**FORECASTING ASSIGNMENT**

**PART 2**

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**PROBLEM**

For the following assignment we are going to analyze the sales of Beer, Wine and Liquor retails across US, from the year 1992 up to 2020, we are going to use 2 different techniques to make a forecast and select the best model based on accuracy and residual analysis.

https://www.kaggle.com/datasets/vishnucr/retails-sales-beer-wine-and-liquor-stores

**DATA EXPLORATION**

Time Series Plot

Chart, histogram

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We can see the there is a clear trend and possibly seasonality on the time series, we can also see a high variance on the data.

Chart

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On the seasonal plot we can see a peak of liquor sales on the month of December, since January there is a slowly increase and exponential increases on the last month of the year.

While one the seasonal subseries plot we can see that the mean shows a peak on the last month and a increasing trend.

Chart, histogram

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Next on our ACF graph we can see that there is a small seasonality having peaks on lag 12, 24 and 36 meaning it’s a yearly seasonality, while slowly decaying into zero, meaning there exists a trend on the time series

On the PACF graph we can see a significant correlation at lag 1, following by a small correlation on lag 2, up to lag 5, this means we should use an MR(5) model

A picture containing text, antenna

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Also after decomposing the data we can clearly se the rising trend and the seasonality .

**TRANSFORMATION**

After analyzing if the time series needs transformation, based on the lambda value that we got of 0.05812355, we decide to apply a Box Cox transformation, since the value is so close to zero the transformation will work like a logarithmic transformation.

Since we are using mainly the forecast function, we can apply the transformation on every forecasting using the lambda parameter, this will allow us to transform the data using the Box Cox transformation and then reverse it to its original scale without extra steps.

**FORECASTING**

HOTLS WINTER

For our first technique we selected the Hotls winter method, since we learn from our PACF graph we need to use a moving average model, and Holts winter use an exponential moving average, this allow us to take into account a trend and seasonality present on the data.

We are going to compare 4 different variations on the holts winter method, one with Additive seasonal error and other with multiplicative seasonality, while each one having 2 variations of the alpha value, that will help smooth the mean.

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After analyzing the accuracy made on the test set, we can see that the best model is the holts winter with additive method having a alpha value of 0.5, the MASE remains under 1 meaning that this models still able to predict out of sample accurately.

Chart

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HWA HWA0.5 HWM HWM0.5

After analyzing the graphs we can see that all of them have information on their residual al multiple lags

A screenshot of a computer

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This missing information on the residuals may be explained by the high variance that exists on the information.

ETS

For the second technique we are going to use a ETS model, since ETS, since this model alowsa us to use with data that has trend and seasonality. Here we use 4 different variations that take into account the trend and seasonality, based on hotls winter additive trend

. the first model is an “AAA” that has additive errors, additive trend and additive seasonality, the second model is “MAM”, having multiplicative errors, additive trend and multiplicative seasonality , the third model is the same as the first but adds a damped effect, and finally the last one is an “MAA” model that has Multiplicative error and additive trend and seasonality.

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After checking the accuracy on the 4 models we can say that the MAM model is the best performing , having the lowest RMSE, MAE, MAPE and a MASE lower than 1.

Chart

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AAA MAM AAdA MAA

On the residuals we have the same problem as before, all the models have information on the residuals that can be used.

**CONCLUSION**

After using two different techniques we compare the best model for each technique, having the holts winter with additive method and a alpha of 0.5 and the MAM model from the ETS

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Based on accuracy we can see that the holts winter has a lower error on RMSE MAE, MAPE and MASE compared to the ETs model, therefore we can conclude that the Holts winter is the best model out of these two

Graphical user interface

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