

**corrgram** — Tabulate and graph autocorrelations
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## Description

`corrgram` produces a table of the autocorrelations, partial autocorrelations, and portmanteau ( $Q$ ) statistics. It also displays a character-based plot of the autocorrelations and partial autocorrelations. See [TS] [wntestq](#) for more information on the  $Q$  statistic.

`ac` produces a correlogram (a graph of autocorrelations) with pointwise confidence intervals that is based on Bartlett's formula for MA(q) processes.

`pac` produces a partial correlogram (a graph of partial autocorrelations) with confidence intervals calculated using a standard error of  $1/\sqrt{n}$ . The residual variances for each lag may optionally be included on the graph.

## Quick start

Produce correlogram for `y` using `tsset` data

```
corrgram y
```

As above, but limit the number of computed autocorrelations to 10

```
corrgram y, lags(10)
```

Plot the autocorrelation function for `y`

```
ac y
```

As above, and generate `newv` to hold the autocorrelations

```
ac y, generate(newv)
```

Plot partial autocorrelation function for `y` and include standardized residual variances in the graph

```
pac y, srv
```

## Menu

### **corrgram**

Statistics > Time series > Graphs > Autocorrelations & partial autocorrelations

### **ac**

Statistics > Time series > Graphs > Correlogram (ac)

### **pac**

Statistics > Time series > Graphs > Partial correlogram (pac)

## Syntax

Autocorrelations, partial autocorrelations, and portmanteau ( $Q$ ) statistics

```
corrgram varname [if] [in] [, corrgram_options]
```

Graph autocorrelations with confidence intervals

```
ac varname [if] [in] [, ac_options]
```

Graph partial autocorrelations with confidence intervals

```
pac varname [if] [in] [, pac_options]
```

<i>corrgram_options</i>	Description
Main	
<u>lags</u> (#)	calculate # autocorrelations
<u>noplot</u>	suppress character-based plots
<u>yw</u>	calculate partial autocorrelations by using Yule–Walker equations

<i>ac_options</i>	Description
Main	
<u>lags</u> (#)	calculate # autocorrelations
<u>generate</u> ( <i>newvar</i> )	generate a variable to hold the autocorrelations
<u>level</u> (#)	set confidence level; default is <code>level(95)</code>
<u>fft</u>	calculate autocorrelation by using Fourier transforms

Plot	
<i>line_options</i>	change look of dropped lines
<i>marker_options</i>	change look of markers (color, size, etc.)
<i>marker_label_options</i>	add marker labels; change look or position

CI plot	
<u>ciopts</u> ( <i>area_options</i> )	affect rendition of the confidence bands

Add plots	
<u>addplot</u> ( <i>plot</i> )	add other plots to the generated graph

Y axis, X axis, Titles, Legend, Overall	
<i>twoway_options</i>	any options other than <code>by()</code> documented in [G-3] <i>twoway_options</i>

<i>pac_options</i>	Description
Main	
<code>lags(#)</code>	calculate # partial autocorrelations
<code>generate(newvar)</code>	generate a variable to hold the partial autocorrelations
<code>yw</code>	calculate partial autocorrelations by using Yule–Walker equations
<code>level(#)</code>	set confidence level; default is <code>level(95)</code>
Plot	
<code>line_options</code>	change look of dropped lines
<code>marker_options</code>	change look of markers (color, size, etc.)
<code>marker_label_options</code>	add marker labels; change look or position
CI plot	
<code>ciopts(area_options)</code>	affect rendition of the confidence bands
SRV plot	
<code>srv</code>	include standardized residual variances in graph
<code>srvopts(marker_options)</code>	affect rendition of the plotted standardized residual variances (SRVs)
Add plots	
<code>addplot(plot)</code>	add other plots to the generated graph
Y axis, X axis, Titles, Legend, Overall	
<code>twoway_options</code>	any options other than <code>by()</code> documented in [G-3] <code>twoway_options</code>

You must `tsset` your data before using `corrgram`, `ac`, or `pac`; see [TS] `tsset`. Also, the time series must be dense (nonmissing and no gaps in the time variable) in the sample if you specify the `fft` option. `varname` may contain time-series operators; see [U] 11.4.4 Time-series `varlists`.

## Options for corrgram

Main

`lags(#)` specifies the number of autocorrelations to calculate. The default is to use  $\min(\lfloor n/2 \rfloor - 2, 40)$ , where  $\lfloor n/2 \rfloor$  is the greatest integer less than or equal to  $n/2$ .

`noplot` prevents the character-based plots from being in the listed table of autocorrelations and partial autocorrelations.

`yw` specifies that the partial autocorrelations be calculated using the Yule–Walker equations instead of using the default regression-based technique. `yw` cannot be used if `srv` is used.

## Options for ac and pac

Main

`lags(#)` specifies the number of autocorrelations to calculate. The default is to use  $\min(\lfloor n/2 \rfloor - 2, 40)$ , where  $\lfloor n/2 \rfloor$  is the greatest integer less than or equal to  $n/2$ .

`generate(newvar)` specifies a new variable to contain the autocorrelation (`ac` command) or partial autocorrelation (`pac` command) values. This option is required if the `nograph` option is used.

`nograph` (implied when using `generate()` in the dialog box) prevents `ac` and `pac` from constructing a graph. This option requires the `generate()` option.

`yw` (`pac` only) specifies that the partial autocorrelations be calculated using the Yule–Walker equations instead of using the default regression-based technique. `yw` cannot be used if `srv` is used.

`level(#)` specifies the confidence level, as a percentage, for the confidence bands in the `ac` or `pac` graph. The default is `level(95)` or as set by `set level`; see [R] [level](#).

`fft` (`ac` only) specifies that the autocorrelations be calculated using two Fourier transforms. This technique can be faster than simply iterating over the requested number of lags.

#### Plot

`line_options`, `marker_options`, and `marker_label_options` affect the rendition of the plotted autocorrelations (with `ac`) or partial autocorrelations (with `pac`).

`line_options` specify the look of the dropped lines, including pattern, width, and color; see [G-3] [line\\_options](#).

`marker_options` specify the look of markers. This look includes the marker symbol, the marker size, and its color and outline; see [G-3] [marker\\_options](#).

`marker_label_options` specify if and how the markers are to be labeled; see [G-3] [marker\\_label\\_options](#).

#### CI plot

`ciopts(area_options)` affects the rendition of the confidence bands; see [G-3] [area\\_options](#).

#### SRV plot

`srv` (`pac` only) specifies that the standardized residual variances be plotted with the partial autocorrelations. `srv` cannot be used if `yw` is used.

`srvopts(marker_options)` (`pac` only) affects the rendition of the plotted standardized residual variances; see [G-3] [marker\\_options](#). This option implies the `srv` option.

#### Add plots

`addplot(plot)` adds specified plots to the generated graph; see [G-3] [addplot\\_option](#).

#### Y axis, X axis, Titles, Legend, Overall

`twoway_options` are any of the options documented in [G-3] [twoway\\_options](#), excluding `by()`. These include options for titling the graph (see [G-3] [title\\_options](#)) and for saving the graph to disk (see [G-3] [saving\\_option](#)).

## Remarks and examples

[stata.com](http://www.stata.com)

Remarks are presented under the following headings:

[Basic examples](#)

[Video example](#)

## Basic examples

`corrgram` tabulates autocorrelations, partial autocorrelations, and portmanteau ( $Q$ ) statistics and plots the autocorrelations and partial autocorrelations. The  $Q$  statistics are the same as those produced by [TS] `wntestq`. `ac` produces graphs of the autocorrelations, and `pac` produces graphs of the partial autocorrelations. See [Beckett \(2013\)](#) for additional examples of how these commands are used in practice.

### ► Example 1

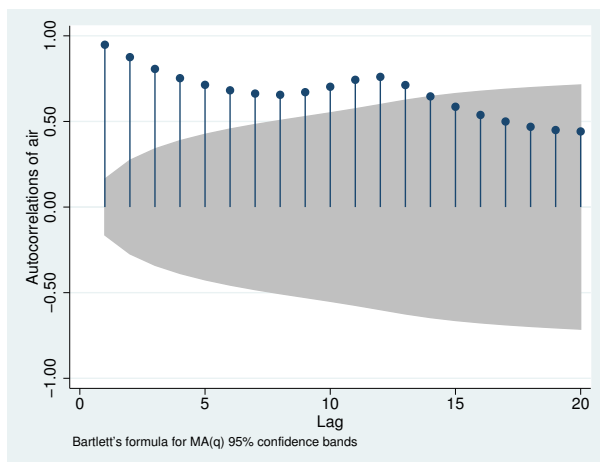
Here we use the international airline passengers dataset ([Box, Jenkins, and Reinsel 2008](#), Series G). This dataset has 144 observations on the monthly number of international airline passengers from 1949 through 1960. We can list the autocorrelations and partial autocorrelations by using `corrgram`.

```
. use http://www.stata-press.com/data/r14/air2
(TIMESLAB: Airline passengers)
. corrgram air, lags(20)
```

LAG	AC	PAC	Q	Prob>Q	-1	0	1	-1	0	1
					[Autocorrelation]			[Partial Autocor]		
1	0.9480	0.9589	132.14	0.0000						
2	0.8756	-0.3298	245.65	0.0000						
3	0.8067	0.2018	342.67	0.0000						
4	0.7526	0.1450	427.74	0.0000						
5	0.7138	0.2585	504.8	0.0000						
6	0.6817	-0.0269	575.6	0.0000						
7	0.6629	0.2043	643.04	0.0000						
8	0.6556	0.1561	709.48	0.0000						
9	0.6709	0.5686	779.59	0.0000						
10	0.7027	0.2926	857.07	0.0000						
11	0.7432	0.8402	944.39	0.0000						
12	0.7604	0.6127	1036.5	0.0000						
13	0.7127	-0.6660	1118	0.0000						
14	0.6463	-0.3846	1185.6	0.0000						
15	0.5859	0.0787	1241.5	0.0000						
16	0.5380	-0.0266	1289	0.0000						
17	0.4997	-0.0581	1330.4	0.0000						
18	0.4687	-0.0435	1367	0.0000						
19	0.4499	0.2773	1401.1	0.0000						
20	0.4416	-0.0405	1434.1	0.0000						

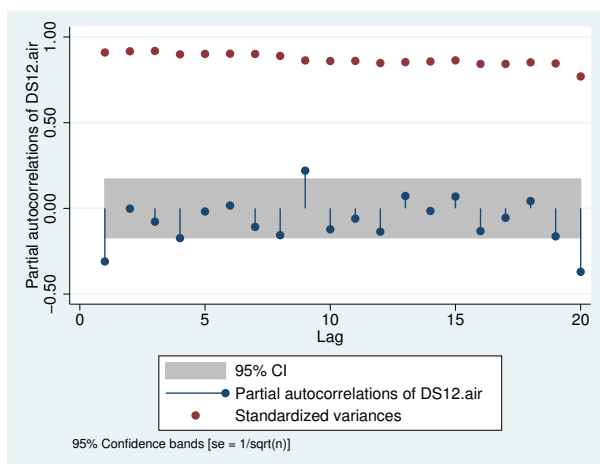
We can use `ac` to produce a graph of the autocorrelations.

```
. ac air, lags(20)
```



The data probably have a trend component as well as a seasonal component. First-differencing will mitigate the effects of the trend, and seasonal differencing will help control for seasonality. To accomplish this goal, we can use Stata's time-series operators. Here we graph the partial autocorrelations after controlling for trends and seasonality. We also use `srv` to include the standardized residual variances.

```
. pac DS12.air, lags(20) srv
```



See [U] [11.4.4 Time-series varlists](#) for more information about time-series operators.

## Video example

Time series, part 4: Correlograms and partial correlograms

## Stored results

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

### Scalars

<code>r(lags)</code>	number of lags
<code>r(ac#)</code>	AC for lag #
<code>r(pac#)</code>	PAC for lag #
<code>r(q#)</code>	$Q$ for lag #

### Matrices

<code>r(AC)</code>	vector of autocorrelations
<code>r(PAC)</code>	vector of partial autocorrelations
<code>r(Q)</code>	vector of $Q$ statistics

## Methods and formulas

Box, Jenkins, and Reinsel (2008, sec. 2.1.4); Newton (1988); Chatfield (2004); and Hamilton (1994) provide excellent descriptions of correlograms. Newton (1988) also discusses the calculation of the various quantities.

The autocovariance function for a time series  $x_1, x_2, \dots, x_n$  is defined for  $|v| < n$  as

$$\widehat{R}(v) = \frac{1}{n} \sum_{i=1}^{n-|v|} (x_i - \bar{x})(x_{i+v} - \bar{x})$$

where  $\bar{x}$  is the sample mean, and the autocorrelation function is then defined as

$$\widehat{\rho}_v = \frac{\widehat{R}(v)}{\widehat{R}(0)}$$

The variance of  $\widehat{\rho}_v$  is given by Bartlett's formula for MA(q) processes. From Brockwell and Davis (2002, 94), we have

$$\text{Var}(\widehat{\rho}_v) = \begin{cases} 1/n & v = 1 \\ \frac{1}{n} \left\{ 1 + 2 \sum_{i=1}^{v-1} \widehat{\rho}_v^2(i) \right\} & v > 1 \end{cases}$$

The partial autocorrelation at lag  $v$  measures the correlation between  $x_t$  and  $x_{t+v}$  after the effects of  $x_{t+1}, \dots, x_{t+v-1}$  have been removed. By default, `corrgram` and `pac` use a regression-based method to estimate it. We run an OLS regression of  $x_t$  on  $x_{t-1}, \dots, x_{t-v}$  and a constant term. The estimated coefficient on  $x_{t-v}$  is our estimate of the  $v$ th partial autocorrelation. The residual variance is the estimated variance of that regression, which we then standardize by dividing by  $\widehat{R}(0)$ .

If the `yw` option is specified, `corrgram` and `pac` use the Yule–Walker equations to estimate the partial autocorrelations. Per Enders (2010, 66–67), let  $\phi_{vv}$  denote the  $v$ th partial autocorrelation coefficient. We then have

$$\widehat{\phi}_{11} = \widehat{\rho}_1$$

and for  $v > 1$

$$\hat{\phi}_{vv} = \frac{\hat{\rho}_v - \sum_{j=1}^{v-1} \hat{\phi}_{v-1,j} \hat{\rho}_{v-j}}{1 - \sum_{j=1}^{v-1} \hat{\phi}_{v-1,j} \hat{\rho}_j}$$

and

$$\hat{\phi}_{vj} = \hat{\phi}_{v-1,j} - \hat{\phi}_{vv} \hat{\phi}_{v-1,v-j} \quad j = 1, 2, \dots, v-1$$

Unlike the regression-based method, the Yule–Walker equations-based method ensures that the first-sample partial autocorrelation equal the first-sample autocorrelation coefficient, as must be true in the population; see [Greene \(2008, 725\)](#).

[McCullough \(1998\)](#) discusses other methods of estimating  $\phi_{vv}$ ; he finds that relative to other methods, such as linear regression, the Yule–Walker equations-based method performs poorly, in part because it is susceptible to numerical error. [Box, Jenkins, and Reinsel \(2008, 69\)](#) also caution against using the Yule–Walker equations-based method, especially with data that are nearly nonstationary.

## Acknowledgment

The `ac` and `pac` commands are based on the `ac` and `pac` commands written by Sean [Becketti \(1992\)](#), a past editor of the *Stata Technical Bulletin* and author of the Stata Press book *Introduction to Time Series Using Stata*.

## References

- Becketti, S. 1992. `sts1: Autocorrelation and partial autocorrelation graphs`. *Stata Technical Bulletin* 5: 27–28. Reprinted in *Stata Technical Bulletin Reprints*, vol. 1, pp. 221–223. College Station, TX: Stata Press.
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- Brockwell, P. J., and R. A. Davis. 2002. *Introduction to Time Series and Forecasting*. 2nd ed. New York: Springer.
- Chatfield, C. 2004. *The Analysis of Time Series: An Introduction*. 6th ed. Boca Raton, FL: Chapman & Hall/CRC.
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## Also see

- [TS] [tsset](#) — Declare data to be time-series data
- [TS] [pergram](#) — Periodogram
- [TS] [wntestq](#) — Portmanteau (Q) test for white noise