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Project Report

Lecture Business Forecasting

Mini Case Study 1

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1. Mini Case Study I

The decision maker is interested in an appropriate method to perform one-month-ahead forecasts of total US retail sales. In this case we have been given the period from January 2001 to December 2012 to be our Estimation Sample. Thus, making our Hold-out sample from January 2013 to December 2015.

In order to predict the one month ahead forecasts, it is necessary to check for the Trends and Seasonal Patterns. After plotting the general time plot for the entire US Retail sales data (Fig. 1), it is very clear that a strong trend as well as seasonality exists. Hence, we decided that the PIVASE framework will helps us the best to match the planning problem and the kind of forecast we need.

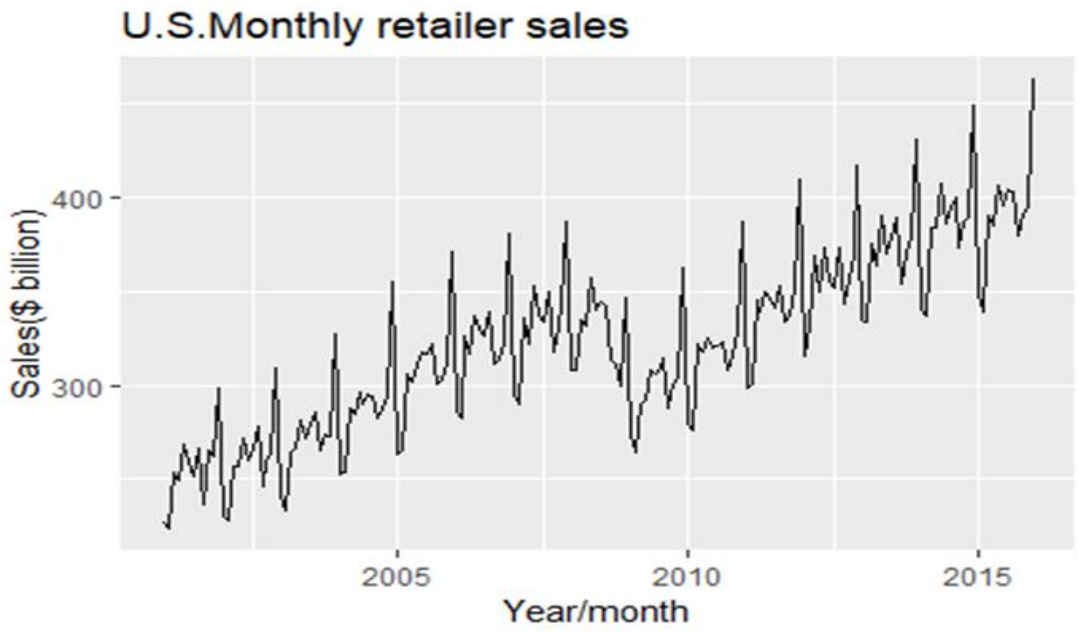

Figure 1: Time Plot of US Retail Sales from January 2001 to December 2015

2. Procedure Followed:

To start performing the forecast analysis we are using the PIVASE Framework and it is as follows:

i. **Purpose:** For this case study, the purpose was to forecast the sales for one month ahead forecasts of the US Retail Sales.

ii. **Information:** The case study consisted of a Data set of Monthly Retail Sales in Billion from January 2001 to December 2015.

iii. **Value:** The value of the forecast lies with the decision maker who needs the one month ahead forecasts.

iv. **Analysis:** Along with a time plot we plotted a seasonal plot (Fig.2) in which the under lying seasonal pattern was clearly visible.

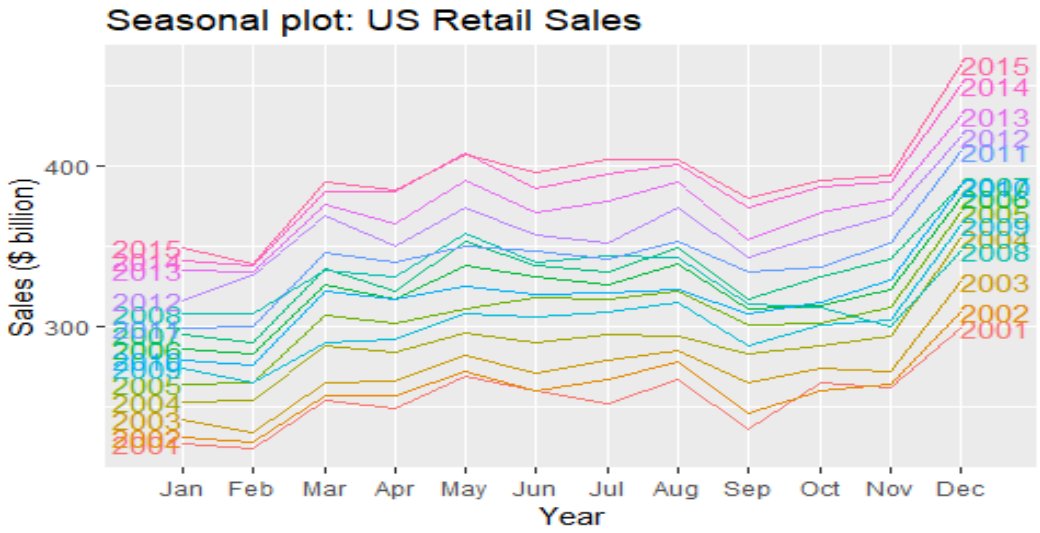

Figure 2: Seasonal Plot of US Retail Sales from January 2001 to December 2015

2.1. Benchmarking Methods - The three Benchmarking methods i.e., the Average or Mean method, the Naïve method and the Seasonal Naïve method were tested. However, in this case (Fig.3), all of the results point to the Seasonal Naïve method as the best of these three methods for this data set since the RMSE is the lowest compared to all three methods.

This was performed on R by using the functions meanf (y, h), rwf (y, h), snaive (y, h) which corresponds to the Average (Mean) method, Naïve method and Seasonally Naïve method respectively. Here, y contains the time series, h is the forecast horizon.

Method	ME	RMSE	MAPE	MASE
Mean Method	-8.68e-15	21.8636	6.061334	1.803481
Naïve Method	2.882914	25.85801	7.118891	2.13455
Seasonal Naïve Method	8.352625	10.05256	3.251252	1

Figure 3: Comparison of the Benchmarking Methods

2.2. Choice of models for forecasting: R was the chosen software to execute all the forecasting methods. While choosing models, we have to separate the Estimation sample and the Holdout sample. The Estimation Sample is used to estimate any parameters of a forecasting method whereas the Holdout Sample is used to evaluate its accuracy.

Simple Exponential Smoothing was eliminated because of the evident seasonality present in the data.

a. Linear Exponential Smoothing: Since there is a very clear presence of a trend in the data (Fig.1) Holts method was used. First the data set was divided into Estimation and Hold-out sample and stored as time series object "Estimationts" and "Holdts" respectively. -The LES function is executed with the syntax "holt (y, h)" for the Estimation sample first because we need to set the smoothing parameters alpha and beta which was 0.1805 and 0.1163 respectively and then forecasted the Holdout sample with these values.
b. Damped LES: The damped LES function is executed with the syntax "holt (y, damped=TRUE, h)" for the Estimation Sample first and the smoothing parameters alpha and beta values were 0.0553 and 0.0504 respectively.

c. Holt Winters Additive: The Holt-Winters Additive function is executed by first assigning the training data and test data and then with the syntax "hw (y, seasonal="additive", initial ="simple", h)" for the Estimation Sample first and the smoothing parameters alpha and beta values were 0.6323 and 0 respectively.

d. Holt Winters Multiplicative: The Holt-Winters Multiplicative function is executed by first assigning the training data and test data and then with the syntax "hw (y, seasonal=" multiplicative", initial = "simple", h) "for the Estimation Sample first and the smoothing parameters alpha and beta values were 0.6291 and 0 respectively.

e. Holt Winters Damped Multiplicative: Damping is possible with both additive and multiplicative Holt-Winter's method. A method that often provides accurate and robust forecasts for seasonal data is the Holt-Winter's method with a damped trend and multiplicative seasonality.

-The Holt-Winters Damped Multiplicative function is executed by first assigning the training data and test data and then with the syntax "hw (y, damped=true, seasonal="

multiplicative", h) "for the Estimation Sample first and the smoothing parameters alpha and beta were 0.6221 and 0.0263 respectively.

	RMSE	MAE	MAPE	Alpha	Beta
LES	22.63029	17.00778	6.434177	0.1805	0.1163
Damped LES	19.80701	14.01157	5.296369	0.0553	0.0504
Holt Winter's Additive	5.373619	3.398082	1.270671	0.6323	0
Holt Winter's Multiplicative	5.504416	3.366492	1.264555	0.6291	0
Holt Winter's Damped	4.285394	3.270304	1.232992	0.6221	0.0263

Figure 4: Overall View of the Different Forecast Methods and their Corresponding Values

As seen in Figure 4, Holt Winters Damped Method is chosen as the best method as it gives us the smallest RMSE value compared to all other methods. RMSE values show us the accuracy of the forecast and it's clear that this method is the best method.

v. **System:** The software that was required to meet the goal was R, and the system of forecasts(models) we used to be Holts Linear Trend Method, Damped Trend Method, Holt-Winters Additive Method, Holt-Winters Multiplicative Method and Holt-Winter's Damped Method.

vi. **Evaluation:** The Estimation Sample is usually 70%-80% of the total data set while the Holdout Sample constitutes the rest. The Estimation Sample was changed from January 2001-December 2012 to different values with respect to dividing of the data 70%-30% (January 2001 – December 2011). The RMSE value obtained was 4.337674. Hence, the present Estimation Sample gives us the best RMSE value (4.285394) with the Holt Winter's Damped method and therefore is the best choice for the Estimation Sample.

2.3. One-Month Ahead Forecasts:

The One-month ahead Forecasts from January 2016 to December 2016 are as follows:

Month	Sales($Billions)
January 2016	250.3192
February 2016	245.1882
March 2016	276.4687
April 2016	275.4913
May 2016	292.6460
June 2016	281.6818
July 2016	283.4530
August 2016	295.3040
September 2016	266.5446
October 2016	284.1646
November 2016	284.5055
December 2016	332.4140

Figure 5: One-Month Ahead Forecasts

3.CONCLUSION

The best Forecasting method chosen is Holt Winter's Damped Method which gives us an RMSE value of 4.285394 with the smoothing parameters alpha value of 0.6221 and beta value of 0.0263. The one-month ahead forecasts are shown in Figure 5 and hence the objective has been achieved.

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