UNIVERSITY OF ALBERTA
ALBERTA SCHOOL OF BUSINESS

OM471 Group Project

Triple Exponential Smoothing Forecasting Method Application User Manual

Howie Zhou
Junaid Grewal
Joe Hyung Ha
Fatemeh Moeinipour

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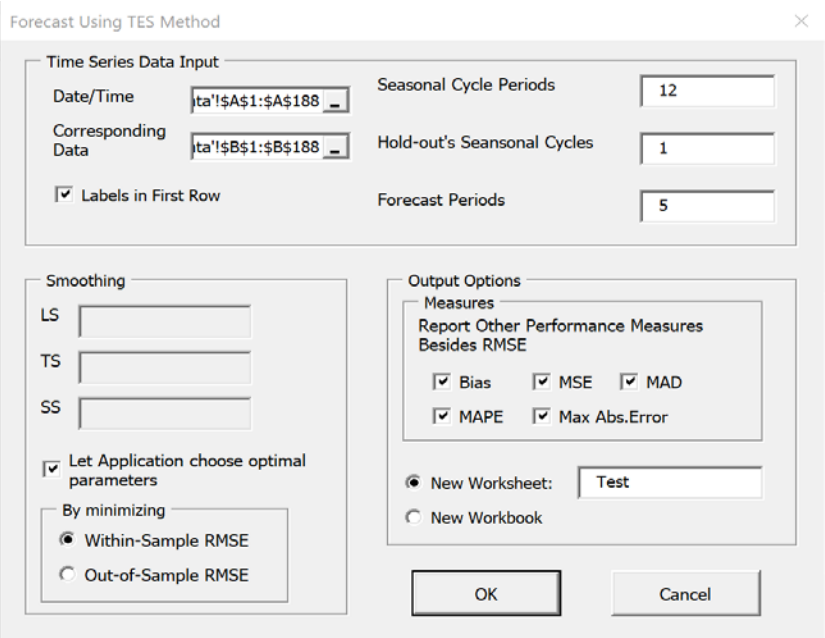
Triple Exponential Smoothing ("TES") is a method which uses three parameters of level (LS), trend (TS) and seasonality (SS) to generate forecasting. This application uses the inputted training data and finds the above-mentioned parameters by minimizing the RMSE and any other performance measures, if selected. The application also allows you to decide on the parameters values as well as visualize the results of the forecast with a graph.

Run Application:



By clicking on the button "Run Application" in the dashboard, you will see a form called "Forecast Using TES Method" asking for the necessary data among the provided options. For users with excel version other than 2016, the application will ask to select the worksheet where data is located (See appendix 1.1). In either case, make sure the workbook which contains data set is open before you run the application.

The form begins by asking you:

Time series data input:

- Select the Date/ time inputs from your data workbook;
- Select the corresponding time series data to be used in forecasting;
- Number of periods in each seasonal cycle, p: The period of seasonality, e.g., data has a tendency to exhibit behavior that repeats itself every p periods;
- The part of the data that will be used as the "holdout" data, a.k.a. "out-of-sample" data. The rest of the data will be the "training" data, a.k.a. "in-sample" data. Enter zero if you do not want a hold-out analysis;
- Number of forecasts into the future. Enter zero if you do not want the application to do any forecast into future.

Output options:

- Which of the following performance measures (besides RMSE) should the application report, if any: mean squared error (MSE), bias (BIAS), mean absolute deviation (MAD), and mean absolute percent error (MAPE), and maximum absolute error (Max Abs.Error);
- Should the outputs be displayed in a new worksheet, then enter a name for the worksheet, or in a new workbook.

Smoothing:

- Whether the user wants to provide values for level, trend, and seasonality smoothing constants (LS, TS, and SS, respectively), or whether the application decides on the optimal values;
- And lastly, if the smoothing values should be calculated by minimizing within sample or out of Sample RMSE.

After entering the necessary data, you may click the forecast button. The application will check the following before running presenting a report:

- Range of selected dates and its corresponding data should be the same. Ensure you select a valid range for this section as VBA will perform an error check. If titles of these columns are selected too, make sure "Labels in fist row" is selected;
- Number of periods in seasonal cycle and Number of cycles for hold-out analysis should be entered as an integer bigger than zero. If hold out value is equal to zero, the whole selected data set will be used for forecasting;
- The "number of forecast periods" textbox is the number of periods you would like to forecast past the last data point entered. Ensure you enter a positive integer as VBA will not advance past this form otherwise;
- By default, "Let the application choose optimal parameters" is selected which means that Smoothing parameters can be found by the application. You also have the option to select either "Within-sample" or "Out-of-Sample" data for this calculation;
- Should you decide on using your own values, ensure the above- mentioned check box is not selected first. Enter a number between 0 and 1 exclusively. By selecting a value closer to 1, more weight is given to more recent data;
- By selecting "New Worksheet" in the output options section, the application will show the results in a new worksheet. The name of this worksheet shouldn't be a copy of other sheets in this workbook.

After completing the Input Data form, you may select OK to complete the forecast. Remember that this application may take a couple minutes to fully present the report. From that point, a new worksheet/workbook will be created. It will contain all results of the TES forecast. The results of this sheet are dependent upon the inputs of the input data form.

Refer to appendix 1.2 and 1.3 for a completed report sample. Cells in blue are changing variables (independent variables), meaning you may change the values in those cells if you want to. Current values are the value you gave initially, or the optimal values chosen by application. Cell in yellow is the objective variable (dependent variable). If you let the application decide the optimal values for smoothing, this value in yellow cell would be minimized. If you want to check detailed calculation on error, absolute error etc. You may click button "Show Error Calculation" on the report page.

Note that that sample report contains hold-out analysis and forecast into future. For reports without hold-out analysis, there will be no "Out-of-Sample Measures".

Structure of the Application Code

The sub that generates the forecast result calls the following major subs from the main sub in the following order: InputFormula, ErrorCalculation, Measures, RunSolver, IntoFuture, and BuildChart. There are also four other subs which do not functionally matter to this application.

InputFormula

This sub includes all the formulas used in the final report page. It starts with calculating level, trend and seasonality initialization by using LS, TS and SS values and continues to training and hold out data. If the holdout cycle was entered as zero, this sub will use the whole data set for forecasting. If in the user form, you have entered these values manually, the formulas will incorporate them into the formulas.

ErrorCalculation

By starting to generate titles for each performance measure, the sub continues to calculate and show error, Sqr. Error, Abs.Error and %Error corresponding to its data point. Whether you want to see the calculations or not are optional and can be decided by clicking on either of the following buttons found on the right side of the forecasting result page. These button will be created by two separate subs at the end.

“Show Error Calculation” and “Hide Error Calculation”.

Measures

The values generated by the error calculation sub are later used in this sub to calculate, Bias, MSE, MAD, MAPE, Max Abs.Error, if selected in the form, and RMSE. If the user entered 0 for the hold out cycles, out of sample measures will be excluded from the calculations. As a result, you will only see the within-sample values of performance measures.

RMSE: root mean square error is calculated by using SQRT and SUMXMY2 excel functions

Bias: Average of error values

MSE: average of squared errors

MAD: average of absolute values of errors

MAPE: average of absolute percentage errors

Max Abs.Error: using MAX function to see the maximum value of percentage errors.

IntoFuture

Depending on whether the user enters any integers other than zero in the number of forecasting cycles text box in the form, the application will start running the future forecasting. For this sub,

an if statement checks the number of holdout cycles and if it's not equal to zero, autofill the forecast range with previous cycle formulas. However, if the holdout cycle is zero, the sub writes the formulas such as VLookup to create the forecast value.

RunSolver

By minimizing RMSE value for either Within-Sample or Out-of-sample data, the values of smoothing parameters are found by solver. The constraints are forcing the smoothing values to be between 0 and 1 exclusively. Multi-start function enables solver to find the global minimum value of RMSE.

BuildChart

After running through the above subs, the next sub that will be called is the BuildChart. This sub will select the data found within the output worksheet named by you in order to create a chart. The chart will graph the user inputted data, along with the TES results from the forecast. It is especially useful in visualizing any found parameters found in the data.

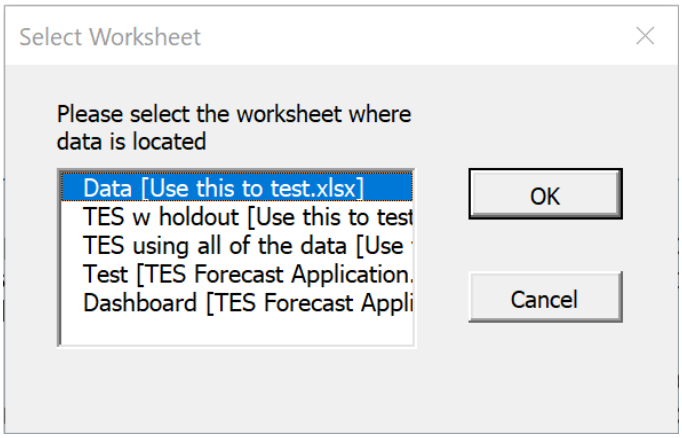
Others

The following subs give user options to hide or show error calculation:

CreateButton1; CreateButton2; ShowCalculation; Hide Calculation.

There is another sub DeleteWS assigned to button "Delete All Report" allows user to delete all worksheets except for dashboard.

APPENDICES



Appendix 1.1

Summary Report (Using all of the data)

Date	Actual	k	TES Foreca	Level	Trend	p	Seasonality
01-Jan-80	112					1	0.764505
01-Feb-80	118					2	0.805461
01-Mar-80	129					3	0.880546
01-Apr-80	99					4	0.675768
01-May-80	116					5	0.791809
01-Jun-80	168					6	1.146758
01-Jul-80	118					7	0.805461
01-Aug-80	129					8	0.880546
01-Sep-80	205					9	1.399317
01-Oct-80	147					10	1.003413
01-Nov-80	150					11	1.023891
01-Dec-80	267			146.5	1.166667	12	1.822526
01-Jan-81	126		112.8919	149.7441	1.332269	1	0.799356
01-Feb-81	129		121.6861	152.1766	1.419972	2	0.824595
01-Mar-81	124		135.2489	152.0487	1.296586	3	0.851092
01-Apr-81	97		103.6259	152.1573	1.201885	4	0.658431
01-May-81	102		121.4312	150.3858	0.964864	5	0.740367
01-Jun-81	127		173.5625	146.4309	0.572695	6	1.02016
01-Jul-81	222		118.4056	162.5873	1.814921	7	1.059132
01-Aug-81	214		144.7637	173.9293	2.574356	8	1.039029
01-Sep-81	118		246.9846	165.335	1.684068	9	1.088723
01-Oct-81	141		167.5891	163.8083	1.428131	10	0.93879
01-Nov-81	154		169.1841	163.4396	1.284897	11	0.986903
01-Dec-81	226		300.2146	159.7906	0.891597	12	1.637616
01-Jan-82	89		128.4422	154.7036	0.415023	1	0.697852

LS	TS	SS
0.121165	0.079713	0.453016

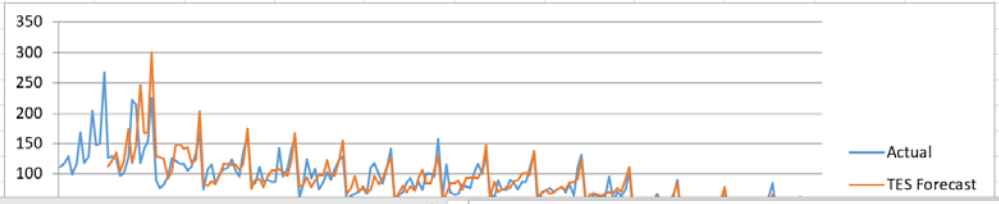
Within-Sample Measures	
RMSE	22.15084
Bias	-2.33934
MSE	491.6599
MAD	14.20484
MAPE	0.150767
Max Abs.Error	128.9846

Out-of-Sample Measures	
RMSE	13.66099
Bias	10.10918
MSE	187.6228
MAD	11.63204
MAPE	0.227317
Max Abs.Error	128.9846

Error	Sqr. Error	Abs.Error	%Error
13.10808	171.8217	13.10808	0.104032
7.313874	53.49276	7.313874	0.056697
-11.2489	126.5377	11.2489	0.090717
-6.62585	43.9019	6.625851	0.068308
-19.4312	377.5703	19.43117	0.190502
-46.5625	2168.066	46.56249	0.366634

Show Error Calculation

Hide Error Calculation



Test | Dashboard

Appendix 1.2

175	01-May-94	44		38.42693	49.99858	-0.53378	5	0.826443
176	01-Jun-94	45		46.03724	49.32977	-0.54454	6	0.922336
177	01-Jul-94	32		51.41211	46.55333	-0.72245	7	0.887832
178	01-Aug-94	36	1	40.63416			8	0.886611
179	01-Sep-94	46	2	38.90487			9	0.862475
180	01-Oct-94	51	3	40.58717			10	0.914414
181	01-Nov-94	63	4	43.69486			11	1.000718
182	01-Dec-94	84	5	65.45974			12	1.524409
183	01-Jan-95	30	6	24.46615			1	0.579511
184	01-Feb-95	39	7	29.43592			2	0.709365
185	01-Mar-95	45	8	34.34459			3	0.842322
186	01-Apr-95	52	9	35.41684			4	0.884288
187	01-May-95	28	10	32.50301			5	0.826443
188	01-Jun-95	40	11	35.60801			6	0.922336
189	01-Jul-95	62	12	33.63454			7	0.887832
190	01-Aug-95		13	32.94774			8	0.886611
191	01-Sep-95		14	31.4277			9	0.862475
192	01-Oct-95		15	32.6597			10	0.914414
193	01-Nov-95		16	35.01919			11	1.000718
194	01-Dec-95		17	52.24396			12	1.524409
195								

Test | Dashboard

Appendix 1.3