STAT8008: Times Series & Multi-Variate Analysis

LECTURE 05: UNDERSTANDING TIME SERIES MODELER

Outline

- Introduce the Expert Modeler.
- Review the results of a model built using the Expert Modeler.

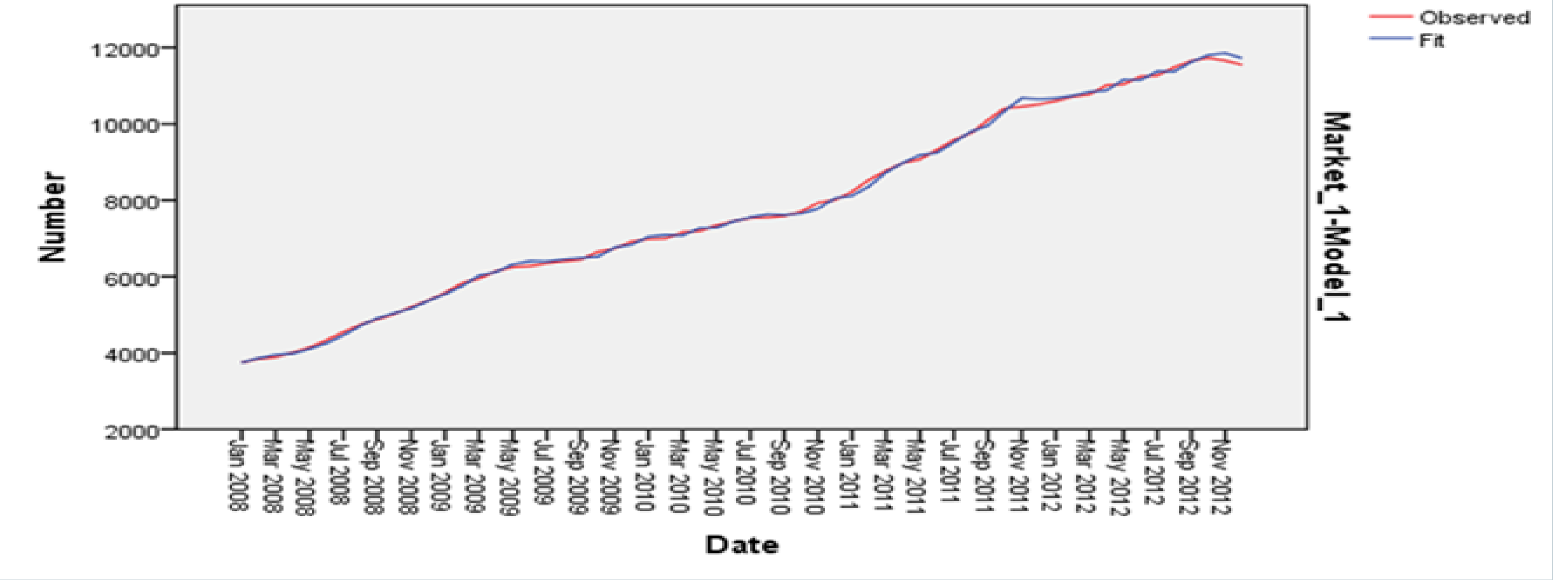
Developing a Forecasting Model

1. Stage one involves using exploratory techniques such as *Descriptives*, *Crosstabs*, *Sequence charts*, etc. to help **identify important factors** to be included in the models. This is you use your <u>experience and knowledge</u> to look at the data and choose the important variables and approach.
2. Stage two involves creating a variety of **time series model** to fit the data. Some of the models will be pure time series models and some will be causal time series models (assuming appropriate predictors are available).
3. Stage three is where you look at each of the models and sees how well **each fit the original data**.
4. In stage four, you will **compare the fit** performance of the models on various measures.
5. In stage five, you will **select the best model**, using both fit performance and your own knowledge.
6. In stage six, you use the model to **forecast** the series into the future.
7. In stage seven, you will wait and collect **additional data** over time to see how well the chosen model performed.
8. If necessary, in stage eight, you will update and **refine** the model, and continue the process.

These steps should not be regarded as rigid but as a guide to the way in which to develop successful forecasting models. It is important to compare several models before choosing a final model.

Fit and Error

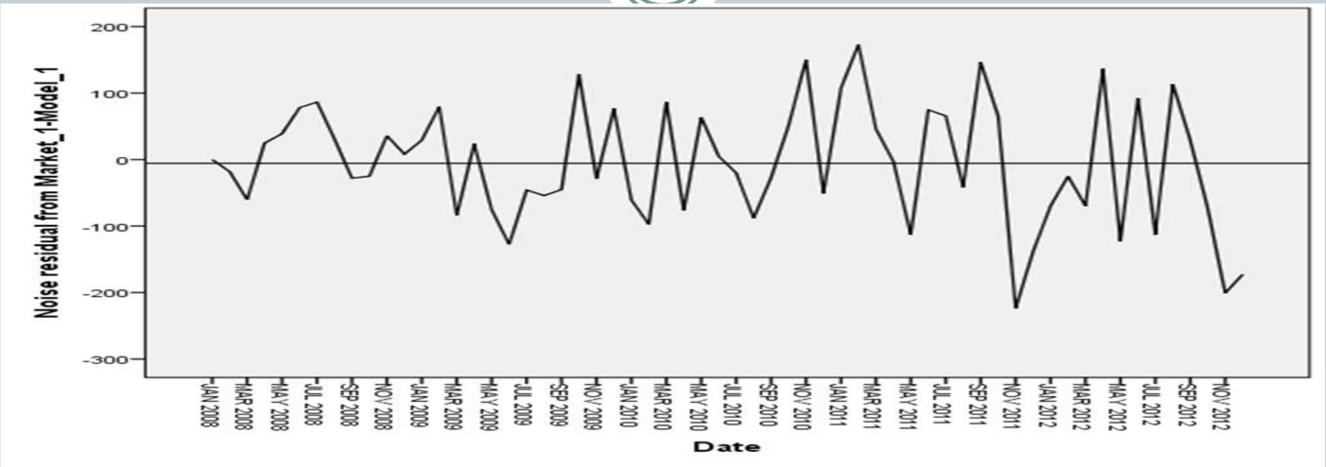
- Time series models typically fit past data very well, but they won't fit perfectly.
- Any variation not picked up by the model is unexplained variation.



Error: Unexplained variation

- If a time series model has been successful in extracting all the common patterns out of the series, then the error should be **random**.
- This is a very important test of a time series model. Not all models will be successful at detecting common patterns in the data.
- A model may, for example, fail to use an important factor influencing the series you wish to forecast.
- If a model is unsuccessful in explaining common patterns in the data, then some of the common patterns will instead be picked up by the residual or error variables.
- If this is the case the error term will not be random, and the time series model will be misspecified.
- If the model is a good fit then the actual series will be close to the series fit, and the error would therefore be close to zero for all points over time

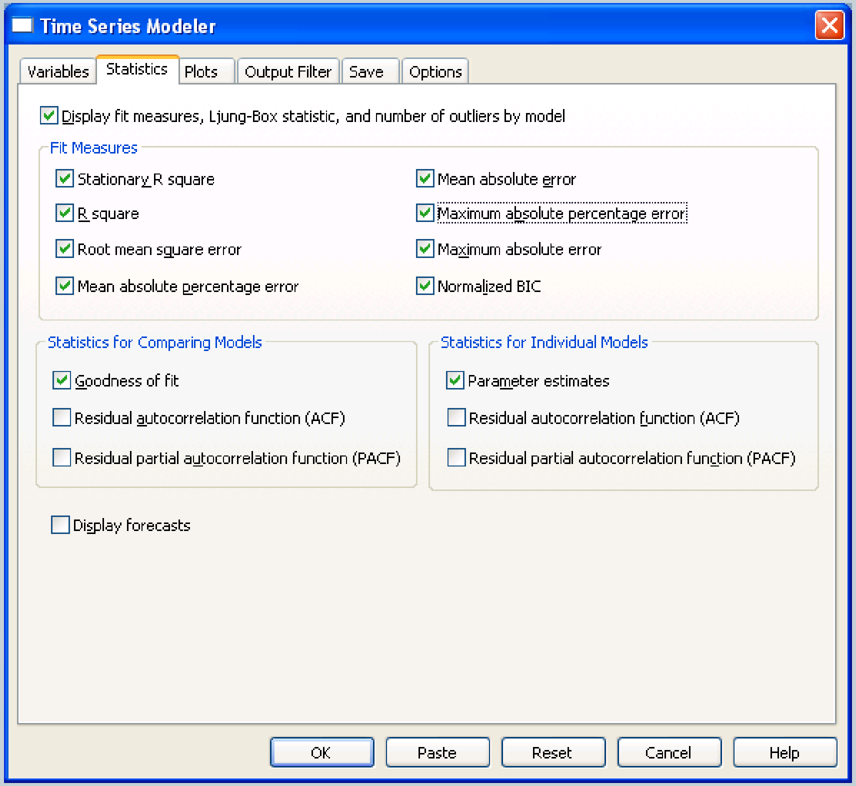
Error: Unexplained variation



- We see that error looks fairly random.
- There is no obvious tendency for a positive error to be followed by another positive error.
- That is, the model does not consistently under-predict (or over-predict) over a number of consecutive periods.

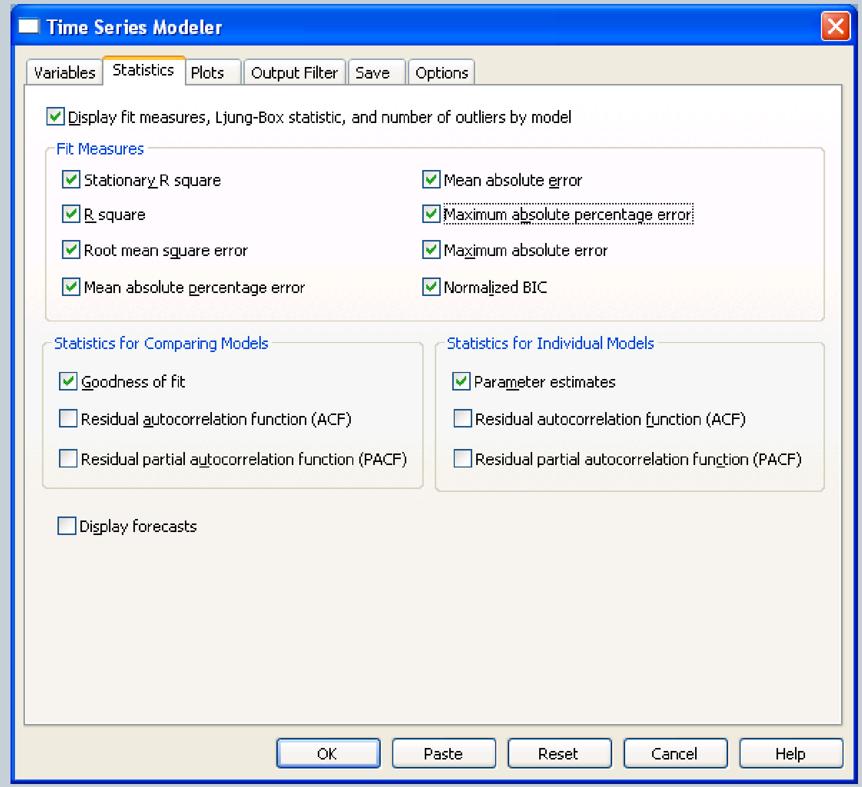
Fit measures

- **Stationary R square**: A measure that compares the stationary part of the model to a simple mean model.
- This measure is **preferable to the usual R square when there is a trend or seasonal pattern**.
- Stationary R-square can be negative, and has a range of negative infinity to +1.
- **Negative values** mean that the model under consideration is worse than the baseline model.
- **Positive values** mean that the model under consideration is better than the baseline model.



Fit measures

- **R square:** An estimate of the proportion of the total variation in the series that is explained by the model.
- This measure is most useful when the series is **stationary (no trend)**.
- R-square can be negative, and has a range of negative infinity to +1.
- Negative values mean that the model under consideration is worse than the baseline model.
- Positive values mean that the model under consideration is better than the baseline model.



Fit measures

- **Root mean square error (RSME)**. A measure of how much a series varies from the forecasted values. Square error is the square of the difference between the fitted value and the observed value, in units that are the same as the dependent series.

- **Mean absolute percentage error (MAPE)**. A measure of how much a series varies from its forecasted values, independent of the units used. It is the mean of the absolute values of the percentage errors.

Fit Statistic	Mean
Stationary R-squared	.262
R-squared	.999
RMSE	90.490
MAPE	.939
MaxAPE	2.141
MAE	73.765
MaxAE	223.839
Normalized BIC	9.147

Fit measures

- **Maximum absolute percentage error (MaxAPE)**: The largest forecast error, expressed as a percentages. This measure gives a worst case scenario indication of model performance
- **Mean absolute error (MAE):** Mean of the absolute values of the forecast errors. MAE is in the same units as the dependent series. MAE is appropriate when the cost of the forecast errors is proportional to the absolute size of the forecast error.
- **Maximum absolute error (MaxAE):** The largest forecast error, expressed in the same units as the dependent series. This measure gives a worst case scenario indication of model performance.
- **Normalized BIC:** The Normalized Bayesian Information Criterion (BIC) is a measure of overall fit that enables you to compare different models for the same series. Normalized BIC "rewards" models that fit better, that is, produce predicted values that are closer to the dependent series values, while it "penalises" models that use more parameters. In general, all other things equal, you should prefer the **model for a dependent series that has the minimum BIC**.

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Model parameters: *alpha*

Exponential Smoothing Model Parameters						
Model			Estimate	SE	t	Sig.
Subscribers for Market 1-Model_1	No Transformation	Alpha (Level)	1.000	.138	7.239	.000
		Gamma (Trend)	.300	.135	2.223	.030

- The ***alpha* smoothing parameter taps the extent to which the recent observations in the series are predictive of the current value**.
- *Alpha* also be viewed as the factor used to weight the recent prediction error in order to bring the prediction in line with the actual series. It is designed to adjust for local shifts in the mean level of the series.
- As **the *alpha* parameter value moves closer to 1, more and more weight is given to the most recent observations**. In the extreme, when *alpha* equals 1 the single most recent observation is used exclusively. The *alpha* parameter is used for all exponential smoothing models.
- The parameters all have a standard error and thus significance tests, which test whether they are significantly different from zero. *Alpha* in the model has a value of 1.000, and it is significant ($p < 0.001$). This indicates that there is a **tendency for more recent observations to have more weight**.

Model parameters: *gamma*

Exponential Smoothing Model Parameters						
Model			Estimate	SE	t	Sig.
Subscribers for Market 1-Model_1	No Transformation	Alpha (Level)	1.000	.138	7.239	.000
		Gamma (Trend)	.300	.135	2.223	.030

- The ***gamma* weight captures the trend component of the series**.
- It is important to note that there may well be trend to the series if the gamma coefficient estimate is 0.
- A ***gamma* of 0 simply implies that the trend is constant over time**, and each observation is given equal weight.
- Conversely, the **closer to 1, the more the trend is changing over time**, and so more recent observations are given more weight in the model.
- In our example the *gamma* coefficient is .3 which is significantly different from zero. Thus, we can say that the trend is **not constant over time**.

Model parameters: *delta*

Exponential Smoothing Model Parameters

Model			Estimate	SE	t	Sig.
parcel-Model_1	No Transformation	Alpha (Level)	.237	.055	4.327	.000
		Gamma (Trend)	.001	.006	.159	.874
		Delta (Season)	.323	.077	4.176	.000

- The ***delta* parameter controls the relative weight given to recent observations in estimating seasonality**. It ranges from 0 to 1.
- **Values near 1 giving higher weight to recent values**.
- As with *gamma*, a delta of 0 does not imply there is no seasonality, but that the seasonality is constant over time.
- In the above model (different from previous slide), the *delta* value is .323, and is significantly different from zero. This indicates that there is **seasonality which is changing over time**.

Model parameters: *phi*

Exponential Smoothing Model Parameters

Model			Estimate	SE	t	Sig.
Subscribers for Market 1-Model_1	No Transformation	Alpha (Level)	.999	.146	6.838	.000
		Gamma (Trend)	.324	.163	1.985	.052
		Phi (Trend damping factor)	.973	.031	31.335	.000

- The *phi* parameter dampens the trend value of the forecast in exponential smoothing.
- The smaller the *phi* parameter is, the more strongly the trend value will be dampened.
- If the ***phi* parameter is 1, no trend dampening occurs**.
- In the above model (different from previous slide), the *phi* value is .973, and is significantly different from zero. This indicates that there is **not much trend dampening over time**.