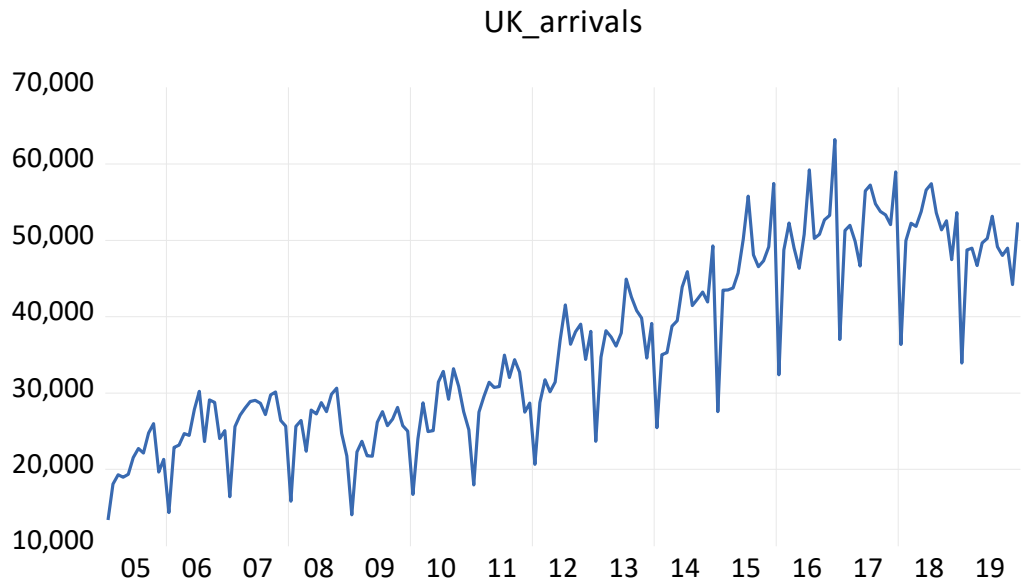
Eviews workflow

There are seven steps included in the forecasting. Steps from 1 to 4 are data preparation, with the purpose to demonstrate data distribution, remove seasonality, check stationary, and generate new time series, respectively. Step 5 is conducting Single Exponential Smoothing (SES) and Step 6 is running ETS. The last step is the evaluation of the performance of SES and ETS.

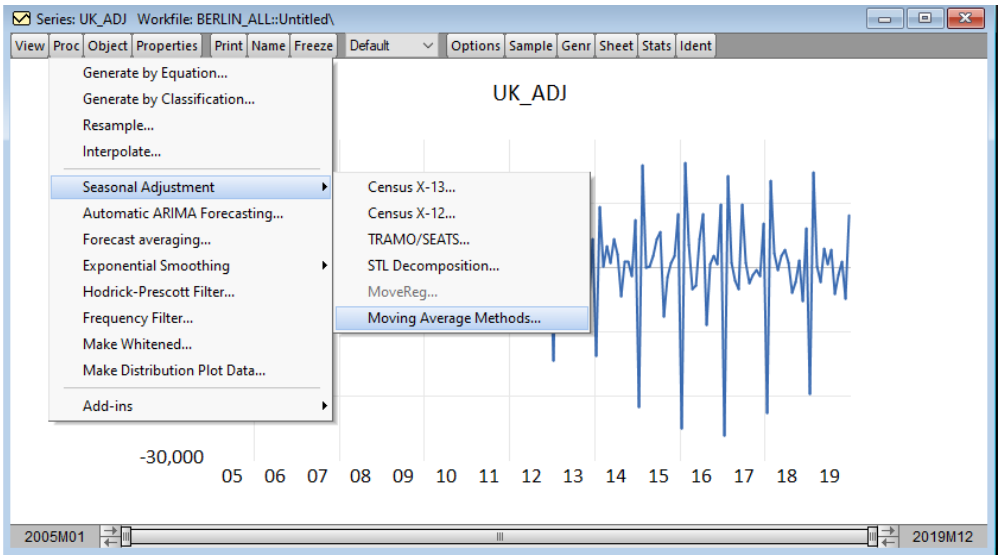
This is a step-by-step explanation of how to run Single Exponential Smoothing (SES) and ETS on Eviews as an example. We used UK arrivals data as an example. The same process has been applied to all the other time series (Total market, German, Italian, Spanish markets) in the final analysis.

1. First step is to check the distribution of data.

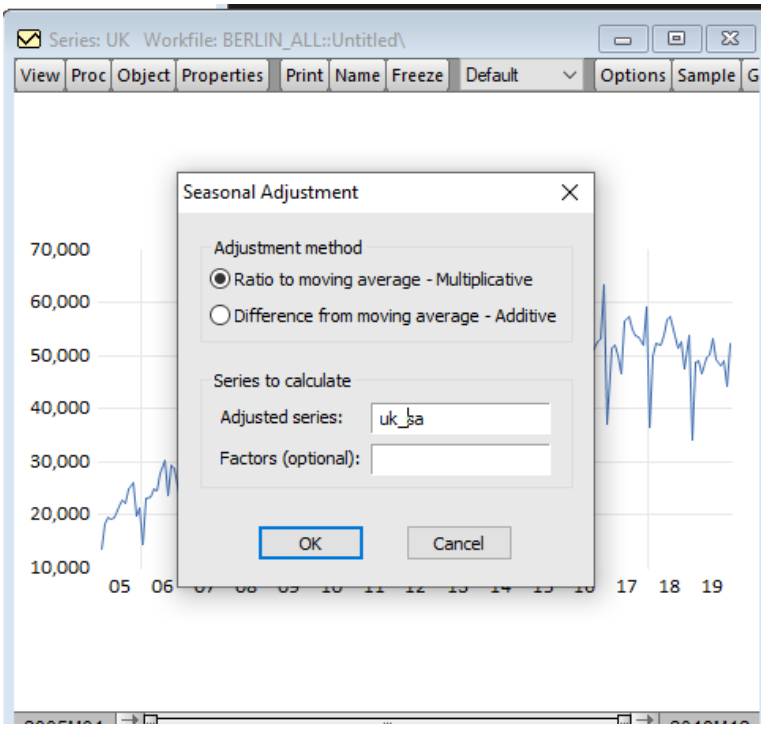


The graph shows a clear seasonality pattern. The arrivals decrease and increase at specific months each year.

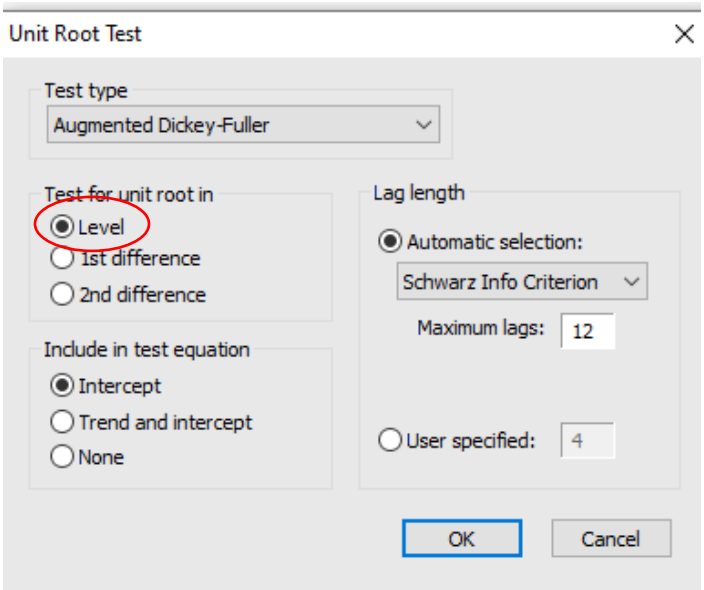
2. We need to remove seasonality from our time series to run analysis that does not take into account seasonality such as single exponential smoothing.



Since seasonality is multiplicative in tourism destinations, we use ratio to moving average-multiplicative method to remove seasonality. The new time series is called *uk_sa*.



3. Next step is to check if time series is stationary thus, we check if there is a unit root. We conduct ADF test on seasonality adjusted time series (uk_sa). The null hypothesis of ADF test is the time series has a unit root.



Null Hypothesis: UK_SA has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.081062	0.7229
Test critical values:	1% level	-3.467633	
	5% level	-2.877823	
	10% level	-2.575530	

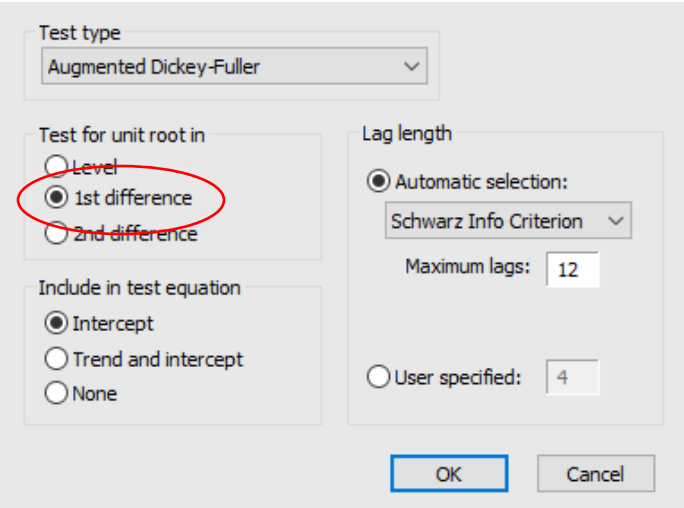
*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(UK_SA)
Method: Least Squares
Date: 02/12/21 Time: 09:28
Sample (adjusted): 2005M05 2019M12
Included observations: 176 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UK_SA(-1)	-0.016680	0.015429	-1.081062	0.2812
D(UK_SA(-1))	-0.206992	0.075225	-2.751634	0.0066
D(UK_SA(-2))	-0.296397	0.073194	-4.049464	0.0001
D(UK_SA(-3))	-0.255663	0.074800	-3.417931	0.0008
C	883.2548	576.0595	1.533270	0.1271

R-squared	0.145667	Mean dependent var	177.4081
Adjusted R-squared	0.125683	S.D. dependent var	2395.753
S.E. of regression	2240.147	Akaike info criterion	18.29447
Sum squared resid	8.58E+08	Schwarz criterion	18.38454
Log likelihood	-1604.913	Hannan-Quinn criter.	18.33100
F-statistic	7.289034	Durbin-Watson stat	2.013984
Prob(F-statistic)	0.000019		

The results show that there is a unit root in the series so we check the first difference of time series to see if there is unit root. In Eviews, you can do it by selecting 1st difference in test for unit root option.



Null Hypothesis: D(UK_SA) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.75343	0.0000
Test critical values:	1% level	-3.467633	
	5% level	-2.877823	
	10% level	-2.575530	

*MacKinnon (1996) one-sided p-values.

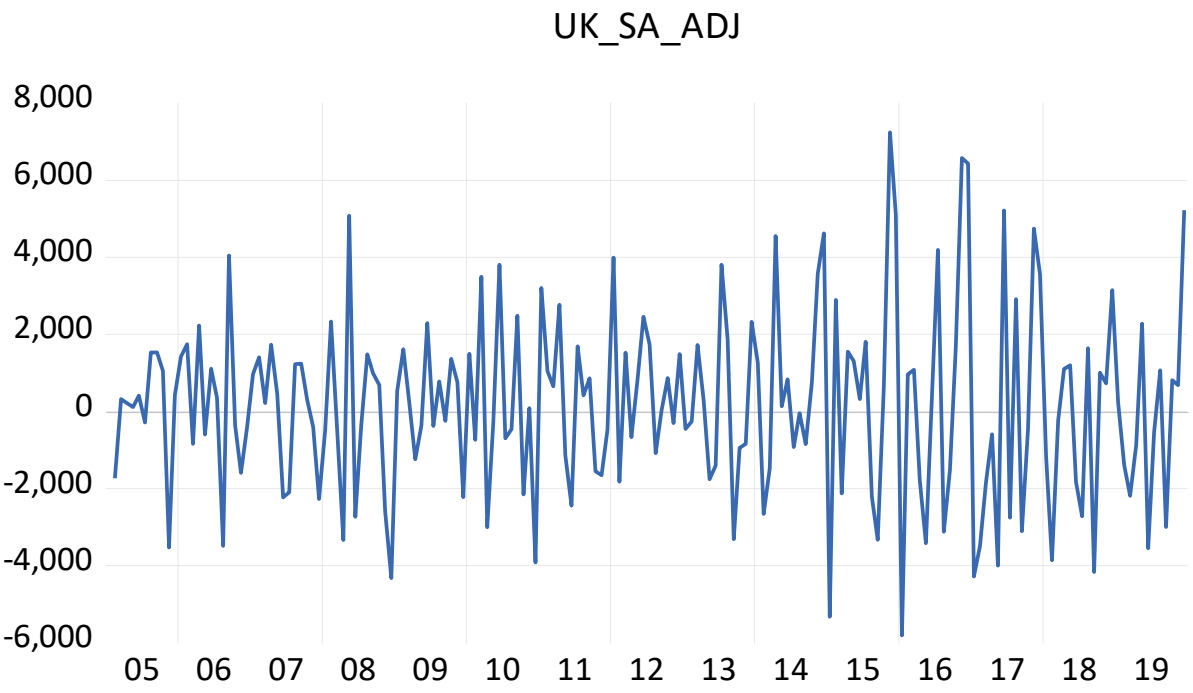
Augmented Dickey-Fuller Test Equation
Dependent Variable: D(UK_SA,2)
Method: Least Squares
Date: 02/12/21 Time: 09:29
Sample (adjusted): 2005M05 2019M12
Included observations: 176 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(UK_SA(-1))	-1.777240	0.151210	-11.75343	0.0000
D(UK_SA(-1),2)	0.561852	0.112231	5.006193	0.0000
D(UK_SA(-2),2)	0.259375	0.074758	3.469518	0.0007
C	288.3108	170.3136	1.692823	0.0923

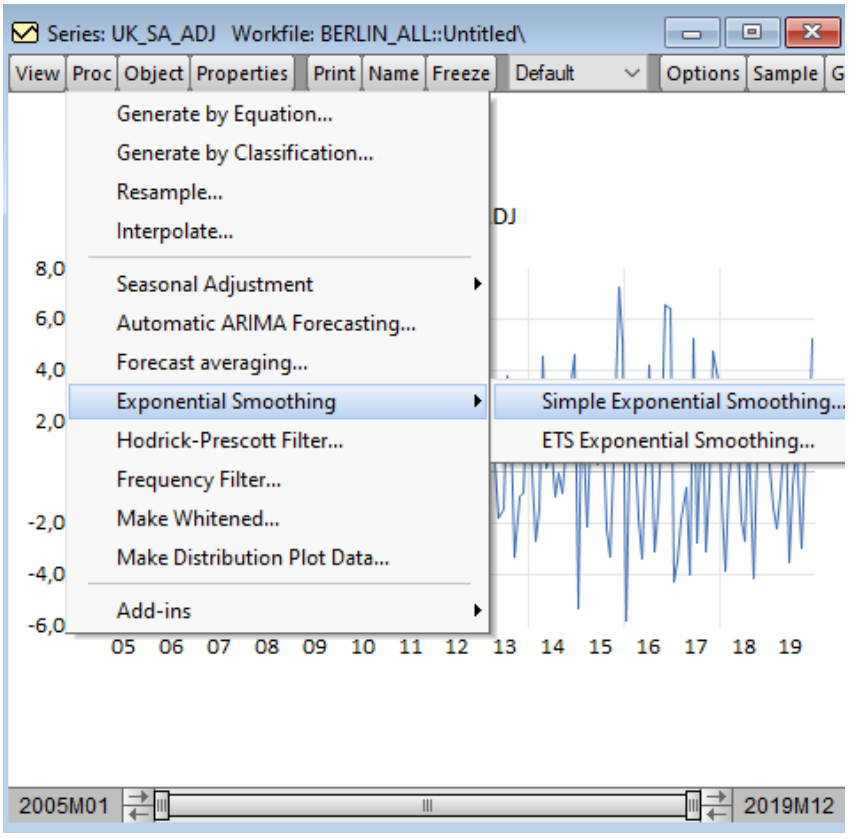
R-squared	0.608760	Mean dependent var	28.42200
Adjusted R-squared	0.601936	S.D. dependent var	3552.326
S.E. of regression	2241.246	Akaike info criterion	18.28992
Sum squared resid	8.64E+08	Schwarz criterion	18.36197
Log likelihood	-1605.513	Hannan-Quinn criter.	18.31914
F-statistic	89.20916	Durbin-Watson stat	2.017019
Prob(F-statistic)	0.000000		

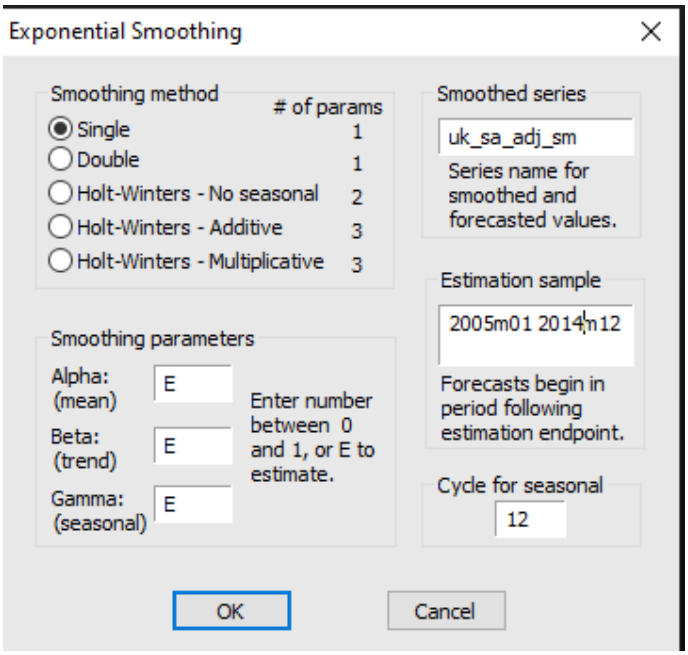
4. The results show that the first difference of our time series does not have unit root, so we take the first difference of our time series by generating a new time series with a different name. You can use the following code to create new time series which we called *uk_sa_adj*.

   uk_sa_adj = d(uk_sa,1)



5. Since we have stationary data, we can run Single Exponential Smoothing (SES) analysis using the adjusted time series (*uk_sa_adj*).





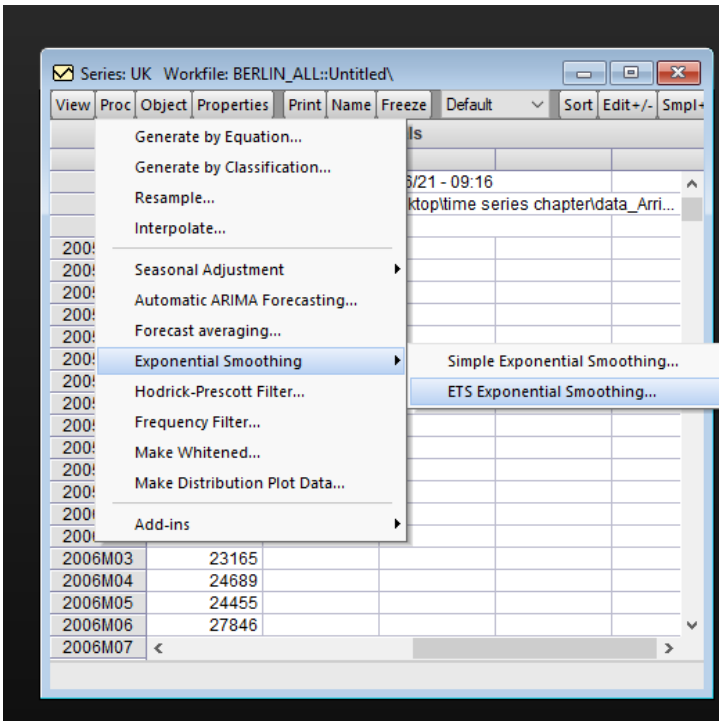
Our estimation sample is from 2005 M01 to 2014 M12. We chose single as smoothing method since we are conducting SES. The new smoothed series is called *uk_sa_adj_sm*, which we will use for forecasting 2015 M01 to 2019 M12 to evaluate our model.

Date: 02/12/21 Time: 09:37
Sample: 2005M02 2014M12
Included observations: 119
Method: Single Exponential
Original Series: UK_SA_ADJ
Forecast Series: UK_SA_ADJ_SM

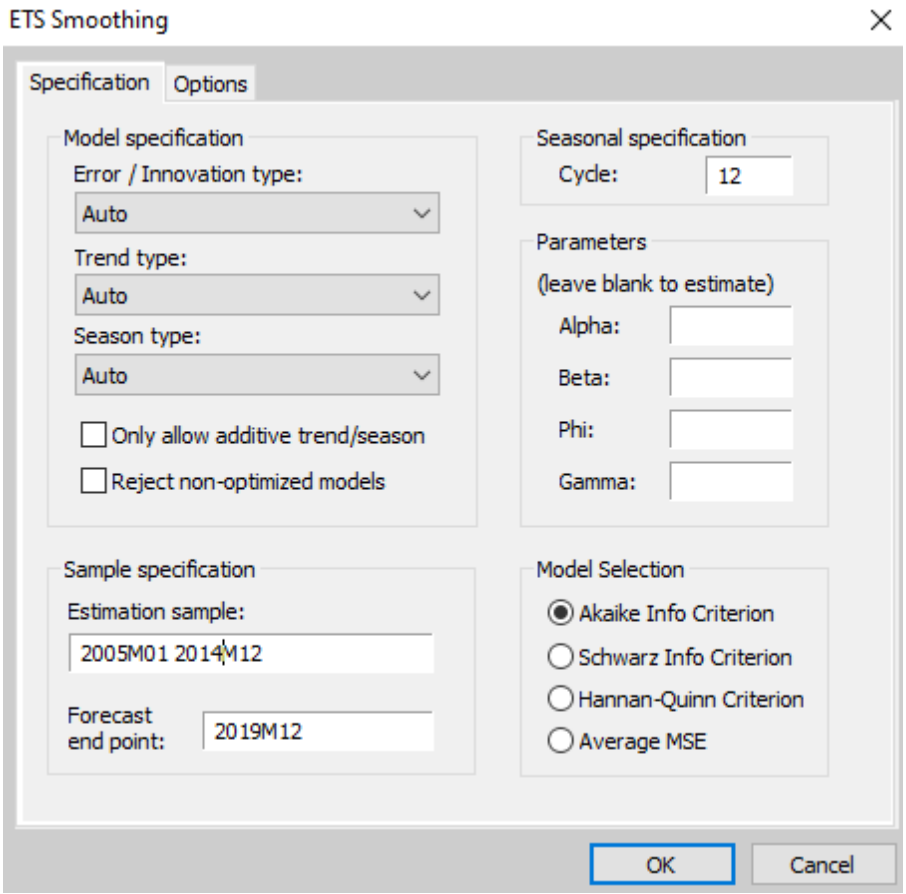
Parameters:	Alpha	0.0010
Sum of Squared Residuals		4.34E+08
Root Mean Squared Error		1909.553
End of Period Levels:	Mean	102.3282

We will evaluate the forecast of SES and ETS at the end to see the comparison of all forecasts together.

6. For running ETS model we can use the raw data sample (uk time series) since it already takes into account that time series have a trends and seasonality.



Eviews can automatically choose if error, trends, and seasonality is additive or multiplicative or if we don't have that feature in our time series. So, we choose Auto for error, trend, seasonality in model specification. In addition, estimation sample is 2005M01 – 2014M12, and forecast end point is 2019M12.



ETS Smoothing
Original series: UK
Date: 02/12/21 Time: 12:59
Sample: 2005M01 2014M12
Included observations: 120
Model: M,M,M - Multiplicative Error, Multiplicative Trend, Multiplicative Season (Auto E=*, T=*, S=*)
Model selection: Akaike Information Criterion
Convergence achieved on boundaries.

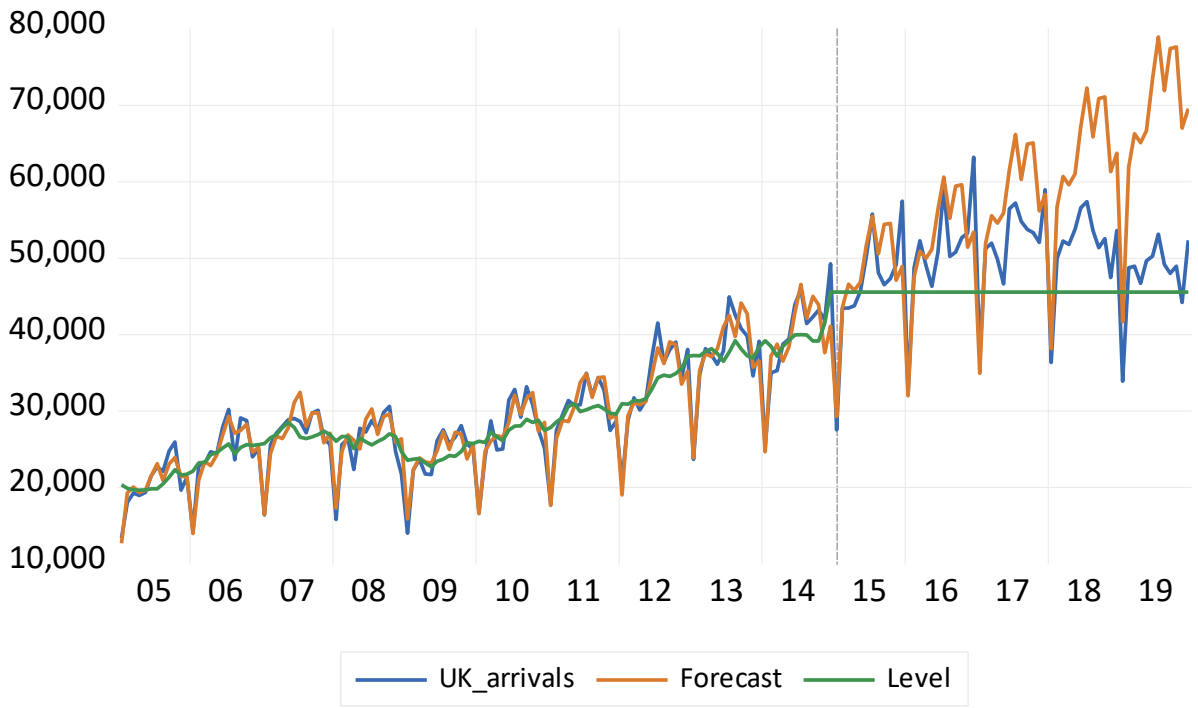
Parameters	
Alpha:	0.452560
Beta:	0.000000
Gamma:	0.000000

Initial Parameters	
Initial level:	19754.69
Initial trend:	1.007364
Initial state 1:	0.982839
Initial state 2:	0.953385
Initial state 3:	1.112557
Initial state 4:	1.117907
Initial state 5:	1.046297
Initial state 6:	1.156525
Initial state 7:	1.084168
Initial state 8:	0.991133
Initial state 9:	0.975128
Initial state 10:	1.000152
Initial state 11:	0.941554
Initial state 12:	0.638355

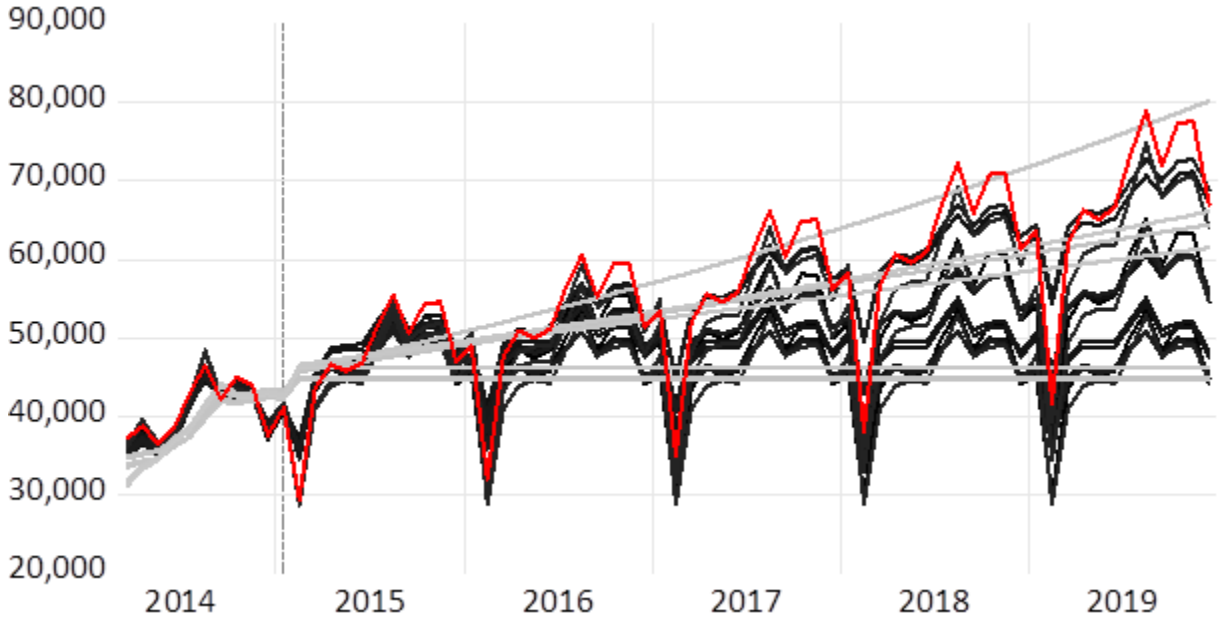
Compact Log-likelihood	-1179.090
Log-likelihood	-1062.113
Akaike Information Criterion	2390.180
Schwarz Criterion	2434.780
Hannan-Quinn Criterion	2408.292
Sum of Squared Residuals	0.430757
Root Mean Squared Error	0.059914
Average Mean Squared Error	4470581.

The model selected by Eviews is M,M, M for this time series.

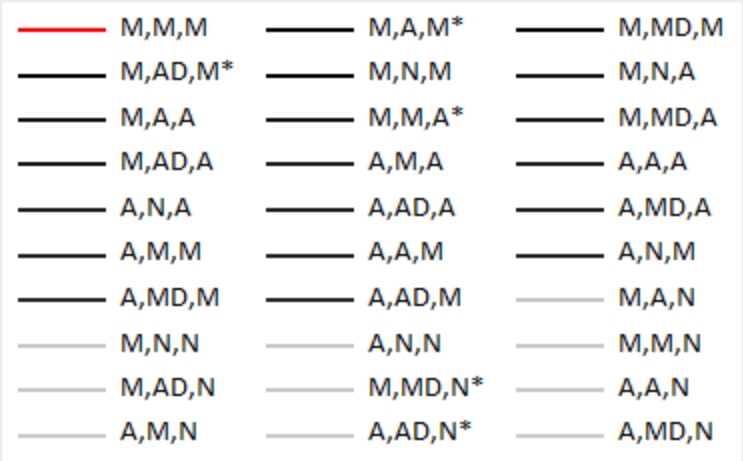
Decomposition graph



Forecast comparison graph

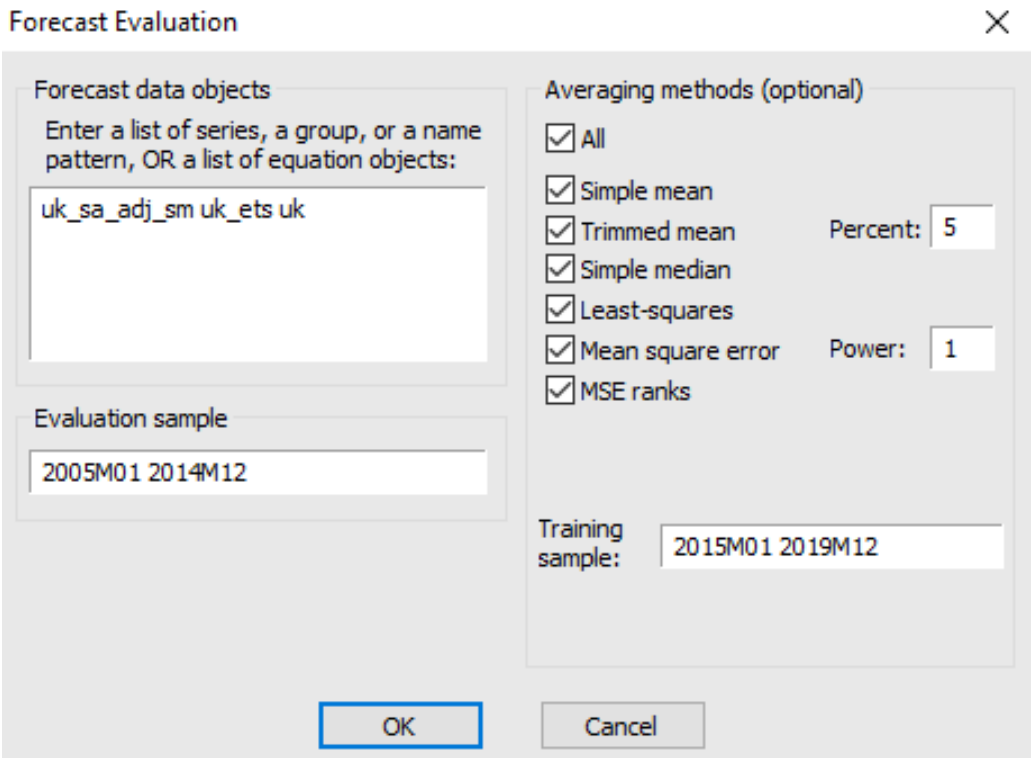


Forecasting models tested for ETS:



7. Forecast evaluation for the ETS and SES model:

Open time series *uk_sa_adj_sm* and click on View and choose Forecast evaluation. You will see the following options shown in Figure x. Include the time series you want to compare under forecast data objects. We included *uk_sa_adj_sm* (SES forecast), *uk_ets* (ETS forecast), and *uk* (raw time series) to compare the forecasts methods. The evaluation sample and forecast time period also has been added in the selection.



Forecast comparison table below shows the comparison of ETS, SES, and the actual data. It includes the MAPE and RMSE for evaluation of the models.

⊟ Evaluation

Forecast Evaluation
Date: 02/12/21 Time: 10:26
Sample: 2005M01 2014M12
Included observations: 120
Evaluation sample: 2005M01 2014M12
Training sample: 2015M01 2019M12
Number of forecasts: 8

Combination tests
Null hypothesis: Forecast i includes all information contained in others

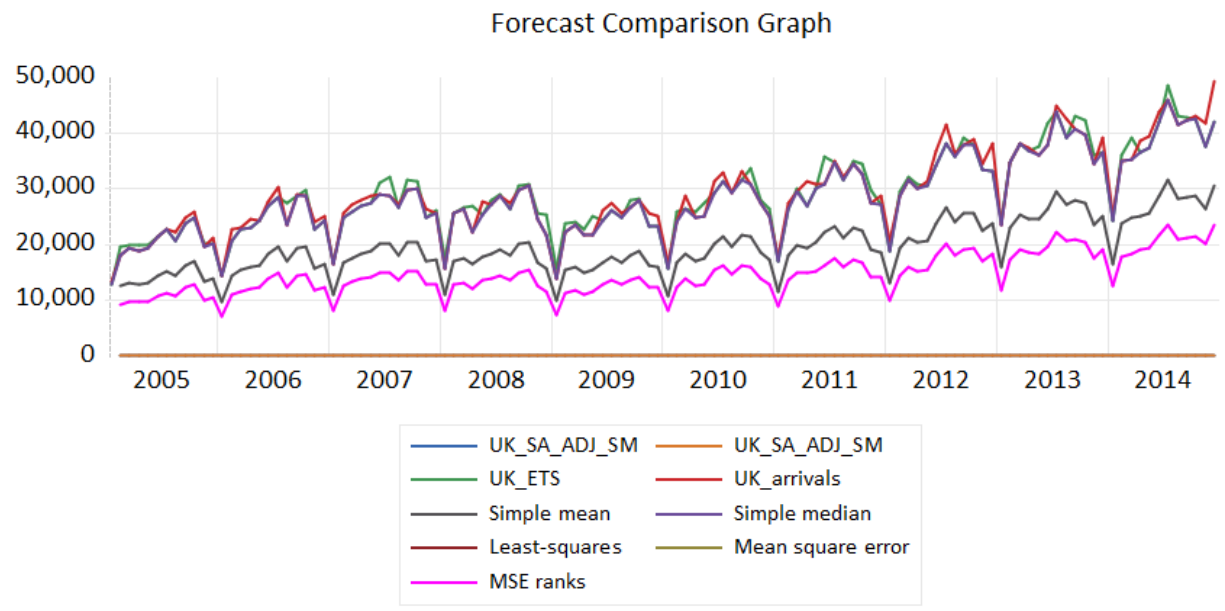
Forecast	F-stat	F-prob
UK_SA_ADJ_SM	NA	NA
UK_ETS	783.3546	0.0000
UK	766.6307	0.0000

Evaluation statistics

Forecast	RMSE	MAE	MAPE	SMAPE	Theil U1	Theil U2
UK_SA_ADJ_SM	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
UK_ETS	29942.73	29098.47	32587.22	198.7211	0.994165	15780.57
UK	30036.33	29139.93	32628.14	198.7182	0.994187	15839.18
Simple mean	19982.42	19412.80	21738.46	198.0879	0.991282	10534.41
Simple median	29201.19	28366.98	31766.24	198.6866	0.994018	15397.28
Least-squares	NA	NA	NA	NA	NA	NA
Mean square error	NA	NA	NA	NA	NA	NA
MSE ranks	14995.50	14563.05	16307.25	197.4579	0.988418	7906.151

*Trimmed mean could not be calculated due to insufficient data

Forecast comparison graph.



The table below shows the variables and their definitions that are used in this example.

Variable names	
uk	Raw time series
uk_sa	Seasonality adjusted *uk* time series
uk_sa_adj	First differenced seasonality adjusted time series
uk_sa_adj_sm	First differenced seasonality adjusted and smoothed (SES) time series
uk_ets	ETS applied time series