QMB 612 – Fall 2023: Critical Thinking Project 2

Dr. John Oruongo October 26, 2023

Rules

This is a take-home project. The rules are as follows:

I This is to be your own work. You may not consult with anyone, except the Professor, regarding these problems.

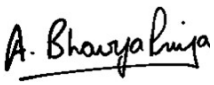
II You may not consult any references other than your text, your class notes from this course, material on the course's Blackboard site and your assignments.

III Show all work leading to your answers in a clear and organized fashion. Show your Excel calculations explicitly. No Work means No Credit. Do not copy and paste values and lose the formulas.

IV This Project is due by 5:00 PM on Tuesday, November 2, 2023. All work must be submitted electronically on Blackboard in the Assignments area, including a photo of this signature page with your Signature.

V Half of the grade is on Excel calculations/work and the other half on the managerial report. Remember to write the report to the recipient identified in the description below. It should not be read like an assignment, but like a managerial report. You will lose points for grammar and punctuation errors. You are allowed a maximum of ten grammar errors and typos. If you have more than ten of these, you will get a zero on the report. So, take it seriously!

VI I, **Bhavya Priya Akula**, certify that, by submitting this cover page, I completed all work according to rules I–IV, and that I did not copy nor use anyone else's ideas or work to complete this project. I also certify that I will not share this project or my work on this project with anyone else now or in the future.

Signature 

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CASE INTRODUCTION

The Fodor department store is located the South Florida area and suffered heavy damage when a hurricane struck on August 31 of 2023. The store was closed for four months (September through December), and the company is now involved in a dispute with its insurance company about the number of lost sales during the time the store was closed.

Considering the above business situation, we need to help Ryan Fodor, the CEO of the company in resolving two key issues:

1. The amount of sales Fodor would have made if the hurricane had not struck, and
2. Whether Fodor is entitled to any excess sales due to increased business activity after the storm.

Also, it was told that more than $8 billion in federal disaster relief and insurance money came into the county, resulting in increased sales at department stores and numerous other businesses. Using this information, Ryan wants us to analyze if there were any excess storm related sales that were made by county department store which will help the company to claim insurance for the excess sale Fodor department store would have made in addition to ordinary sales, along with claiming the relief for the damage.

Table 1 gives us the details of the actual sales of Fodor Department Store for the 48 months preceding the storm.

Month	Year 1	Year 2	Year 3	Year 4	Year 5
January		1.66	3.27	3.65	4.35
February		2.12	2.71	3.17	3.89
March		2.44	2.92	3.88	4.62
April		2.45	3.26	3.95	4.28
May		2.91	3.53	4.17	4.73
June		2.81	3.19	3.95	4.12
July		2.77	3.42	3.94	4.04
August		3.21	3.36	4.13	3.92
September	1.71	2.55	2.89	3.48	
October	1.98	2.9	3.54	4.25	
November	2.9	3.53	4.42	4.99	
December	4.72	5.73	6.29	7.4	

Table 1: Sales for Fodor Department Store ($Millions)

Table 2 gives us the details of the actual sales of Department Stores for the County (48 months preceding the storm and for four months during which Fodor store was closed)

Month	Year 1	Year 2	Year 3	Year 4	Year 5
January		53.64	66.22	69.19	81.55
February		56.45	69.56	72.55	88.11
March		72.25	85.96	92.28	98.84
April		70.87	85.11	86.12	100.35
May		77.58	89.51	91.55	103.94
June		74.42	82.32	86.25	99.2
July		73.38	76.46	89.24	100.7
August		83.3	89.29	100.18	108.51
September	55.8	77.32	76.27	78.81	123.44
October	58.73	72.72	84.31	91.3	132.46
November	79.75	99.93	107.85	113.99	156.83
December	128.1	163.84	169.37	169.36	218.52

Table 2: Department Store Sales for the County ($Millions)

RESEARCH PROBLEM

The objective of the analysis is to forecast lost sales of Fodor Department store, using the above data. As a part of this analysis, the following research questions will be answered and accordingly Ryan will be given suitable recommendations backed by forecast.

1) **An estimate of sales for Fodor Department Store had there been no hurricane.**

   After analyzing the pattern and nature of the sales data, we will be employing suitable methods to forecast the Fodor department sales for the months of September to December, based on previous sales data given. This forecast would give us the information on estimate of sale for Fodor Department has there been no hurricane. The right forecast will be chosen based on the SSE value.

2) **An estimate of countywide department store sales had there been no hurricane.**

   Similar to the above approach, we will also forecast the county department store sales to estimate the sales of countywide department stores had there been no hurricane. The right forecast will be chosen based on the SSE value for further analysis.

3) **An estimate of lost sales for the Fodor Department Store for September through December**

   Since, Fodor was closed during the hurricane we do not have details of the actual sales for the months September through December. We will be comparing the countywide department store's actual sales with its forecasted and estimate a growth rate/ %change in sales. Based on, the rate at which sales changed we can estimate the lost sales for the Fodor Department as the difference between, the estimated sales had there been no hurricane and the sales Fodor department would have had made if it was open during the hurricane.

4) **Analysis for or against excess storm related sales (if any)**

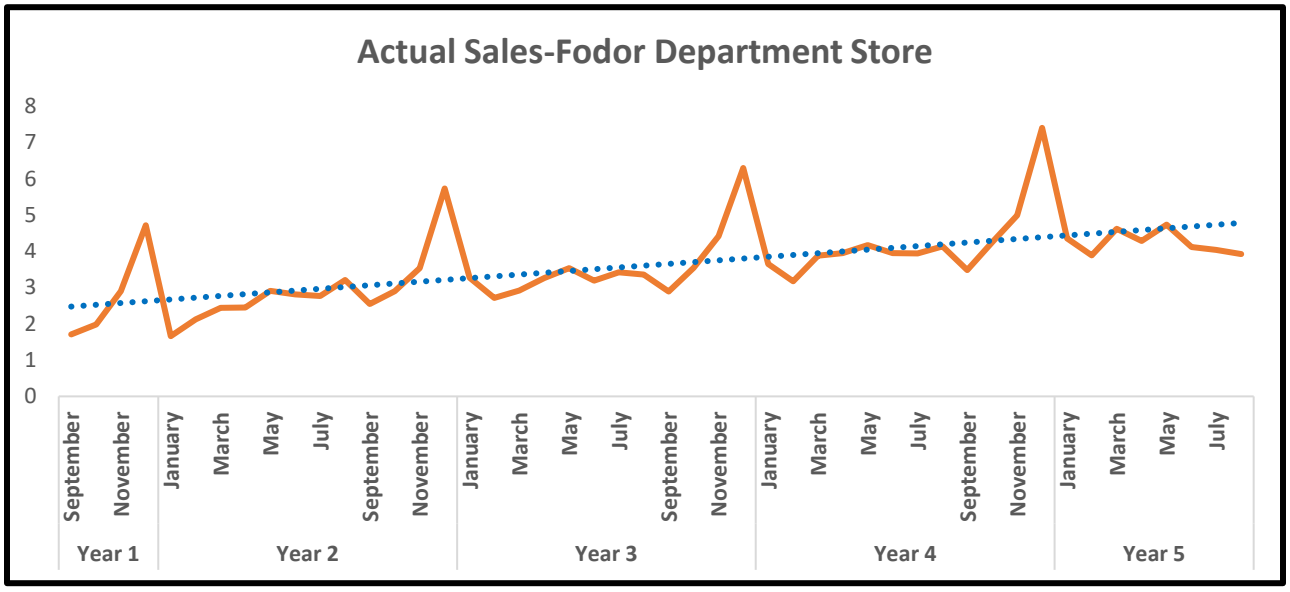
   By comparing the actual sales of county stores with their forecasted sales, we would know if county stores had an excess sale if the actual sales were higher than the estimated county sales. Accordingly, we would analyze the sales performance of county sales to determine the case for excess storm related sales for Fodor.

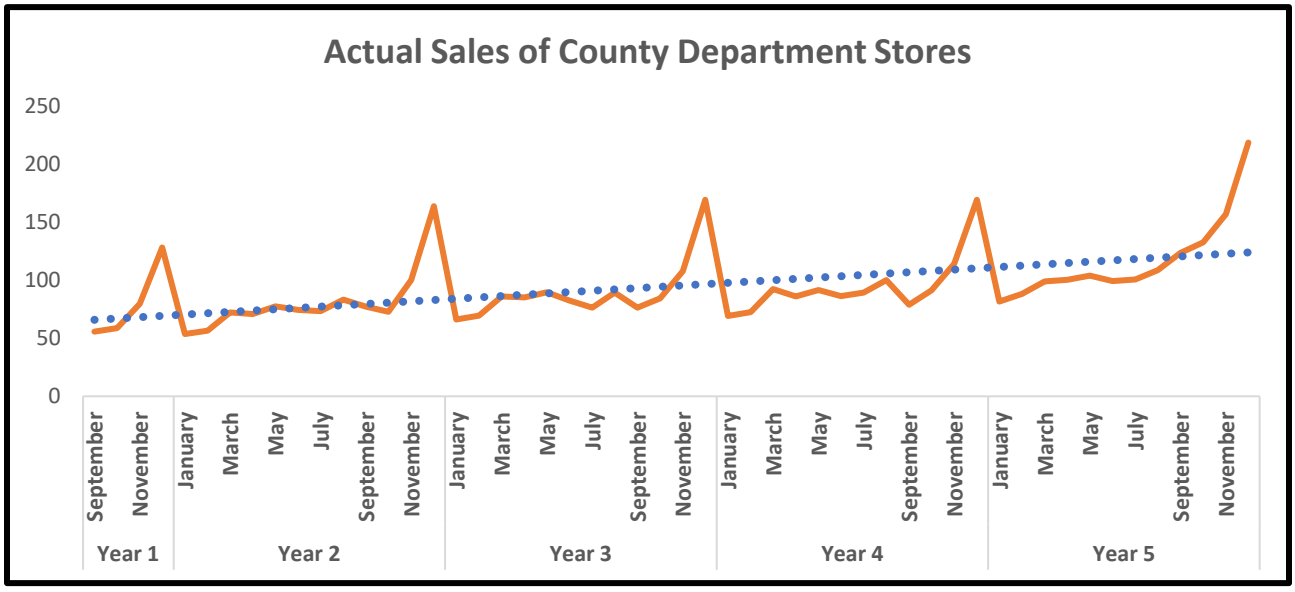
ANALYZING THE PATTERN AND DESCRIPTION OF THE DATA AND SEASONAL FORECASTING

Analyzing the pattern of the data is crucial for the forecast. This steps enables us to choose the appropriate method to Forecast the data. Let us first plot the sales data of Fodor Stores, to analyze the pattern of the data.

We can see that the sales data has been presented for each month over the years and hence, this is a time-series data. Such time series can display a wide variety of patterns when plotted over time. Displaying data in a time-series plot is an important first step in identifying various component parts of the time series. A time series is likely to contain one/more of the following components:

- Trend -Upward or downward movement in data over time.
- Seasonal -Repeating pattern in the data
- Cyclical -Similar to seasonal, but pattern repeats after many years.
- Random-Inexplicable change in data over time.





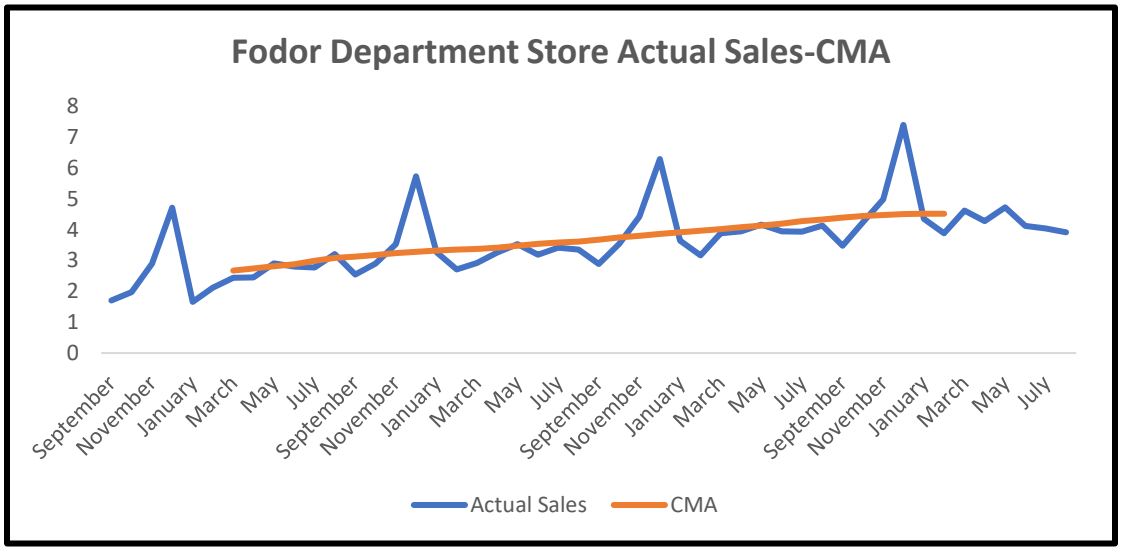
Looking at the above graphs that are showing the actual sales data for Fodor Department stores and the county stores it can be seen that the data is showing a trend and also that the data is seasonal in nature.

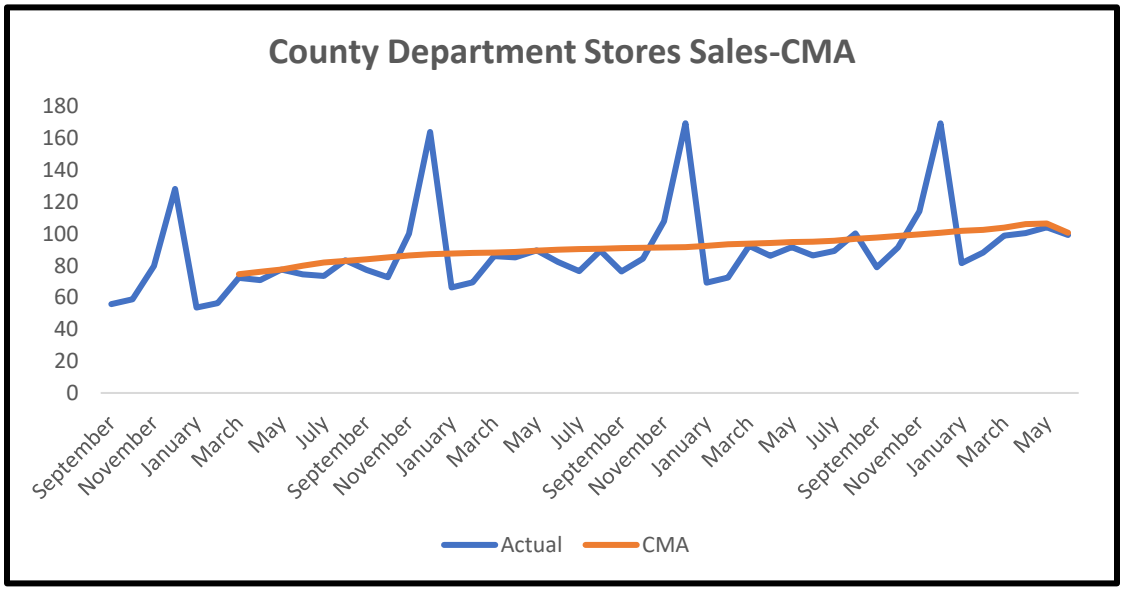
Seasonality comprises movements up and down in a pattern of constant length that repeats itself. For this data, the seasonal pattern is 12 months long. In this approach, we are first eliminating the effect of seasonality on our data then forecasting the sales using a time-series or a causal model and then reseasonalizing the forecasted sales to arrive at the final forecasted sales, we do these steps in order to eliminate/reduce the impact of seasonality on our forecast.

Hence, before we look into forecasting our Sales it is important to perform the below steps of a seasonal forecast for both the datasets :

(**Please refer to excel file attached for detailed calculation*)

1) Calculating a Centered Moving Average based on number of periods. In our case since the data given has 12 periods, we start calculating CMA from $(p/2+1)^{th}$ observations, I.e., 7^{th} , when p is an even number.
2) Calculate the ratios of actual sales and CMA values.



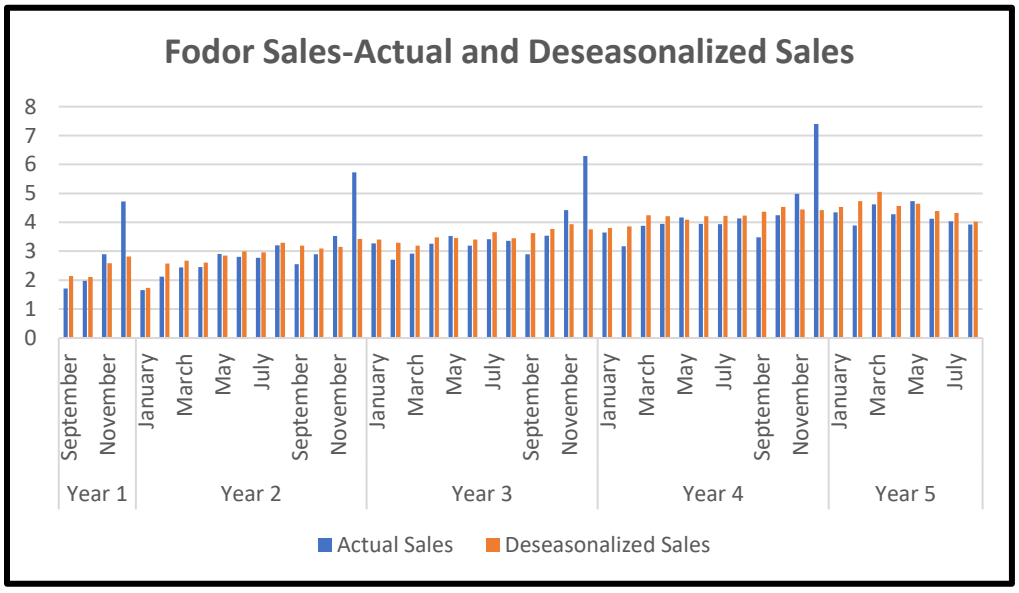


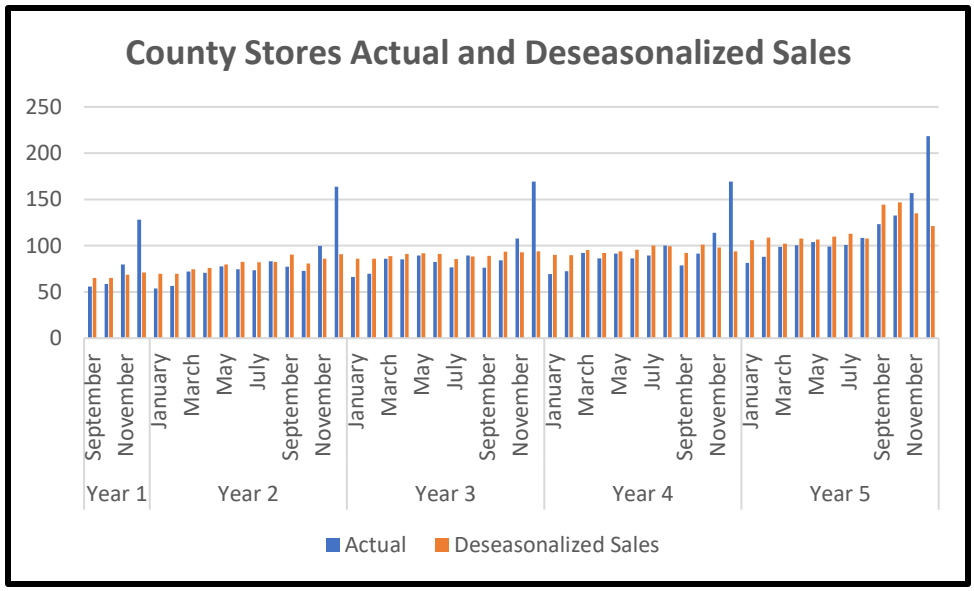
3) Average the ratios of each month to estimate the seasonal Indices, below are the seasonal Indices so obtained.

The below table shows the seasonal Indices for Fodor store and County stores so obtained. Usually, the way these indices are interpreted is, for example, in the month of September an index of 0.798 (0.80) the store sells 20% less than usual. Similarly, for a month like December where index is above 1 that is 1.67 it means Fodor sells 60-70% more than usual during this month.

FODOR STORE		COUNTY STORES
MONTH	Seasonal Indices	Seasonal Indices
September	0.798	0.855
October	0.938	0.901
November	1.122	1.161
December	1.673	1.804
January	0.960	0.769
February	0.823	0.809
March	0.914	0.968
April	0.938	0.933
May	1.019	0.974
June	0.939	0.903
July	0.934	0.892
August	0.974	1.009

4) Estimate the deaseaonalized sales by dividing the actual sales data by its own seasonal index.





5) Use the Deaseaonalized sales as your new actual data for forecasting. We can use n number of methods to forecast our sales (which will be covered in the next section).

6) As the final step, once you have the forecasted values, you multiply them with their respective seasonal indices, and this is called the reseaonalizing of data.

I.ESTIMATING THE SALES FOR FODOR DEPARTMENT STORE HAD THERE BEEN NO HURRICANE

Since, we have our deaseaonalized data ready to perform our forecasts, as the next step of the analysis we would be examining the methods such as Naïve forecast, time-series models since the data has a trend element in it and causal models like regression to estimate our sales for the months of September through December.

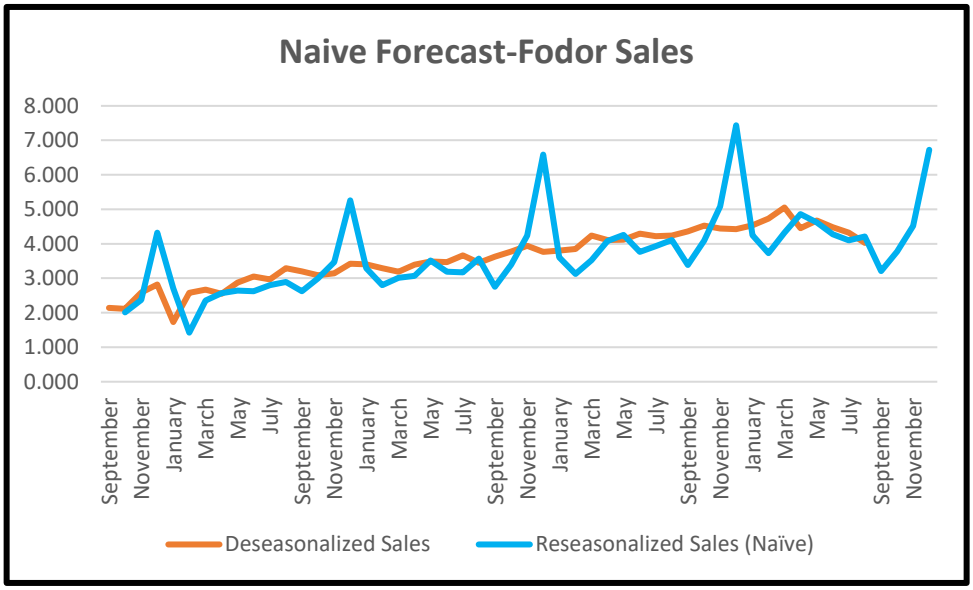
We have also calculated a measure of accuracy **SSE** sum of squared errors in order judge the different forecasts based on accuracy and reliability. We would be choosing the sales forecasted of the model that has comparatively smaller SSE.

We are using a total 11 models for forecasting the sales data of Fodor Department store had there been no hurricane. The models being used for the forecast are Naïve, 4-period and 6-period moving average, weighted moving average 2-period and weighted moving average 3-period, exponential smoothing with alpha of 0.2 and 0.8, Holt's mode and linear, quadratic, and cubic regression models.

****Please refer to excel attached sheet: Table 1_Fodor Sales for detailed calculation of Forecasts***

1) Estimated sales for Fodor stores had there been no hurricane using Naïve Forecast

Naïve is an estimating technique in which the last period's actuals are used as this period's forecast, without adjusting them or attempting to establish causal factors.



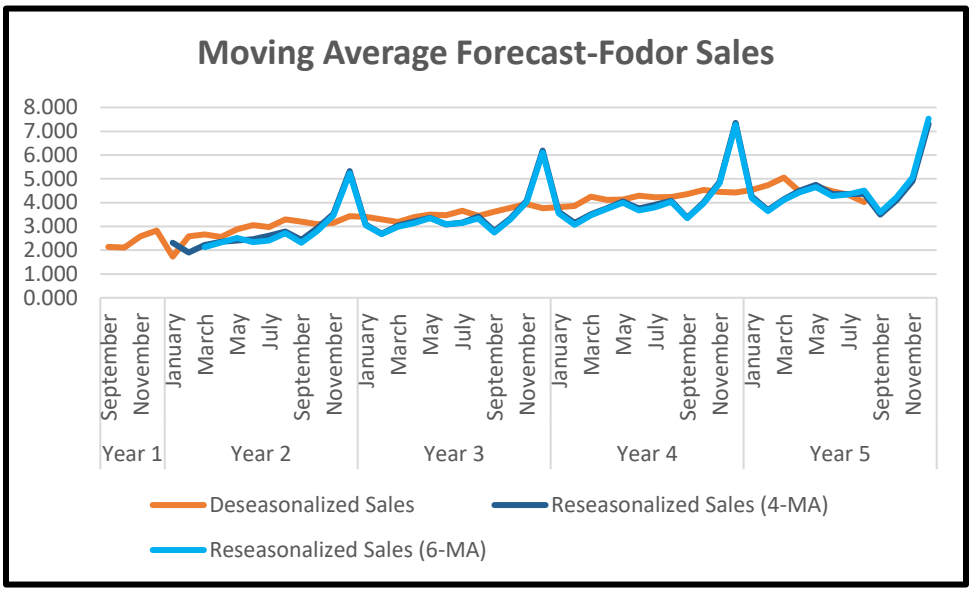
MONTH	SALES FORECAST
September	3.209
October	3.774
November	4.515
December	6.728
SSE=	32.405

As per the Naïve forecast, Fodor Department store would have had made $3.2 million sales in September, $3.74 million sales in October, $4.515 million sales in November and $6.728 million in the month of December had there been no hurricane.
The Naïve model had an SSE of **32.405**.

2) Estimated sales for Fodor stores had there been no hurricane using 4-period and 6-period Moving Average

In this model the average of a fixed number (say, n) of the most recent observations is used as an estimate of the next value of y. The value of n is chosen based on type of data, since we have monthly data of 12 periods, in our case 4-period and 6-period moving average made greater sense to the forecast.

MONTH	4-MA	6-MA
September	3.466	3.591
October	4.075	4.222
November	4.876	5.051
December	7.266	7.528
SSE=	27.862	27.103



As per the 4-period moving average forecast, Fodor Department store would have had made $3.46 million sales in September, $4.07 million sales in October, $4.8 million sales in November and $7.3 million in the month of December had there been no hurricane. This model had an SSE of **27.862**

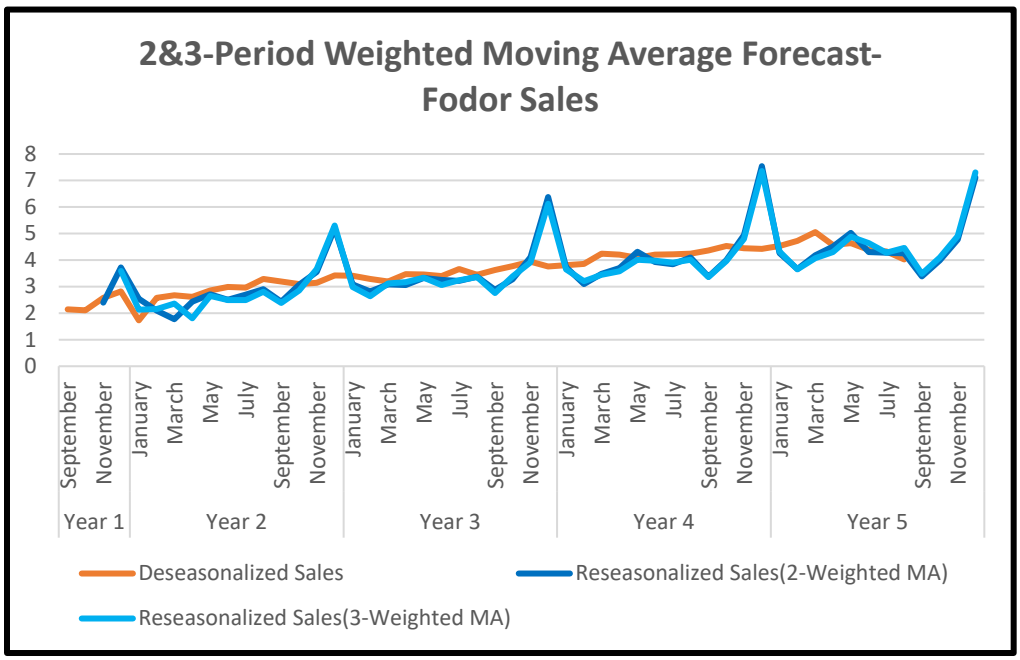
As per the 6-period moving average forecast, Fodor Department store would have had made $3.5 million sales in September, $4.2 million sales in October, $5.05 million sales in November and $7.5 million in the month of December had there been no hurricane. This model showed an SSE of **27.103**

3) Estimated sales for Fodor stores had there been no hurricane using 2-period and 3-period weighted moving average method.

The notion that recent data are more important than old data can be implemented with a weighed n-period moving average.

- We are using 2-period weighted average with the weights of **w1 = 0.753 and w2 = 0.247, these are the optimal weights defined by the Solver.**
- For a 3-period weighted moving average we are using the weights of **w1= 0.769, w2= 0.212 and w3=0.019, again as defined by Solver as the optimal weights.**

MONTH	2-P WMA	3-P WMA
September	3.390644	3.485093
October	3.986868	4.097926
November	4.769999	4.902872
December	7.108531	7.306545
SSE=	30.478	28.724



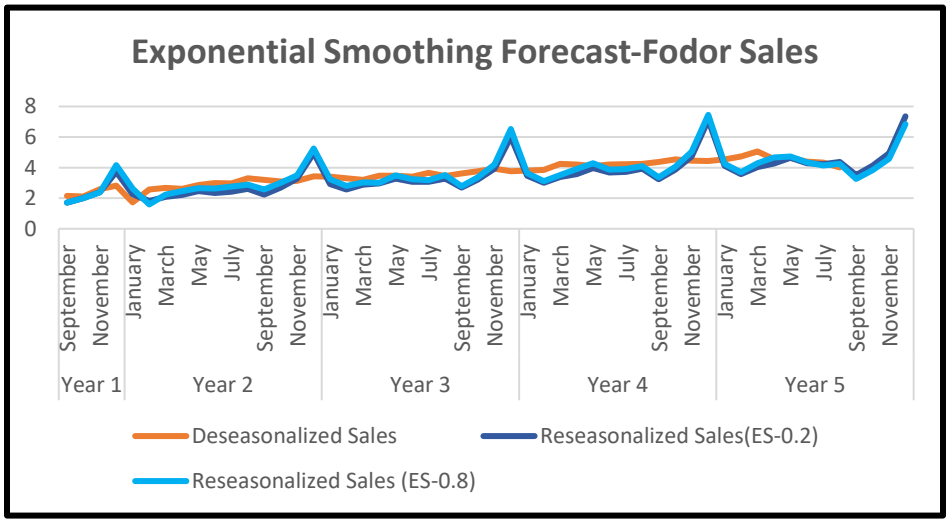
As per the 2-period weighted moving average forecast, Fodor Department store would have had made $3.39 million sales in September, $3.9 million sales in October, $4.76 million sales in November and $7.10 million in the month of December had there been no hurricane. This model had an SSE of **30.478.**

As per the 3-period weighted moving average forecast, Fodor Department store would have had made $3.4 million sales in September, $4.09million sales in October, $4.90 million sales in November and $7.30 million in the month of December had there been no hurricane. This model showed an SSE of **28.724.**

4) Estimated sales for Fodor stores had there been no hurricane using Exponential Smoothing with two different smoothing constants.

Exponential smoothing gives more weight to the recent observations and less to the older observations. The number we choose for α is called the level smoothing constant. The weight of the most recent observation is assigned by multiplying the observed value by α, the next most recent observation by (1 − α)α, the next observation by (1 − α) 2 α, and so on.

- We have run the exponential smoothing forecast twice, once with alpha value of 0.2 and then with an alpha value of 0.8.



MONTH	ES-0.2 Sales Forecast	ES-0.8 Sales Forecast
September	3.507637	3.261339
October	4.124434	3.834826
November	4.934587	4.588091
December	7.353809	6.837441
SSE=	29.3	31.5

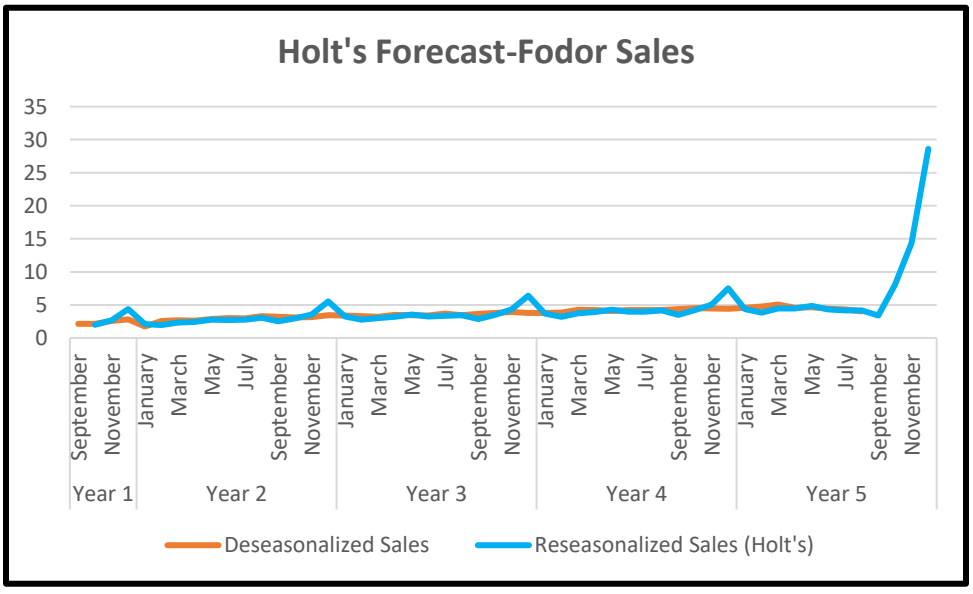
As per the exponential smoothing forecast with an alpha of **0.2** , Fodor Department store would have had made $3.50 million sales in September, $4.12 million sales in October, $4.93 million sales in November and $7.35 million in the month of December had there been no hurricane. This model had an SSE of **29.3.**

As per the exponential smoothing forecast with an alpha of **0.8** , Fodor Department store would have had made $3.26 million sales in September, $3.83 million sales in October, $4.58 million sales in November and $6.83 million in the month of December had there been no hurricane. This model had an SSE of **31.5.**

5) Estimated sales for Fodor stores had there been no hurricane using Holt's model.

Holt is an extended simple exponential smoothing model to allow the forecasting of data with a trend. This method involves a forecast equation and two smoothing equations (one for the level and one for the trend).

- For our forecast of sales using Holt's model, we used an **alpha value of 0.5 and beta value of 0.02** as defined by Solver and k values of 1,2,3 and 4 for forecasting the Fodor's sales data for four periods September to December.



MONTH	HOLT'S FORECAST
September	3.411494
October	8.02277
November	14.39799
December	28.60897
SSE=	29.67

As per the Holt's forecast with an alpha of **0.5 and Beta of 0.02** , Fodor Department store would have had made $3.41 million sales in September, $8.02 million sales in October, $14.39 million sales in November and $28.6 million in the month of December had there been no hurricane. This model had an SSE of **29.67.**

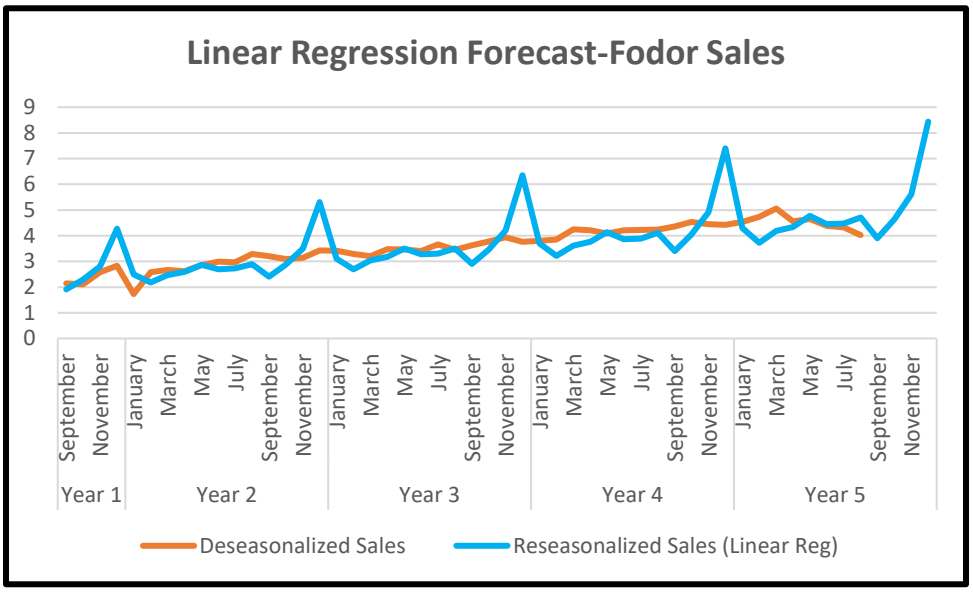
6) Estimated sales for Fodor stores had there been no hurricane using Linear Regression.

We are bringing a new approach to our sales forecast by implementing causal models to estimate the sales. Since, we know that there is an element of trend in the data, we can run a forecast based regression considering time as an independent variable and sales as the dependent variable.

Since, there is a relationship between values of the time and sales and since the values for the independent variables are known and available, we can implement the regression models, and linear regression to start with. Linear regression takes the form of the below equation,

Sales (Y-predicted)= 2.344(b0) + (b1) 0.052*Period (X)

In the above equation, b0 is calculated as intercept and b1 is calculated as slope using the range of X and Y values available.



MONTH	Linear Regression Forecast
September	3.89926
October	4.633627
November	5.602071
December	8.435374
SSE=	29.641

As per the linear regression forecast, Fodor Department store would have had made $3.89 million sales in September, $4.63 million sales in October, $5.60 million sales in November and $8.4 million sales in the month of December had there been no hurricane. This model had an SSE of **29.641.**

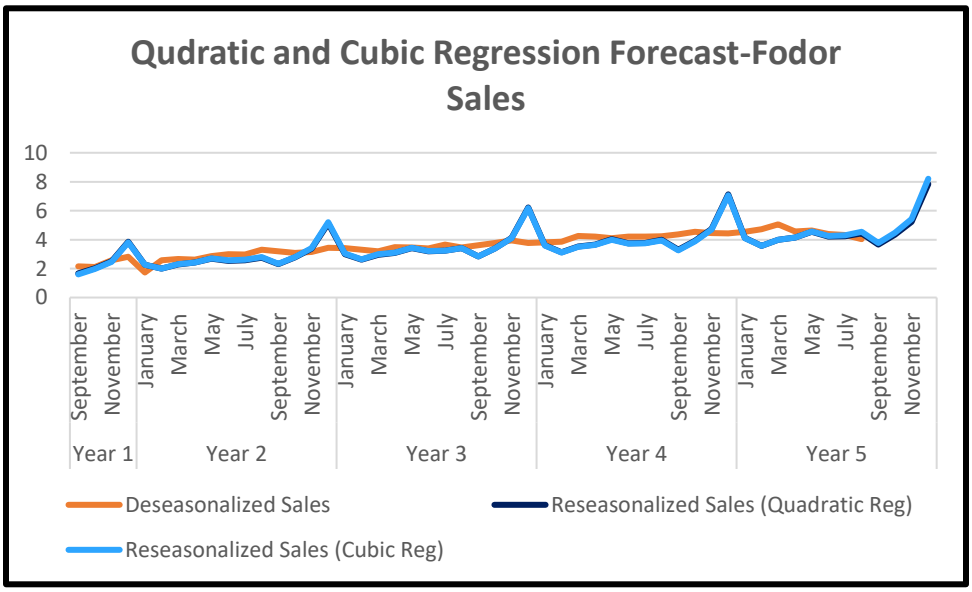
7) Estimated sales for Fodor stores had there been no hurricane using Quadratic Regression.

It is always said that a quadratic fit will always yield in a lower error when compared to a linear regression. Hence, we tried to estimate the sales for Fodor department stores using the method of Quadratic regression too.

In a quadratic regression, the equation takes the following form. The coefficient and intercept values of b0, b1 and b2 were optimal values as defined by the Solver.

Though we also tried employing (please refer excel table 1 forecast 11) cubic regression, the forecast values looked very similar to that of quadratic forecast like seen in the below chart and b3 was given a value that very close to zero.

Sales (Y-predicted)= 2.023 (b0) + (b1) 0.071*Period (X)+(b2)-0.003 *X^2



MONTH	QUADRTIC REG	CUBIC REG
September	3.661231	3.759855
October	4.336119	4.479431
November	5.224176	5.431591
December	7.838215	8.205902
SSE=	28.251	28.179

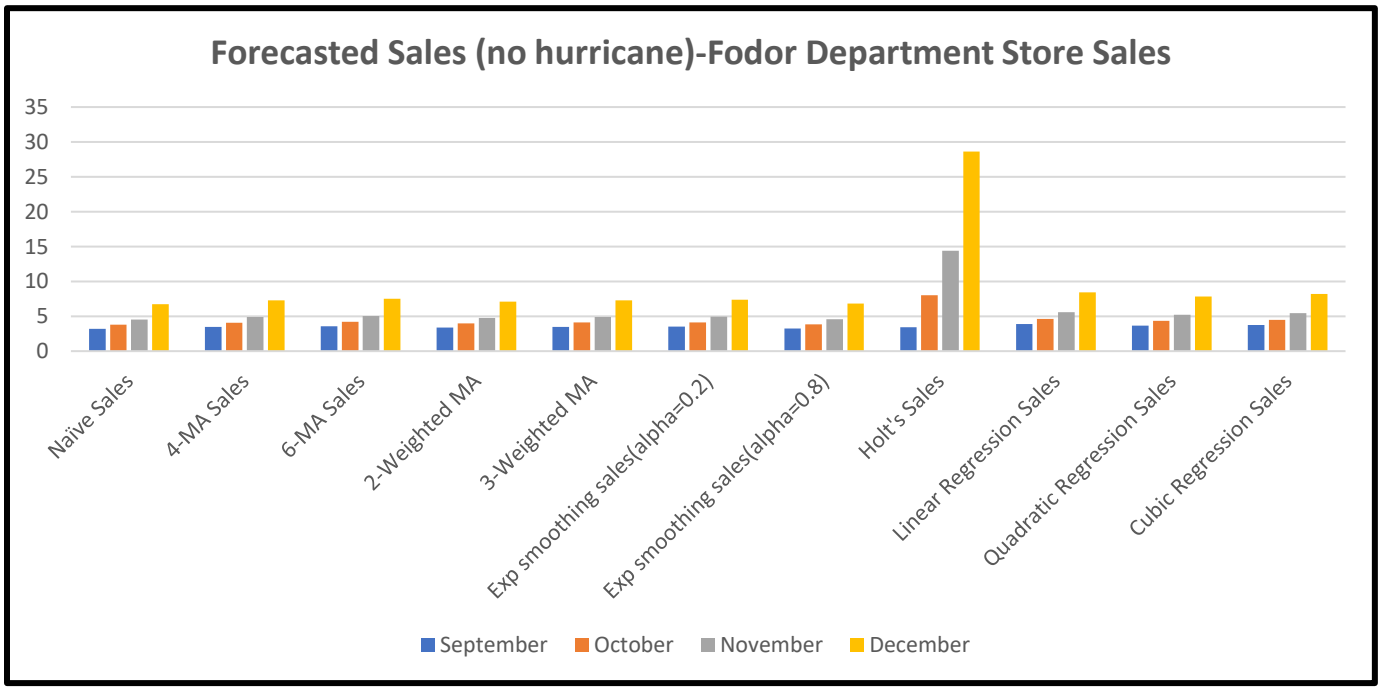
As per the quadratic regression forecast, Fodor Department store would have had made $3.66 million sales in September, $4.33 million sales in October, $5.22 million sales in November and $7.83 million sales in the month of December had there been no hurricane. This model had an SSE of **28.25.**

SUMMARY OF FINDINGS

The below table summarizes the findings of forecasted value of sales for Fodor Departments stores had there been no hurricane by giving the value of forecasted sales from September through December for each method of forecast.

The below table presents forecasted sales for Fodor Department Store in ($ million).

Month	September	October	November	December	Total Sales	SSE
Naïve Sales	3.209	3.774	4.515	6.728	18.227	32.45
4-MA Sales	3.466	4.075	4.876	7.266	19.683	27.86
6-MA Sales	3.590	4.221	5.050	7.526	20.386	**27.10**
2-Weighted MA	3.391	3.987	4.770	7.109	19.256	30.47
3-Weighted MA	3.485	4.098	4.903	7.307	19.792	28.72
Exp smoothing sales(alpha=0.2)	3.508	4.124	4.935	7.354	19.920	29.30
Exp smoothing sales(alpha=0.8)	3.261	3.835	4.588	6.837	18.522	31.58
Holt's Sales	3.411	8.023	14.398	28.609	54.441	29.67
Linear Regression Sales	3.899	4.634	5.602	8.435	22.570	29.64
Quadratic Regression Sales	3.661	4.336	5.224	7.838	21.060	**28.25**
Cubic Regression Sales	3.760	4.479	5.432	8.206	21.877	28.18



RECOMMENDATIONS AND JUSTIFICATIONS

Selection of forecast depends on a number of criteria, including: the pattern exhibited by the data, the quantity of historic data available and the length of the forecast horizon. In addition , to the above-mentioned criteria we are also going to look at the values of SSE, a measure of accuracy to recommend the best forecast model for considering the estimated sales of Fodor Departments stores had there been no hurricane.

- **Naïve forecast** is not recommended though it had a comparatively low **SSE of 27.103**. Because, as per Naïve forecast, the forecasted sales are going to be constant for n periods in future irrespective of trend and seasonal nature of data. Also, since there exists a causal relationship between the department store sales and time Naïve forecast is not recommended.
- **Moving Average** is a great method to forecast sales , since the average for n periods is calculated based on nature of data, that is number of periods the data is exhibiting. Since the new forecast is an estimate of average historical sales, the method is reliable. However, it is important for one to understand the right number of periods to be considered for best moving-average forecast.
- For our analysis, we tried multiple period moving averages but stuck with **4-period and 6-period moving averages** as the forecasted values looked more meaningful when compared to their actuals. 4-period moving average and 6-period average showed the lowest **SSE values of 27.8 and 27.10 respectively**.
- As per the 4-period moving average forecast, Fodor Department store would have had made **$3.46 million sales in September, $4.07 million sales in October, $4.8 million sales in November and $7.3 million in the month of December** had there been no hurricane.
- As per the 6-period moving average forecast, **Fodor Department store would have had made $3.5 million sales in September, $4.2 million sales in October, $5.05 million sales in November and $7.5 million in the month of December** had there been no hurricane.
- Another method that looked attractive from an SSE standpoint was the **3-period weighted moving average with an SSE of 28.72.** However, we are not recommending this method as this method assigns more weights recent data and less to more older data. Considering the seasonality, the sales forecast might not be accurate when using this method.
- We are recommending ignoring the forecasts of **exponential smoothing forecasts** as it had SSE which was higher than the other methods and since simple exponential smoothing is not a reliable method forecast when data involves trend and seasonality. Between the forecasts with the **smoothing constants of 0.2 and 0.8**, it appears that the forecast with an alpha of **0.2 is more accurate**.
- **Holt's exponential smoothing** is comparatively a better forecast when compared to simple exponential smoothing. However, it projected a comparatively higher **SSE of 29.67** and since the method is known to capture the trend but no seasonal pattern of the data, we are dropping this approach.
- Since, we have identified a causality that is a relationship between the time and Fodor department sales we have employed three types of regression models of **linear, quadratic, and cubic regression to forecast** the sales for the months September through December.
- Though, the cubic regression was the one that was similar to quadratic with a b3 value close to zero, all the three models exhibited almost minimum values **of SSE. Linear=29.6, Quadratic-28.21 and Cubic-28.17.**

Hence, we recommend Ryan to consider the Moving average forecast for his estimate of sales had there been no hurricane. Moving average appears to be the best forecast method of all time-series model we have employed to forecast sales.

We suggest Ryan to go by the Fodor department store sales had there been no hurricane as forecasted by **a 6-period moving average:**

September: $3.59 million

October: $4.22 million
November: $5.05 million
December: $7.52 million

A total of $20.39 million sales has been forecasted for the Fodor Department store had there been no hurricane, as per this forecast.

We recommend Ryan to use the forecast of Quadratic Regression since it showed the lowest SSE amongst the causal models and one of the lowest when all the models were considered together.
If a causal model were to be considered, with a very close SSE value we recommend Ryan to consider the **forecast of Quadratic regression sales, which estimated a sale of:**

September: $3.66 million
October: $4.33 million
November: $5.22 million
December: $7.83 million

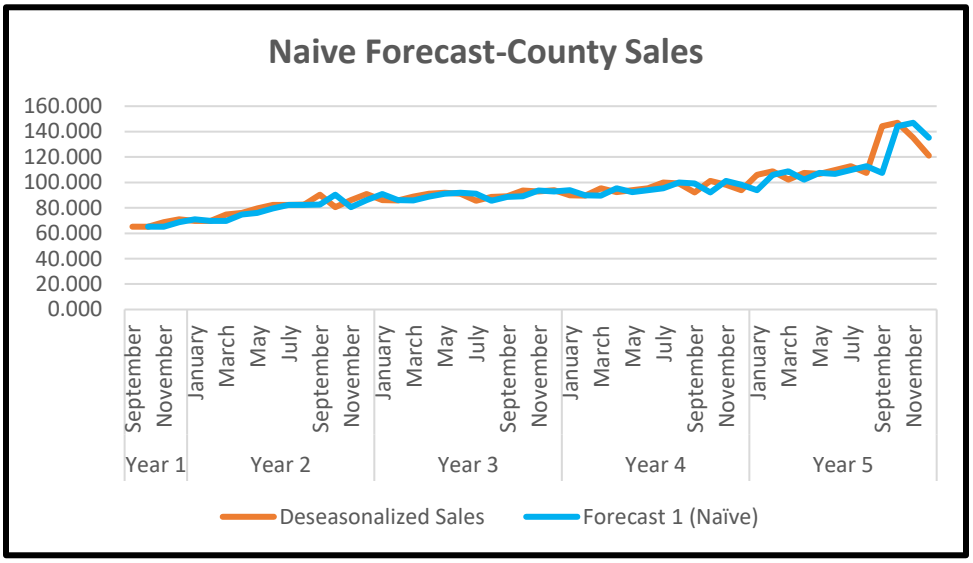
A total of $21.05 million sales has been forecasted for the Fodor Department store had there been no hurricane, as per this forecast.

II.ESTIMATING COUNTY WIDE DEPARTMENT STORE SALES HAD THERE BEEN NO HURRICANE.

Please refer to the attached excel sheet: Table2_County sales for detailed calculations.

We will be using the same methods as above for forecasting the sales of county department stores, had there been no hurricane.

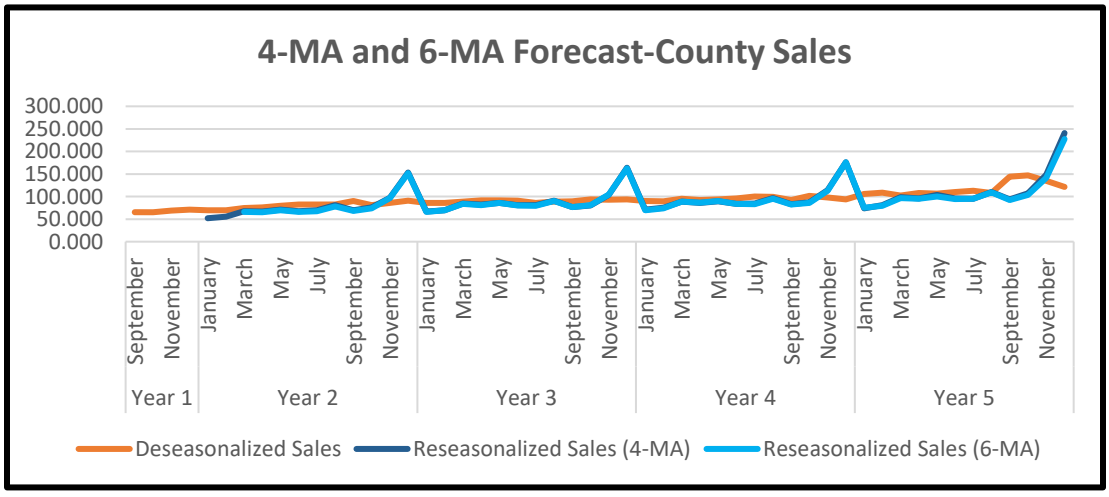
1) **Estimated sales for county stores had there been no hurricane using Naïve Forecast**



MONTH	NAÏVE FORECAST
September	91.999
October	130.098
November	170.585
December	243.692
SSE=	45263.950

As per the estimates of Naïve Forecast, the county department stores would have had sales of $91.99 million for September, $130.09 million for October, $170.58 million for November and $243.69 million for the month of December, had there been no hurricane. This model had an SSE of **45263.95.**

2) **Estimated sales for county stores had there been no hurricane using 4 period and 6 period moving Average.**



MONTH	4-MA FORECAST	6-MA FORECAST
September	93.424	92.172
October	106.948	103.481
November	148.499	140.889
December	240.781	227.469
SSE=	41452.538	38407.520

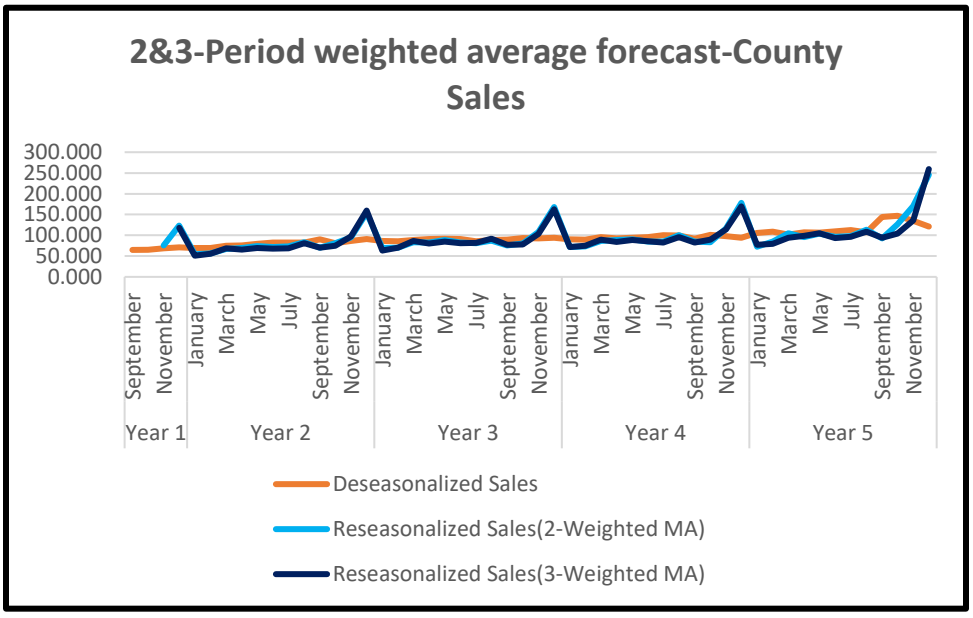
As per the estimates of 4-period moving average, the county department stores would have had sales of $93.42 million for September, $106.94 million for October, $148.49 million for November and $240.78 million for the month of December, had there been no hurricane. This model had an SSE of **41452.53.**

As per the estimates of 6-period moving average, the county department stores would have had sales of $92.172 million for September, $103.48 million for October, $140.88 million for November and $227.46 million for the month of December, had there been no hurricane. This model had an SSE of **38407.52**

3) **Estimated sales for county stores had there been no hurricane using 2-period and 3-period weighted moving average.**

For estimating the county sales using the 2-period weighted moving average we used the optimal weights of w1 =0.100 and w2=0.900 as defined by the solver.

Whereas, for 3-period weighed moving average method we used the weights of w1=0.75, w2=0.15 and w3=0.10 for estimating the sales.

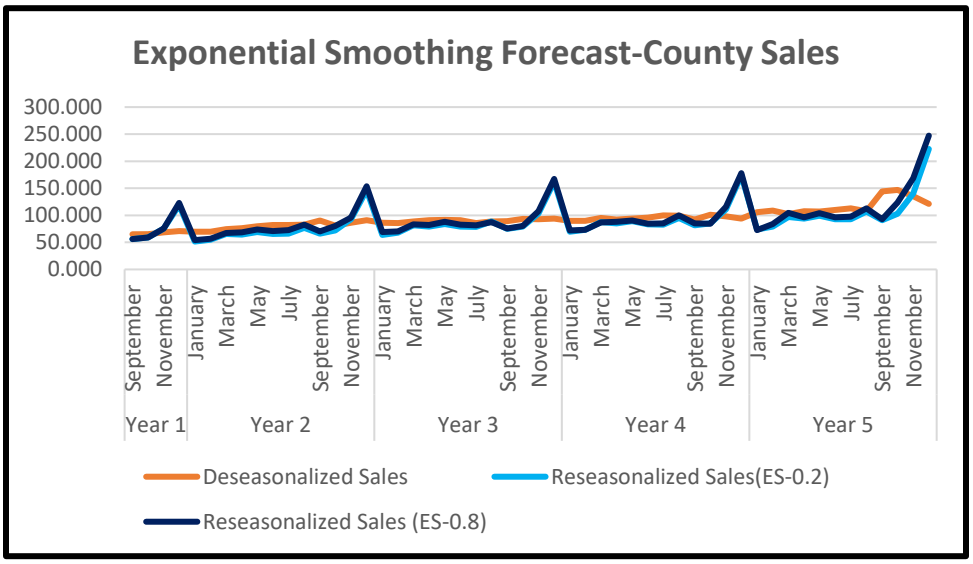


MONTH	2-WMA	3-WMA
September	92.451	94.136
October	126.784	103.846
November	170.280	135.841
December	245.829	259.382
SSE=	45708.283	48209.726

As per the estimates of 2-period weighted moving average, the county department stores would have had sales of $92.45 million for September, $126.78 million for October, $170.28 million for November and $245.82 million for the month of December, had there been no hurricane. This model had an SSE of **45708.28.**

As per the estimates of 3-period weighted moving average, the county department stores would have had sales of $94.136 million for September, $103.84 million for October, $135.84 million for November and $259.382 million for the month of December, had there been no hurricane. This model had an SSE of **48209.7.**

4) Estimated sales for county stores had there been no hurricane using exponential smoothing (with alpha = 0.2 and alpha=0.8)



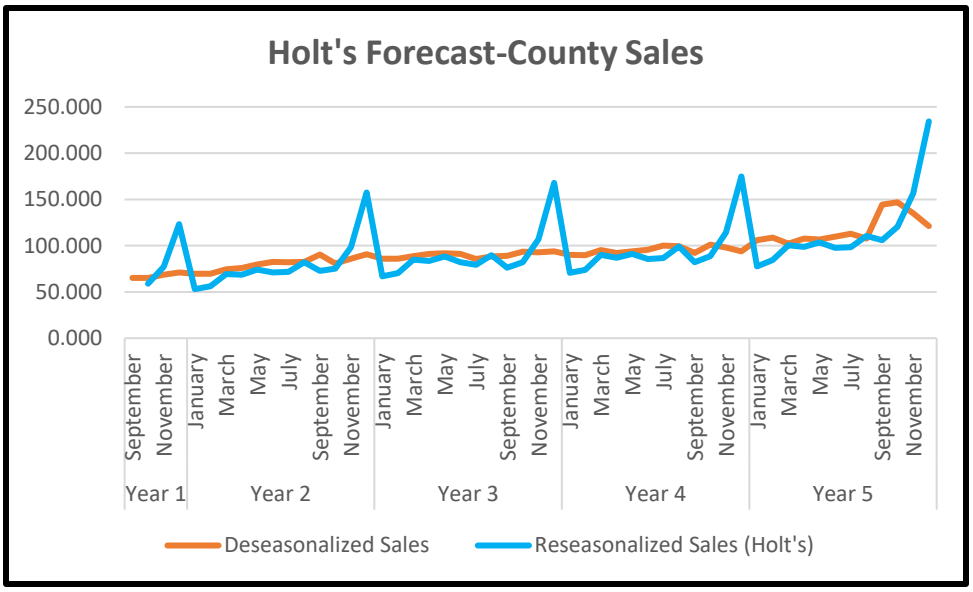
MONTH	ES-0.2	ES-0.8
September	90.915	92.778
October	102.674	123.635
November	139.897	168.312
December	222.644	247.260
SSE=	40428.699	46035.993

As per the estimates of an exponential smoothing forecast with an alpha=0.2, the county department stores would have had sales of $90.91 million for September, $102.67 million for October, $139.89 million for November and $222.644 million for the month of December, had there been no hurricane. This model had an SSE of **40428.69.**

As per the estimates of an exponential smoothing forecast with an alpha=0.8, the county department stores would have had sales of $92.77 million for September, $123.84 million for October, $168.3 million for November and $247.26 million for the month of December, had there been no hurricane. This model had an SSE of **46035.9.**

5) Estimated sales for county stores had there been no hurricane using Holt's model.

While estimating the county sales using the Holt's model, we used an alpha value of 0.4 and a beta value of 0.01 as these were the optimal values given by Solver.



MONTH	HOLT'S
September	106.027
October	120.552
November	156.559
December	234.324
SSE=	40752.242

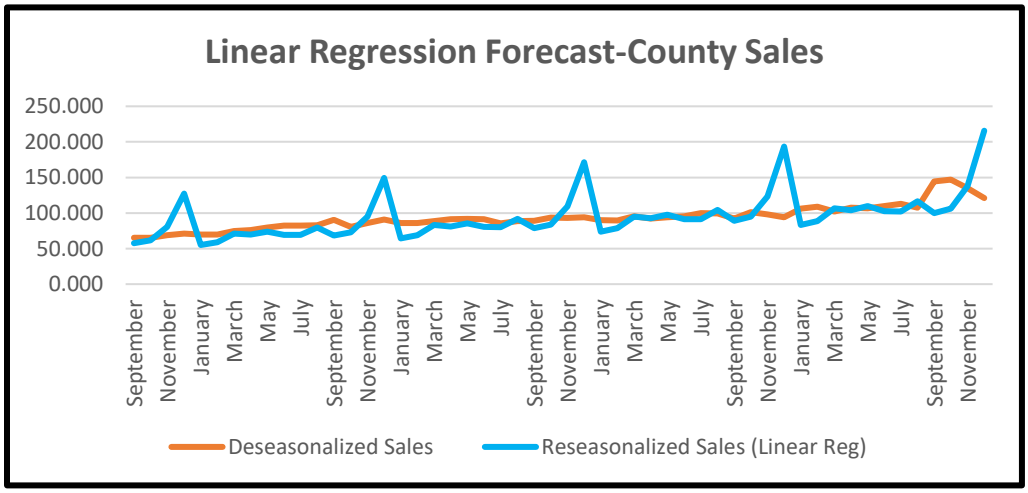
As per the estimates of a Holt's forecast with an alpha=0.4 and beta of 0.01, the county department stores would have had sales of $106.027 million for September, $120.55 million for October, $156.55 million for November and $234.644 million for the month of December, had there been no hurricane. This model had an SSE of **40752.69.**

6) Estimated sales for county stores had there been no hurricane using linear regression.

Linear regression takes the form of the below equation,

County Sales (Y-predicted)= 66.491 (b0) + (b1) 1.021*Period (X)

In the above equation, b0 is calculated as intercept and b1 is calculated as slope using the range of X and Y values available.



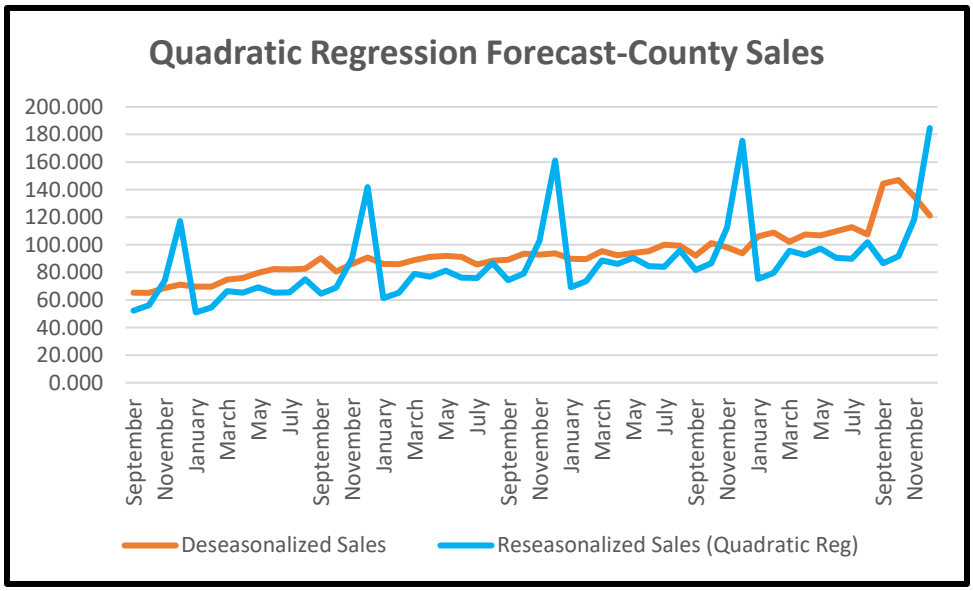
MONTH	LINEAR REGRESSION FORECAST
September	99.656
October	105.952
November	137.632
December	215.703
SSE=	40782.514

As per the estimates of a Linear regression forecast the county department stores would have had sales of $99.65 million for September, $105.95 million for October, $137.63 million for November and $215.70 million for the month of December, had there been no hurricane. This model had an SSE of **40782.69**

7) **Estimated sales for county stores had there been no hurricane using Quadratic regression.**

The estimates of sales when forecasted using the method Quadratic regression, the equation took the below form. b0, b1 and b2 values were the optimal values defined by solver.

County Sales (Y-predicted)= 59.85 (b0) + (b1)1.328*Period (X)-0.10*X^2



MONTH	QUADRATIC REG FORECASTS
September	86.689
October	91.686
November	118.466
December	184.651
SSE=	36299.888

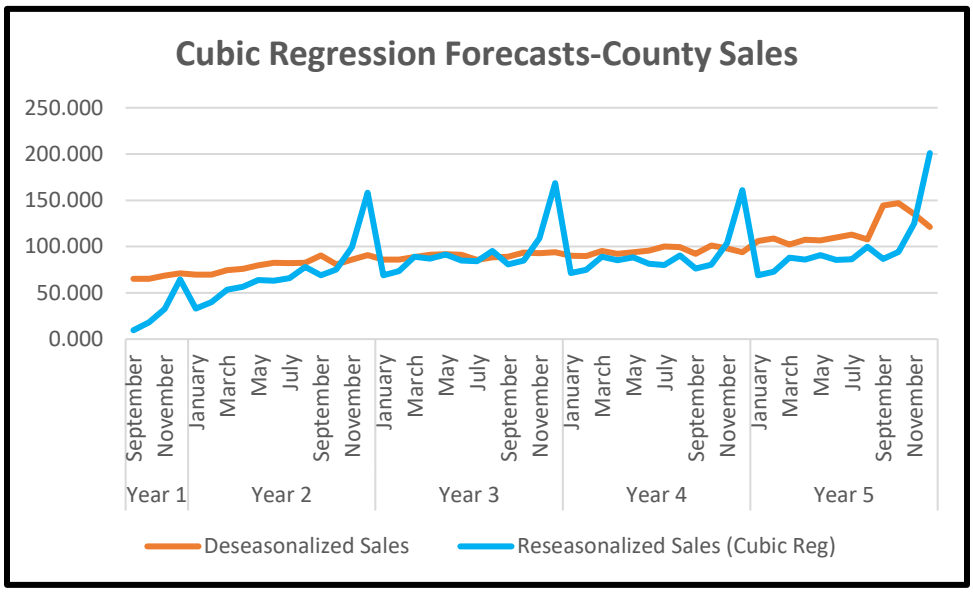
As per the estimates of a quadratic regression forecast the county department stores would have had sales of $86.68 million for September, $91.86 million for October, $118.46 million for November and $184.65 million for the month of December, had there been no hurricane. This model had an SSE of **36299.88.**

8) Estimated sales for county stores had there been no hurricane using Cubic regression.

We went forward and tried applying a higher ordered regression model, that is cubic regression to forecast the sales of department stores of the county had there been no hurricane.

The regression equation took the below form, and b0, b1, b2 and b3 coefficients and the intercept were the optimal values as defined by the Solver.

County Sales (Y-predicted)= 1.741 (b0) + (b1)9.755*Period (X)-(b2)0.339*X^2+(b3)0.004*X^3



MONTH	CUBIC REG FORECASTS
September	86.754
October	94.084
November	125.035
December	201.053
SSE=	46575.713

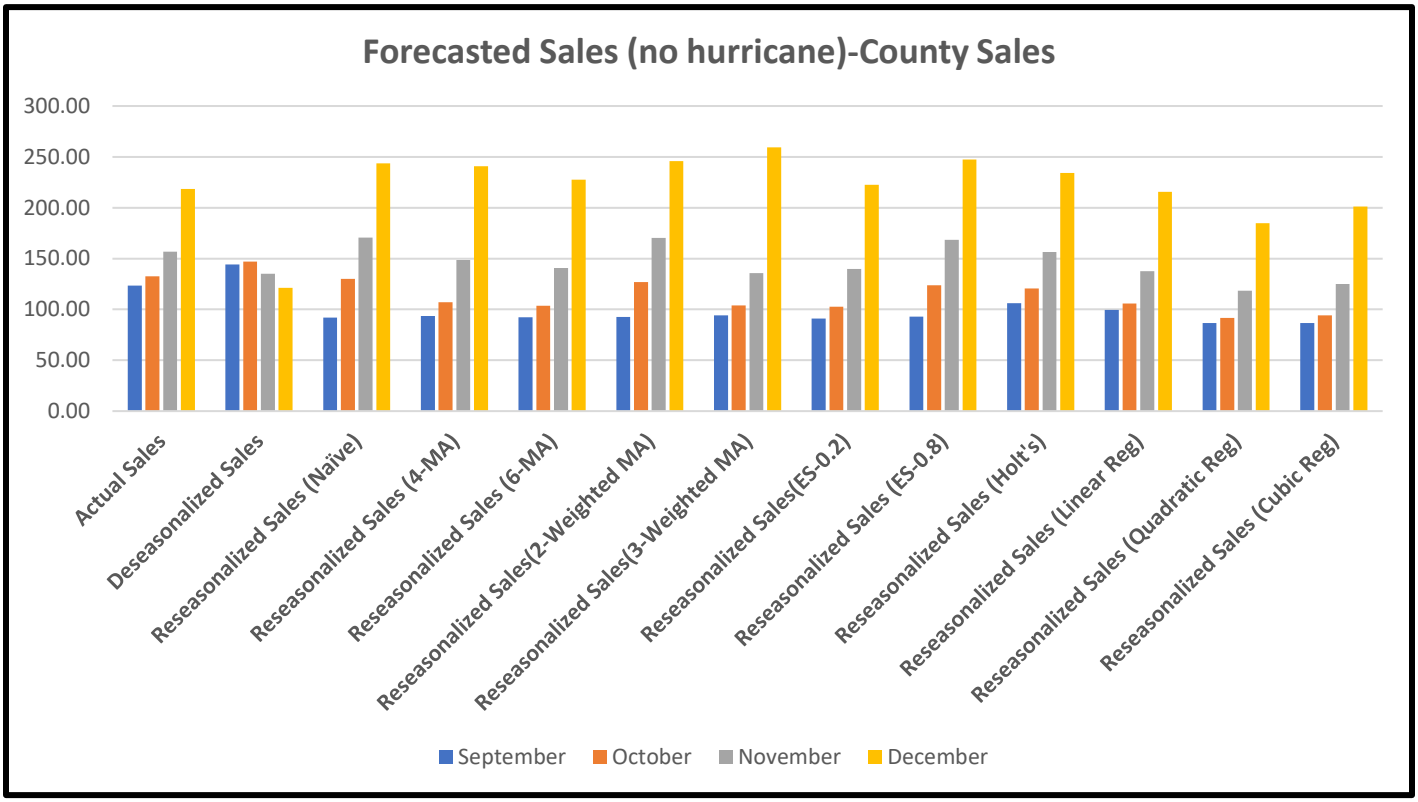
As per the estimates of a cubic regression forecast the county department stores would have had sales of $86.75 million for September, $94.08 million for October, $125.03 million for November and $201.05 million for the month of December, had there been no hurricane. This model had an SSE of **46575.**

SUMMARY OF FINDINGS

The below tables summarize the findings of the analysis, that is the county department store sales had there been no hurricane as forecasted by the above models.

The column actual sales will help us in understanding if each forecast has underpredicted or overpredicted the sales data. SSE will help us in deciding on choosing the best forecast.

Month	September	October	November	December	SSE
Actual Sales	123.44	132.46	156.83	218.52	-
Deaseaonalized Sales	144.33	146.95	135.10	121.15	-
Reseasonalized Sales (Naïve)	92.00	130.10	170.58	243.69	45263.9
Reseasonalized Sales (4-MA)	93.42	106.95	148.50	240.78	41452.5
Reseasonalized Sales (6-MA)	92.17	103.48	140.89	227.47	38407.5
Reseasonalized Sales(2-Weighted MA)	92.45	126.78	170.28	245.83	45708.2
Reseasonalized Sales(3-Weighted MA)	94.14	103.85	135.84	259.38	48209.7
Reseasonalized Sales(ES-0.2)	90.91	102.67	139.90	222.64	40428.7
Reseasonalized Sales (ES-0.8)	92.78	123.63	168.31	247.26	46035.9
Reseasonalized Sales (Holt's)	106.03	120.55	156.56	234.32	40752.2
Reseasonalized Sales (Linear Reg)	99.66	105.95	137.63	215.70	40782.5
Reseasonalized Sales (Quadratic Reg)	86.69	91.69	118.47	184.65	36299.8
Reseasonalized Sales (Cubic Reg)	86.75	94.08	125.04	201.05	46575



RECOMMENDATIONS AND JUSTIFICATIONS

We have already analyzed the reasons for choosing or not choosing a specific forecast based on trend, seasonality, nature of the data and the based-on comparison their SSE. In the context of county sales, we had the data for actual sales of the months September, October, November and December, the periods for whom we estimated the sales numbers had there been no hurricane.

Out of all the forecasting methods applied, **the 6-period moving average and the quadratic regression models** showed greatest level of accuracy and reliability with an SSE of below 40 that is **38407.5 and 36299.8** respectively.

- As per the estimates of 6-period moving average, had there been no hurricane the county department stores would have had a sale of:

  September: $92.17 million

  October: $103.48 million

  November: $140.88 million

  December: $227.46 million

And a **total of $564.01 million** in sales would have been made by the County department stores during the months of September, October, November, and December had there been no hurricane.

- If a causal model were to be considered for analysis laying importance on the relationship between county sales and time, we recommend utilizing the estimate of sales provided by the quadratic regression model. As per which, had there been no hurricane the county department stores would have had a sale of:

  September: $86.68 million

  October: $91.86 million

  November: $118.46 million

  December: $184.65 million

And **a total of $481.4 million in sales** would have been made by the County department stores during the months of September, October, November, and December had there been no hurricane. However, a point to be considered is that this model might have slightly underpredicted the sales when compared to the actual sales made by the county department stores.

Thus, we recommend Ryan to choose one of the above forecasts, for his further analysis of Fodor Department sales performance.

III. ESTIMATING LOST SALES FOR THE FODOR DEPARTMENT STORE FOR SEPTEMBER THROUGH DECEMBER

Please refer to the attached excel sheet: Lost sales for detailed calculations and approach.

We are estimating the lost sales that is the sales the Fodor Department store have had made had it been open during the hurricane that is during the months of September, October, November, and December.

For this purpose, we are making use of the county department store actual sales, that is sales generated during the hurricane and the estimated county sales had there been no hurricane to look at the %change in county sales caused by hurricane.

1) We have estimated the lost sales for Fodor department store using the forecasted sales for Fodor had there been no hurricane as given by the two recommended methods of 6-period Moving average and Quadratic regression.
2) We analyzed the %change in sales for the county sales caused by the hurricane and we have used that growth rate percentage and added it to our forecasted sales for Fodor department had there been no hurricane, to estimate the sales Fodor would have had made if it was open during the hurricane.

County Department Store Sales					
Month	**Hurricane (Actual Sales)**	**No Hurricane (Forecast from 6-MA)**	**No Hurricane (Forecast-Quadratic Regression)**	**%Change in Sales (6-MA) (%)**	**%Change in Sales (Quadratic Regression)(%)**
September	123.44	92.172	86.689	**33.92**	**42.393**
October	132.46	103.481	91.686	**28.00**	**44.471**
November	156.83	140.889	118.466	**11.31**	**32.384**
December	218.52	227.469	184.651	**-3.93**	**18.342**
Total Sales	631.25	564.011	481.493	**11.92**	**31.103**

3) 6-MA Forecast-From the above table it can be stated that County department stores made an excess sale of 33.92% in September, 28% in October, 11.3% in November and there was decrease in sale by 3.93% from the sales activity during the hurricane. **In other words, the forecasted sales showed 33.92% less sales in September when compared to actual sales.**

4) **Quadratic Regression Forecast**- From the above table it can be stated that County department stores made an excess sale of 42.3% in September, 44.4% in October, 32.3% in November and 18.34% in December from the sales that were generated during the hurricane.

5) The below table on county sales shows the estimates of %change in sales due to hurricane, using we first estimated Fodor sale if it was open during the hurricane and then took a difference between the sales it was to be made during the hurricane and sales had there been no hurricane to arrive at the lost sales for Fodor.

From the table on Lost sales estimate for Fodor Department Stores:

6) Based on 6-MA Forecast, the Fodor store would have had made a sale of $4.81 million in September, $5.40 million in October, $8.38 million in November and $7.23 million in December, if it was open during the hurricane.

Lost Sales Estimate for Fodor Department Stores								
Month	**No Hurricane (Forecast from 6-MA)**	**No Hurricane (Forecast-Quadratic Reg)**	**%Change in Sales (6-MA) (%)**	**%Change in Sales (Quadratic Reg)**	**Hurricane sales (based on 6-MA forecast)**	**Hurricane sale (based on quadratic Reg forecast)**	**Lost Sales-6MA**	**Lost Sales-Quadratic Reg**
September	3.590	3.661	33.92	42.393	4.81	5.21	**1.218**	**1.55**
October	4.221	4.336	28.00	44.471	5.40	6.26	**1.182**	**1.93**
November	5.050	5.224	11.31	32.384	8.38	6.92	**3.327**	**1.69**
December	7.526	7.838	-3.93	18.342	7.23	9.28	**-0.294**	**1.44**
Total Sales	20.386	21.060	11.92	31.103	25.82	27.67	**5.433**	**6.61**

Hence, as per 6-MA forecasted Fodor sales had there been no hurricane, the estimated lost sales for Fodor department store are seen as $1.21 million in September, $1.18 million in October, $3.3 million in November and a -$0.294 million in December (it would have incurred a loss in December). A total $5.43 million sale was estimated to be lost for Fodor for the store not being open during the hurricane.

7) Similarly, based on the Quadratic Regression Forecast, the Fodor store would have had made a sale of $5.21 million in September, $6.26 million in October, $6.92 million in November and $9.28 million in December, if it was open during the hurricane.

Hence, as per Quadratic regression forecasted Fodor sales had there been no hurricane, the estimated lost sales for Fodor department store are seen as $1.55 million in September, $1.93 million in October, $1.69 million in November and a $1.44 million in December (it would have incurred a loss in December). A total $6.61 million sales were estimated to be lost for Fodor for the store not being open during the hurricane.

IV. ANALYZING IF THERE WERE ANY EXCESS STORM RELATED SALES

Please refer to attached excel sheet: excess sale for detailed calculations and estimates.

The below table shows us the details of calculating if any excess sale was made during the hurricane by County department stores and if yes, by how much. Again, considering the two recommended forecasts of 6-Moving Average and Quadratic Regression forecasts.

Estimating excess sale made by County Department Stores					
Month	**Hurricane (Actual Sales)**	**No Hurricane Sale (Forecast from 6-MA)**	**No Hurricane Sale (Forecast-Quadratic Regression)**	**Excess Sale (6-MA)**	**Excess Sale (Quadratic Reg)**
September	123.44	92.17	86.69	**31.27**	**36.75**
October	132.46	103.48	91.69	**28.98**	**40.77**
November	156.83	140.89	118.47	**15.94**	**38.36**
December	218.52	227.47	184.65	**-8.95**	**33.87**
Total Sales	631.25	564.01	481.49	**67.24**	**149.76**

			%Sale due to Hurricane(6-MA)=	**11.92**
6-MA Forecast on Total Sales=	**20.38**	**Fodor can claim compensation for forecasted sale +% of sale caused due to hurricane**	**Excess Sale compensation eligibility=**	**2.43**
			%Sale due to Hurricane(Quadratic Reg)=	**31.10**
Quadratic Reg Forecast on Total Sales=	**21.06**	**Fodor can claim compensation for forecasted sale +% of sale caused due to hurricane**	**Excess Sale compensation eligibility=**	**6.55**

Hence, from the above estimations it can be concluded that:

- As per the 6-period moving average forecast, the county sales increased by **11.92%** in total during the hurricane. The forecast had estimated a sale of 11.9% less than the actual sales.
- As per the county sales analysis, it can be stated that Fodor Department store would have had made an **excess of $2.43 million sale during the hurricane, considering the Fodor's 6-MA sales forecast.**
- As per the Quadratic regression forecast, county sales increased by **31.1%** in total during the hurricane. The forecast had estimated a sale of 31.1% less than the actual.
- As per the county sales analysis, it can be stated that Fodor Department store would have had made **an excess of $6.55 million sale during the hurricane**, considering the Fodor's Quadratic regression sales forecast.

We strongly recommend Ryan to file a case for gaining compensation for excess sales Fodor Department store would have earned in addition to the ordinary sales if it were selling during hurricane. And Fodor Department store would have **earned $2.43 million in excess** for a forecasted sales of 6-period moving average (had there been no hurricane) **and an excess sale of $6.55 million** was estimated considering the Quadratic regression forecasted sales.