Breusch–Godfrey test

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In statistics, the **Breusch–Godfrey test**, named after Trevor S. Breusch and Leslie G. Godfrey,[1][2] is used to assess the validity of some of the modelling assumptions inherent in applying regression-like models to observed data series. In particular, it tests for the presence of serial correlation that has not been included in a proposed model structure and which, if present, would mean that incorrect conclusions would be drawn from other tests, or that sub-optimal estimates of model parameters are obtained if it is not taken into account. The regression models to which the test can be applied include cases where lagged values of the dependent variables are used as independent variables in the model's representation for later observations. This type of structure is common in econometric models.

Because the test is based on the idea of Lagrange multiplier testing, it is sometimes referred to as **LM test for serial correlation.**[3]

A similar assessment can be also carried out with the Durbin–Watson test and the Ljung–Box test.

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Background

The Breusch–Godfrey serial correlation LM test is a test for autocorrelation in the errors in a regression model. It makes use of the residuals from the model being considered in a regression analysis, and a test statistic is derived from these. The null hypothesis is that there is no serial correlation of any order up to p.[4]

The test is more general than the Durbin–Watson statistic (or Durbin's h statistic), which is only valid for nonstochastic regressors and for testing the possibility of a first-order autoregressive model (e.g. AR(1)) for the regression errors. The BG test has none of these restrictions, and is statistically more powerful than Durbin's h statistic.

Procedure

Consider a linear regression of any form, for example

$$Y_t = \beta_1 + \beta_2 X_{t,1} + \beta_3 X_{t,2} + u_t$$

where the errors might follow an AR(p) autoregressive scheme, as follows:

$$u_t = \rho_1 u_{t-1} + \rho_2 u_{t-2} + \cdots + \rho_p u_{t-p} + \varepsilon_t.$$

The simple regression model is first fitted by ordinary least squares to obtain a set of sample residuals $\hat{u}_t$.

Breusch and Godfrey proved that, if the following auxiliary regression model is fitted

$$\hat{u}_t = \alpha_0 + \alpha_1 X_{t,1} + \alpha_2 X_{t,2} + \rho_1 \hat{u}_{t-1} + \rho_2 \hat{u}_{t-2} + \cdots + \rho_p \hat{u}_{t-p} + \varepsilon_t$$

and if the usual R^2 statistic is calculated for this model, then the following asymptotic approximation can be used for the distribution of the test statistic

$$nR^2 \sim \chi^2_p,$$

when the null hypothesis $H_0 : \{\rho_i = 0 \text{ for all } i\}$ holds (that is, there is no serial correlation of any order up to p). Here n is the number of data-points available for the second regression, that for $\hat{u}_t$,

$$n = T - p,$$

where T is the number of observations in the basic series. Note that the value of n depends on the number of lags of the error term (p).

Software

- In R, this test is performed by function **bgtest**, available in package **lmtest**.[5][6]
- In Stata, this test is performed by the command **estat bgodfrey**.[7][8]
- In SAS, the **GODFREY** option of the **MODEL** statement in **PROC AUTOREG** provides a version of this test.
- In Python Statsmodels, the acorr_breush_godfrey function in the module statsmodels.stats.diagnostic [9]
- In EViews, this test is already done after a regression, you just need to go to "View" → "Residual Diagnostics" → "Serial Correlation LM Test".

See also

- Breusch–Pagan test
- Durbin–Watson test
- Ljung–Box test

References

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Further reading

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