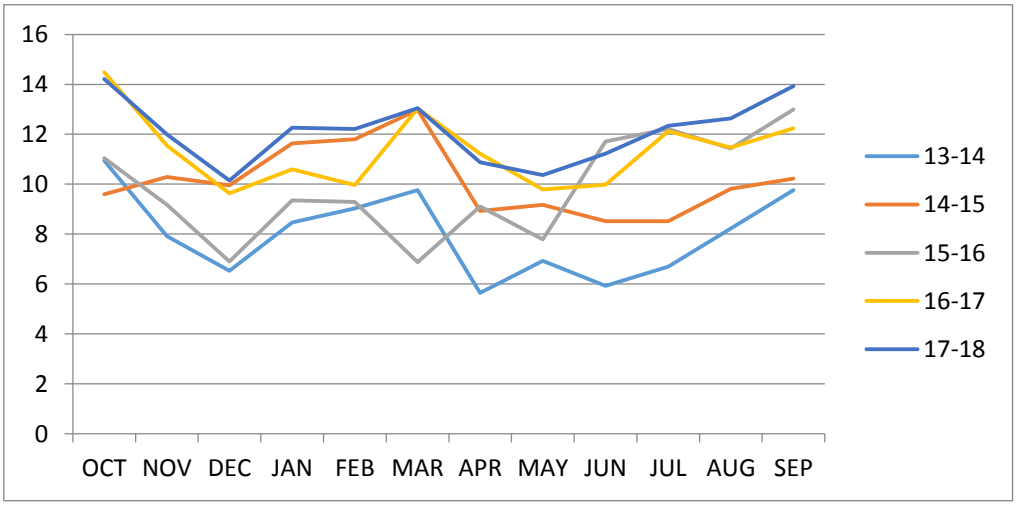


Fig.10 – Final Graph for Winter's Method

Moving Average Method

Now we proceed to forecast data based on moving averages method the only difference being that the outliers will be considered.

Applying the Ratio to Moving Average Method involves the following tasks:

1. Compute monthly moving averages and then determine the centered moving averages.
2. Fit a trend line to the centered moving averages.
3. Compute seasonal indices.
4. Compute forecasts for future periods.

In this case, we apply this method to forecast sales after analysing sales for five years. The sales are given month-wise to improve the forecast efficiency. We calculate the moving average (MA) and the centered moving average (CMA).The CMA acts as a baseline in the analysis & is used to forecast data.

		t		Units sold	MA	Centered Moving Average (Also called Baseline)	S_t, I_t (Units sold/ baseline)
2	Oct-12	1	1	16444			
3	Nov-12	2	2	13538			
4	Dec-12	3	3	11257			
5	Jan-13	4	4	1192			
6	Feb-13	5	5	7769			
7	Mar-13	6	6	8903	9470.75	9241.583333	0.96336306
8	Apr-13	7	7	8918	9012.416667	8777.916667	1.015958608
9	May-13	8	8	8927	8543.416667	8346.75	1.069518076
10	Jun-13	9	9	9628	8150.083333	8453.041667	1.13899829
11	Jul-13	10	10	8546	8756	8808.375	0.970213008
12	Aug-13	11	11	8761	8860.75	8896.5	0.984769291
13	Sep-13	12	12	9766	8932.25	8796.208333	1.110251103
14	Oct-13	13	1	10944	8660.166667	8577.041667	1.275964421
15	Nov-13	14	2	7910	8493.916667	8339.958333	0.948445985
16	Dec-13	15	3	6537	8186	8109.208333	0.806120614

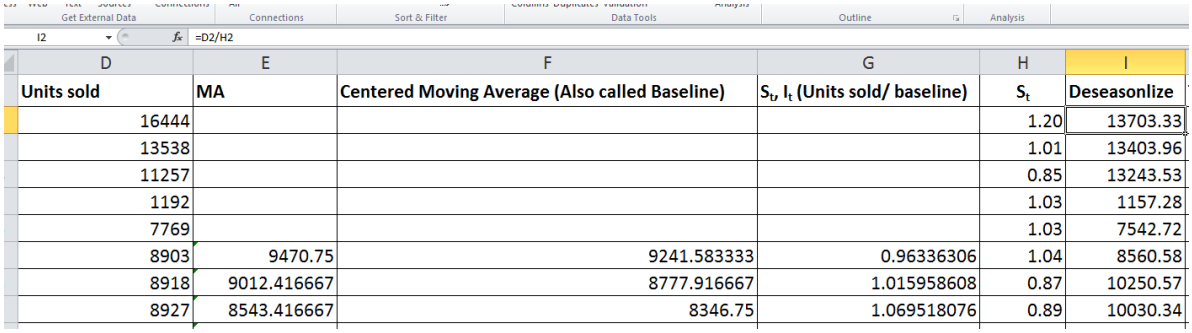
Fig.11 – Calculations for moving averages

The last column in Fig.11 shows units sold/baseline. This value is seen for all months and average of these values for the same month is put in a separate table to obtain the seasonal indices.

Month	St
1	1.2
2	1.01
3	0.85
4	1.03
5	1.03
6	1.04
7	0.87
8	0.89
9	0.95
10	0.94
11	1.002
12	1.11

Fig.12 – Seasonal Indices for Moving Averages

Seasonal Indices give a measure of how much variation is expected in comparison to the average season. Now, we deseasonalize the data to conduct regression analysis.

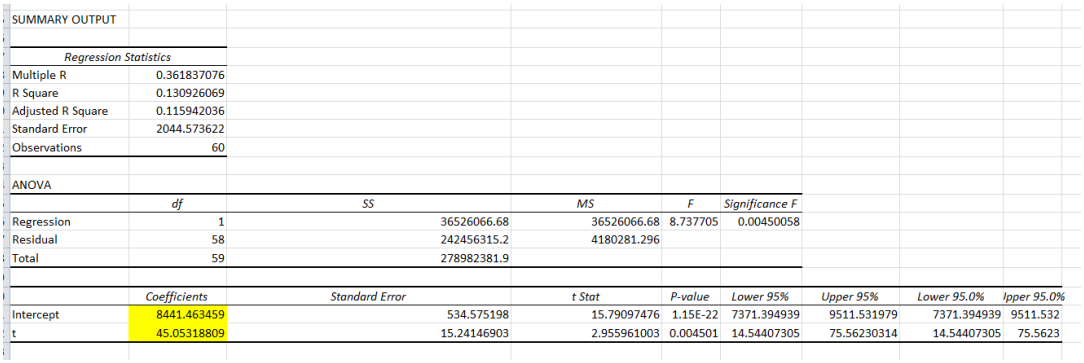


=D2/H2

Units sold	MA	Centered Moving Average (Also called Baseline)	S_t, I_t (Units sold/ baseline)	S_t	Deseasonlize
16444				1.20	13703.33
13538				1.01	13403.96
11257				0.85	13243.53
1192				1.03	1157.28
7769				1.03	7542.72
8903	9470.75	9241.583333	0.96336306	1.04	8560.58
8918	9012.416667	8777.916667	1.015958608	0.87	10250.57
8927	8543.416667	8346.75	1.069518076	0.89	10030.34

Fig.13 – Deseasonalize data

Next we conduct a regression analysis to obtain values of intercept and "t" value to get the trend.



SUMMARY OUTPUT

Regression Statistics

Multiple R	0.361837076
R Square	0.130926069
Adjusted R Square	0.115942036
Standard Error	2044.573622
Observations	60

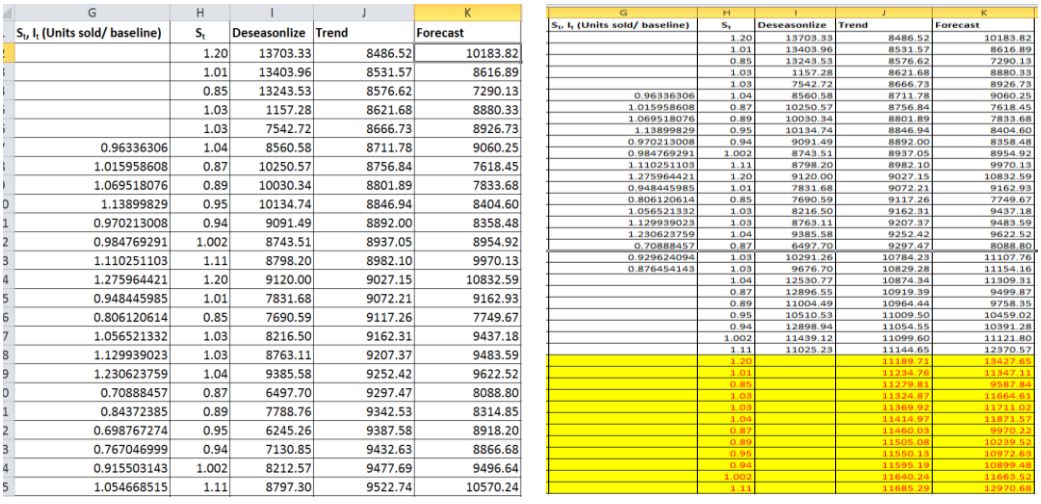
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	36526066.68	36526066.68	8.737705	0.00450058
Residual	58	242456315.2	4180281.296		
Total	59	278982381.9			

	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Ipper 95.0%*
Intercept	8441.463459	534.575198	15.79097476	1.15E-22	7371.394939	9511.531979	7371.394939	9511.532
t	45.05318809	15.24146903	2.955961003	0.004501	14.54407305	75.56230314	14.54407305	75.5623

Fig.14 – Regression Analysis

Since we have the intercept and "t" value, we can get the trend and forecast the data.



S_t, I_t (Units sold/ baseline)	S_t	Deseasonlize	Trend	Forecast
	1.20	13703.33	8486.52	10183.82
	1.01	13403.96	8531.57	8616.89
	0.85	13243.53	8576.62	7290.13
	1.03	1157.28	8621.68	8880.33
	1.03	7542.72	8666.73	8926.73
0.96336306	1.04	8560.58	8711.78	9060.25
1.015958608	0.87	10250.57	8756.84	7618.45
1.069518076	0.89	10030.34	8801.89	7833.68
1.13899829	0.95	10134.74	8846.94	8404.60
0.970213008	0.94	9091.49	8892.00	8358.48
0.984769291	1.002	8743.51	8937.05	8954.92
1.110251103	1.11	8798.20	8982.10	9970.13
1.275964421	1.20	9120.00	9027.15	10832.59
0.948445985	1.01	7831.68	9072.21	9162.93
0.806120614	0.85	7690.59	9117.26	7749.67
1.056521332	1.03	8216.50	9162.31	9437.18
1.129939023	1.03	8763.11	9207.37	9483.59
1.230623759	1.04	9385.58	9252.42	9622.52
0.70888457	0.87	6497.70	9297.47	8088.80
0.84372385	0.89	7788.76	9342.53	8314.85
0.698767274	0.95	6245.26	9387.58	8918.20
0.767046999	0.94	7130.85	9432.63	8866.68
0.915503143	1.002	8212.57	9477.69	9496.64
1.054668515	1.11	8797.30	9522.74	10570.24

S_t, I_t (Units sold/ baseline)	S_t	Deseasonlize	Trend	Forecast
	1.20	13703.33	8486.52	10183.82
	1.01	13403.96	8531.57	8616.89
	0.85	13243.53	8576.62	7290.13
	1.03	1157.28	8621.68	8880.33
	1.03	7542.72	8666.73	8926.73
0.96336306	1.04	8560.58	8711.78	9060.25
1.015958608	0.87	10250.57	8756.84	7618.45
1.069518076	0.89	10030.34	8801.89	7833.68
1.13899829	0.95	10134.74	8846.94	8404.60
0.970213008	0.94	9091.49	8892.00	8358.48
0.984769291	1.002	8743.51	8937.05	8954.92
1.110251103	1.11	8798.20	8982.10	9970.13
1.275964421	1.20	9120.00	9027.15	10832.59
0.948445985	1.01	7831.68	9072.21	9162.93
0.806120614	0.85	7690.59	9117.26	7749.67
1.056521332	1.03	8216.50	9162.31	9437.18
1.129939023	1.03	8763.11	9207.37	9483.59
1.230623759	1.04	9385.58	9252.42	9622.52
0.70888457	0.87	6497.70	9297.47	8088.80
0.929624094	1.03	10291.26	10784.23	11107.76
0.876454143	1.03	9676.70	10829.28	11154.16
	1.04	12530.77	10874.34	11309.31
	0.87	12896.55	10919.39	9499.87
	0.89	11004.49	10964.44	9758.35
	0.95	10510.53	11009.50	10459.02
	0.94	12898.94	11054.55	10391.28
	1.002	11439.12	11099.60	11121.80
	1.11	11025.23	11144.65	12370.57
	1.20		11189.71	13427.65
	1.01		11234.76	11347.11
	0.85		11279.81	9587.84
	1.03		11324.87	11664.61
	1.03		11369.92	11711.02
	1.04		11414.97	11871.57
	0.87		11460.03	9970.22
	0.89		11505.08	10239.52
	0.95		11550.13	10972.63
	0.94		11595.19	10899.48
	1.002		11640.24	11663.52
	1.11		11685.29	12970.68

Fig.15 – Trend & Forecast

The Highlighted cells in Fig.15 are the predicted sales values for the year 2017-2018

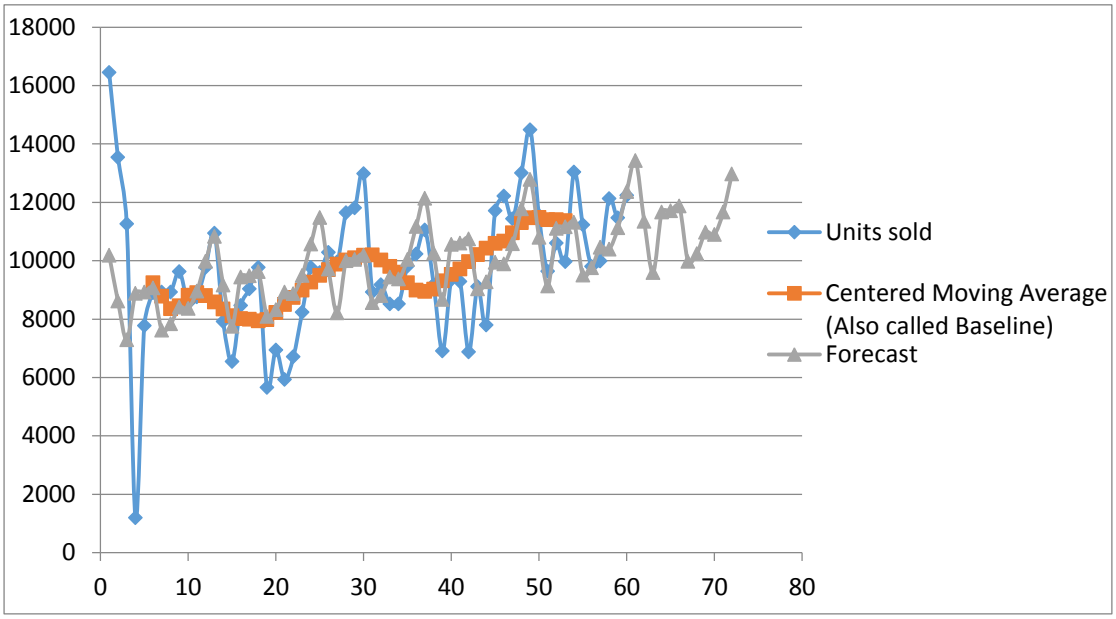


Fig.16 – Forecasted Sales and Baseline

As evident, even though the data is volatile a forecast for the year 2017-2018 is possible.

Conclusion

Since the data that we are dealing with in this case is so volatile, using Winter's method to forecast future sales might be incorrect unless the outliers are removed. But, using the method of moving averages is a better alternative as even the outliers can be considered and a proper forecast can be obtained.

If we compare the both they might be almost equal but the difference in the data taken is crucial as outliers in the Winter's analysis would significantly alter the results.

Winter's Seasonal Indices	Moving Average Seasonal Indices
1.227792736	1.20
1.027712137	1.01
0.86245625	0.85
1.033046913	1.03
1.020761152	1.03
1.082092087	1.04
0.894884774	0.87
0.845893397	0.89
0.908715804	0.95
0.9906934	0.94
1.006122624	1.002
1.099828726	1.11

Comparison in the seasonal indices

Thus, we conclude that Moving average method can predict data that is volatile and for fairly steady data, we can use Winter's method and smoothen the parameters.

SALES

A. For the month

	Domestic			Exports			T	
Category	Oct-17	Oct-16	Oct-15	Oct-17	Oct-16	Oct-15	Oct-17	O
M& HCV	13,787	13,575	12,504	1,721	2,053	1,469	15,508	1
LCV	18,624	16,594	13,615	2,461	3,836	2,737	21,085	2
UTILITY	5,144	1,828	1,749	57	176	2	5,201	
CARS	11,331	14,483	11,049	72	268	361	11,403	1
TOTAL	48,886	46,480	38,917	4,311	6,333	4,569	53,197	5

Car Sales for October 2017

On comparing the forecasted value of sales for October 2017 and on observing the real value, it is quite evident that Moving average method gives a more accurate prediction compared to Winter's method.

References

[1] http://www.tatamotors.com/investor/tml-volumes-flash-figures/