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## Description

`varwle` reports Wald tests the hypothesis that the endogenous variables at a given lag are jointly zero for each equation and for all equations jointly.

## Quick start

Wald lag-exclusion statistics after `var`, `svar`, `ivsvar`, or `xtvar`

```
varwle
```

Same as above, but use estimation results stored in `myest`

```
varwle, estimates(myest)
```

## Menu

Statistics > Multivariate time series > VAR diagnostics and tests > Wald lag-exclusion statistics

## Syntax

```
varwle [ , estimates(estname) separator(#) ]
```

`varwle` can be used only after `var`, `svar`, `ivsvar`, or `xtvar`; see [TS] [var](#), [TS] [var svar](#), [TS] [var ivsvar](#), or [XT] [xtvar](#). `collect` is allowed; see [U] [11.1.10 Prefix commands](#).

## Options

`estimates(estname)` requests that `varwle` use the previously obtained set of `var`, `svar`, `ivsvar`, or `xtvar` estimates stored as *estname*. By default, `varwle` uses the active estimation results. See [R] [estimates](#) for information on manipulating estimation results.

`separator(#)` specifies how often separator lines should be drawn between rows. By default, separator lines do not appear. For example, `separator(1)` would draw a line between each row, `separator(2)` between every other row, and so on.

## Remarks and examples

After fitting a VAR model, one hypothesis of interest is that all the endogenous variables at a given lag are jointly zero. `varwle` reports Wald tests of this hypothesis for each equation and for all equations jointly. `varwle` uses the estimation results from a previously fitted `var` or `svar` or `ivsvar` or `xtvar`. By default, `varwle` uses the active estimation results, but you may also use a stored set of estimates by specifying the `estimates()` option.

After fitting a model with `var`, `svar`, or `ivsvar`, `varwle` presents small-sample  $F$  statistics if the VAR model was fit with the `small` option; otherwise, `varwle` presents large-sample  $\chi^2$  statistics. `varwle` always reports large-sample  $\chi^2$  statistics after `xtvar`.

## ► Example 1: After var

We analyze the model with the German data described in [TS] [var](#) using `varwle`.

```
. use https://www.stata-press.com/data/r19/lutkepohl2
(Quarterly SA West German macro data, Bil DM, from Lutkepohl 1993 Table E.1)
. var dln_inv dln_inc dln_consump if qtr<=tq(1978q4), dfk small
(output omitted)
```

```
. varwle
```

Equation: dln\_inv

| lag | F       | df | df_r | Prob > F |
|-----|---------|----|------|----------|
| 1   | 2.64902 | 3  | 66   | 0.0560   |
| 2   | 1.25799 | 3  | 66   | 0.2960   |

Equation: dln\_inc

| lag | F       | df | df_r | Prob > F |
|-----|---------|----|------|----------|
| 1   | 2.19276 | 3  | 66   | 0.0971   |
| 2   | .907499 | 3  | 66   | 0.4423   |

Equation: dln\_consump

| lag | F       | df | df_r | Prob > F |
|-----|---------|----|------|----------|
| 1   | 1.80804 | 3  | 66   | 0.1543   |
| 2   | 5.57645 | 3  | 66   | 0.0018   |

Equation: All

| lag | F       | df | df_r | Prob > F |
|-----|---------|----|------|----------|
| 1   | 3.78884 | 9  | 66   | 0.0007   |
| 2   | 2.96811 | 9  | 66   | 0.0050   |

Because the VAR model was fit with the `dfk` and `small` options, `varwle` used the small-sample estimator of  $\widehat{\Sigma}$  in constructing the VCE, producing an  $F$  statistic. The first two equations appear to have a different lag structure from that of the third. In the first two equations, we cannot reject the null hypothesis that all three endogenous variables have zero coefficients at the second lag. The hypothesis that all three endogenous variables have zero coefficients at the first lag can be rejected at the 10% level for both of the first two equations. In contrast, in the third equation, the coefficients on the second lag of the endogenous variables are jointly significant, but not those on the first lag. However, we strongly reject the hypothesis that the coefficients on the first lag of the endogenous variables are zero in all three equations jointly. Similarly, we can also strongly reject the hypothesis that the coefficients on the second lag of the endogenous variables are zero in all three equations jointly.

If we believe these results strongly enough, we might want to refit the original VAR model, placing some constraints on the coefficients. See [TS] [var](#) for details on how to fit VAR models with constraints.



## ► Example 2: After svar

Here we fit a simple SVAR model and then run varwle:

```
. matrix a = (.,0\.,.)
. matrix b = I(2)
. svar dln_inc dln_consump, aeq(a) beq(b)
Estimating short-run parameters
Iteration 0: Log likelihood = -159.21683
Iteration 1: Log likelihood = 490.92264
Iteration 2: Log likelihood = 528.66126
Iteration 3: Log likelihood = 573.96363
Iteration 4: Log likelihood = 578.05136
Iteration 5: Log likelihood = 578.27633
Iteration 6: Log likelihood = 578.27699
Iteration 7: Log likelihood = 578.27699
Structural vector autoregression
( 1)  [/A]1_2 = 0
( 2)  [/B]1_1 = 1
( 3)  [/B]1_2 = 0
( 4)  [/B]2_1 = 0
( 5)  [/B]2_2 = 1
Sample: 1960q4 thru 1982q4      Number of obs   =      89
Exactly identified model        Log likelihood   =    578.277
```

|    | Coefficient | Std. err.       | z        | P> z  | [95% conf. interval] |                     |
|----|-------------|-----------------|----------|-------|----------------------|---------------------|
| /A |             |                 |          |       |                      |                     |
|    | 1_1         | 89.72411        | 6.725107 | 13.34 | 0.000                | 76.54315 102.9051   |
|    | 2_1         | -64.73622       | 10.67698 | -6.06 | 0.000                | -85.66271 -43.80973 |
|    | 1_2         | 0 (constrained) |          |       |                      |                     |
|    | 2_2         | 126.2964        | 9.466318 | 13.34 | 0.000                | 107.7428 144.8501   |
| /B |             |                 |          |       |                      |                     |
|    | 1_1         | 1 (constrained) |          |       |                      |                     |
|    | 2_1         | 0 (constrained) |          |       |                      |                     |
|    | 1_2         | 0 (constrained) |          |       |                      |                     |
|    | 2_2         | 1 (constrained) |          |       |                      |                     |

The output table from `var svar` gives information about the estimates of the parameters in the **A** and **B** matrices in the SVAR model. But, as discussed in [TS] [var svar](#), an SVAR model builds on an underlying VAR model. When `varwle` uses the estimation results produced by `svar`, it performs Wald lag-exclusion tests on the underlying VAR model. Next we run `varwle` on these `svar` results.

```
. varwle
```

Equation: dln\_inc

| lag | chi2     | df | Prob > chi2 |
|-----|----------|----|-------------|
| 1   | 6.88775  | 2  | 0.032       |
| 2   | 1.873546 | 2  | 0.392       |

Equation: dln\_consump

| lag | chi2     | df | Prob > chi2 |
|-----|----------|----|-------------|
| 1   | 9.938547 | 2  | 0.007       |
| 2   | 13.89996 | 2  | 0.001       |

Equation: All

| lag | chi2     | df | Prob > chi2 |
|-----|----------|----|-------------|
| 1   | 34.54276 | 4  | 0.000       |
| 2   | 19.44093 | 4  | 0.001       |

Now we fit the underlying VAR model with two lags and apply varwle to these results.

```
. var dln_inc dln_consump
(output omitted)
```

```
. varwle
```

Equation: dln\_inc

| lag | chi2     | df | Prob > chi2 |
|-----|----------|----|-------------|
| 1   | 6.88775  | 2  | 0.032       |
| 2   | 1.873546 | 2  | 0.392       |

Equation: dln\_consump

| lag | chi2     | df | Prob > chi2 |
|-----|----------|----|-------------|
| 1   | 9.938547 | 2  | 0.007       |
| 2   | 13.89996 | 2  | 0.001       |

Equation: All

| lag | chi2     | df | Prob > chi2 |
|-----|----------|----|-------------|
| 1   | 34.54276 | 4  | 0.000       |
| 2   | 19.44093 | 4  | 0.001       |

Because varwle produces the same results in these two cases, we can conclude that when varwle is applied to svar results, it performs Wald lag-exclusion tests on the underlying VAR model.

## Stored results

`varwle` stores the following in `r()`:

Matrices

`if e(small) == ""`

|                      |                          |
|----------------------|--------------------------|
| <code>r(chi2)</code> | $\chi^2$ test statistics |
| <code>r(df)</code>   | degrees of freedom       |
| <code>r(p)</code>    | $p$ -values              |

`if e(small) != ""`

|                      |                               |
|----------------------|-------------------------------|
| <code>r(F)</code>    | $F$ test statistics           |
| <code>r(df_r)</code> | numerator degrees of freedom  |
| <code>r(df)</code>   | denominator degree of freedom |
| <code>r(p)</code>    | $p$ -values                   |

## Methods and formulas

`varwle` uses `test` to obtain Wald statistics of the hypotheses that all the endogenous variables at a given lag are jointly zero for each equation and for all equations jointly. Like the `test` command, `varwle` uses estimation results stored by `var`, `svar`, or `ivsvar` to determine whether to calculate and report small-sample  $F$  statistics or large-sample  $\chi^2$  statistics. `varwle` always reports large-sample  $\chi^2$  statistics after `xtvar`.

**Abraham Wald** (1902–1950) was born in Cluj, in what is now Romania. He studied mathematics at the University of Vienna, publishing at first on geometry, but then became interested in economics and econometrics. He moved to the United States in 1938 and later joined the faculty at Columbia. His major contributions to statistics include work in decision theory, optimal sequential sampling, large-sample distributions of likelihood-ratio tests, and nonparametric inference. Wald died in a plane crash in India.

## References

- Amisano, G., and C. Giannini. 1997. *Topics in Structural VAR Econometrics*. 2nd ed, revised and enlarged. Heidelberg: Springer.
- Hamilton, J. D. 1994. *Time Series Analysis*. Princeton, NJ: Princeton University Press. <https://doi.org/10.2307/j.ctv14jx6sm>.
- Lütkepohl, H. 1993. *Introduction to Multiple Time Series Analysis*. 2nd ed. New York: Springer.
- Mangel, M., and F. J. Samaniego. 1984. Abraham Wald's work on aircraft survivability. *Journal of the American Statistical Association* 79: 259–267. <https://doi.org/10.2307/2288257>.
- Wolfowitz, J. 1952. Abraham Wald, 1902–1950. *Annals of Mathematical Statistics* 23: 1–13 (and other reports in same issue). <https://doi.org/10.1214/aoms/1177729480>.

## Also see

- [TS] **var** — Vector autoregressive models
- [TS] **var intro** — Introduction to vector autoregressive models
- [TS] **var ivsvar** — Instrumental-variables structural vector autoregressive models
- [TS] **var svar** — Structural vector autoregressive models
- [TS] **varbasic** — Fit a simple VAR and graph IRFs or FEVDs
- [XT] **xtvar** — Panel-data vector autoregressive models

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