sts19	Multivariate portmanteau (Q) test for white noise

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Abstract: This routine performs a multivariate portmanteau (Q) test for white noise in a time series context.

Keywords: autocorrelation, white noise, time series, Q test.

Syntax

`wntstmvq` *varlist* [`if` *exp*] [`in` *range*] [, `lags(`*#*`)` `varlags(`*#*`)`]

This test is for use with time-series data; you must `tsset` your data before using this test; see [R] **tsset**. *varlist* may contain time-series operators; see [U] **Time-series varlists**.

Options

`lags(`*#*`)` specifies the number of sample autocorrelations, that is, the maximum lag order to be included in the test. If not specified, it takes on a default value of $\min(N/2-2,40)$ where N is the number of available observations.

`varlags(`*#*`)` specifies the order of the VAR (vector autoregression) used to produce the series in *varlist*. If specified, `varlags` must not exceed `lags`.

Description

`wntstmvq` performs the multivariate Ljung–Box portmanteau (or Q) test for white noise in a set of time series. This test is a generalization of the univariate Ljung–Box portmanteau (Q) test implemented in Stata as `wntestq`. The multivariate form of the test was proposed by Hosking (1980) and others. Hosking (1981) demonstrated the equivalence of the several forms in the literature. The test implemented here is that described in Johansen (1995, 22). It is often applied to the residuals of a multivariate regression, such as a VAR (vector autoregression).

The null hypothesis of the multivariate test is that the autocorrelation functions of all series in *varlist* have no significant elements for lags one through that specified by the `lags` option. The `lags` parameter may be specified by the user. If the series in *varlist* are residuals from a vector autoregression, the *varlist* option should be specified to provide the order of the VAR.

As a function of s lags, the test statistic

$$LB(s) = T\,(T+2)\sum_{j=1}^{s}\frac{1}{T-j}\text{tr}\left[\widehat{C}_{0j}\widehat{C}_{00}^{-1}\widehat{C}_{0j}'\widehat{C}_{00}^{-1}\right],$$

where

$$\widehat{C}_{0j} = T^{-1}\sum_{t=j+1}^{T}\widehat{\epsilon}_t\widehat{\epsilon}_{t-j}'$$

is distributed, under the null hypothesis, as χ^2 with degrees of freedom equal to $p^2(\texttt{lags}-\texttt{varlags})$ where p is the number of series in *varlist*. A rejection indicates that at least one series is not white noise.

Although portmanteau statistics are commonly applied in diagnosing time series models, some caution should be exercised with their use in a cointegration context. Jacobson (1995, 179) states “[O]ne should exercise some care when using the portmanteau statistic for evaluating the fit of a cointegration model. This observation is due to the facts that cointegration implies the presence of unit roots and an assumption underlying the properties of the portmanteau statistic is that of a stationary process disqualifying roots on the unit circle. There is to my knowledge no theoretical result justifying the use of portmanteau statistics in connection with potential unit roots. Nevertheless these tests are being used ...”

Some guidance for the application of tests of this nature in the vector autoregressive setting is given by Bender and Grouven (1993), who find that the number of lags must be carefully chosen in order to avoid significant loss of power of the test. They conduct a simulation study and tabulate appropriate choices of the number of lags as a function of sample size, model order and model dimension.

Saved Results

`wntstmvq` saves the following scalars in `r()`:

`r(stat)`	test statistic
`r(df)`	degrees of freedom
`r(p)`	p-value
`r(k)`	number of series
`r(s)`	maximum lag order
`r(nobs)`	number of observations

Examples

The Grunfeld investment data (20 years of annual data on five U.S. corporations) are analyzed.

```
. set matsize 100
. use http://fmwww.bc.edu/ec-p/data/Greene2000/tbl15-1.dta,clear
. reshape wide i f c,i(year) j(firm)
  (output omitted)
. tsset year,yearly
        time variable:  year, 1935 to 1954
. mvreg i1 i2 i3  = f1 c1 f2 c2 f3 c3
(output omitted)
. for num 1/3:predict epsX,equation(iX) r
  (output omitted)
. wntstmvq eps1-eps3
Multivariate Ljung-Box statistic (3 variables, 8 lags):   189.9422
Prob > chi2(72) = 0.0000
```

The three residual series from this multivariate regression model do not appear to be white noise.

References

Bender, R., and U. Grouven. 1993. On the choice of the number of residual autocovariances for the portmanteau test of multivariate autoregressive models. *Communications in Statistics-Simulation and Computation* 22: 19–32.

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