

Overview

This syntax reference guide describes the command language underlying SPSS Trends. Following this introduction, the commands are described individually in alphabetical order.

Universals

Most of the rules described in the Universals section of the *SPSS Base Syntax Reference Guide* apply to Trends. This section explains some areas that are unique to working with Trends. The topics are divided into five sections:

- *Syntax* provides a quick review of the conventions used in SPSS syntax charts, which summarize command syntax in diagrams and provide an easy reference.
- *Operations* discusses general operating rules, missing values in Trends, and how to control the quantity of output using TSET.
- *New Variables* describes the types of series generated by Trends procedures and their naming conventions.
- *Periodicity* describes the facilities for specifying the periodicity of your series.
- *APPLY Subcommand* discusses the models generated by Trends procedures and how to use the APPLY subcommand as a shorthand method for developing and modifying models.

Syntax

Every effort has been made to keep the language of Trends consistent with that of the SPSS Base system.

Syntax Diagrams

Each Trends command, just like each Base system command, includes a syntax diagram that shows all the subcommands, keywords, and specifications allowed for that command. The rules of the syntax diagram are exactly the same for the Base system and for Trends but are repeated here for your convenience.

- Elements in upper case are subcommands or keywords.
- Elements in lower case describe specifications supplied by the user.
- Elements in boldface type are defaults.
- Elements enclosed in square brackets ([]) are optional. When brackets would confuse the format, they are omitted. The command description explains which specifications are required or optional.
- Braces ({ }) indicate a choice among the elements they enclose.
- Special delimiters—such as parentheses, apostrophes, or quotation marks—should be entered as they appear.

Operations

There are a few general operating rules you should be aware of when working with Trends:

- A pass of the data is caused by every Trends command except the following: MODEL NAME, READ MODEL, SAVE MODEL, and TDISPLAY.
- Except when you apply a previous model with the APPLY subcommand, subcommands are in effect only for the current procedure.
- Whenever a subcommand of a procedure performs the same function as a TSET setting, the procedure subcommand, if specified, overrides TSET.

Missing Values

Since time series observations occur at equally spaced intervals and are thus sequentially related in the data file, missing values in a series can present unique problems. There are several ways missing values are handled in Trends.

- In procedures AREG (method ML) and ARIMA, missing values are allowed anywhere in the series and present no problems in estimating parameters but do require extra processing time. AREG methods CO and PW can handle series that have missing values at the beginning or end of the series by dropping those observations but cannot handle series with imbedded missing values.
- Procedures EXSMOOTH, SEASON, SPECTRA, and X11ARIMA cannot handle missing values anywhere in the series. To use one of these procedures when you have missing data, you must first specify either TSET MISSING=INCLUDE to include user-missing values, the RMV procedure to replace missing values, or the USE command to specify a range of non-missing observations.
- The TSET MISSING command allows you to include or exclude user-missing values in Trends procedures. EXCLUDE is the default.
- RMV allows you to replace user-missing and system-missing values with estimates computed from existing values in the series using one of several methods.

Statistical Output

For some Trends procedures, the amount of output displayed can be controlled by the TSET PRINT setting. TSET PRINT can be set to BRIEF, DEFAULT, or DETAILED. The following are some general guidelines used by procedures with multiple iterations.

- For TSET PRINT=BRIEF, no iteration history is shown. Only the final statistics and the number of iterations required are reported.
- For TSET PRINT=DEFAULT, a one-line statistical summary at each iteration plus the final statistics are reported.
- For TSET PRINT=DETAILED, a complete statistical summary at each iteration plus the final statistics are reported.

For details, refer to the individual procedures.

New Variables

Trends procedures AREG, ARIMA, EXSMOOTH, SEASON, and X11ARIMA automatically create, name, and label new variables each time the procedure is executed. These new variables are added to the working data file and can be used or saved like any other variable. The names of these variables consist of the following prefixes, followed by an identifying numeric extension:

FIT *Predicted values.* When the predictions are for existing observations, the values are called “fitted” values. When the predicted values extend into the forecast period (see PREDICT in the *SPSS Base Syntax Reference Guide*), they are forecasts. Procedures AREG and ARIMA produce one *FIT* variable for each series list (equation); procedure EXSMOOTH produces one *FIT* variable for each series specified.

ERR *Residual or “error” values.* For procedures AREG, ARIMA, and EXSMOOTH, these values are the observed value minus the predicted value. These procedures produce one *ERR* variable for each *FIT* variable. Since *FIT* variables are always reported in the original raw score metric and *ERR* might be reported in the natural log metric if such a transformation was part of the model, the reported *ERR* variable will not always equal the observed variable minus the *FIT* variable. (The discussion under each individual procedure will tell you if this is the case.) The *ERR* variable is assigned the system-missing value for any observations in the forecast period that extend beyond the original series.

For procedures SEASON and X11ARIMA, the *ERR* values are what remain after the seasonal, trend, and cycle components have been removed from the series. These procedures produce one *ERR* variable for each series.

LCL *Lower confidence limits.* These are the lowerbound values of an estimated confidence interval for the predictions. A 95% confidence interval is estimated unless another interval is specified on a subcommand or on a previous TSET CIN command. Procedures AREG and ARIMA produce confidence intervals.

- UCL** *Upper confidence limits.* These are the upperbound values of an estimated confidence interval for the predictions. The interval is 95%, unless it is changed on a subcommand or on a previous TSET CIN command.
- SEP** *Standard errors of the predicted values.* Procedures AREG and ARIMA produce one *SEP* variable for every *FIT* variable.
- SAS** *Seasonally adjusted series.* These are the values obtained after removing the seasonal variation of a series. Procedures SEASON and X11ARIMA produce one *SAS* variable for each series specified.
- SAF** *Seasonal adjustment factors.* These values indicate the effect of each period on the level of the series. Procedures SEASON and X11ARIMA produce one *SAF* variable for each series specified.
- STC** *Smoothed trend-cycle components.* These values show the trend and cyclical behavior present in the series. Procedures SEASON and X11ARIMA produce one *STC* variable for each series specified.
- If TSET NEWVAR=CURRENT (the default) is in effect, only variables from the current procedure are saved in the working data file, and the suffix #*n* is used to distinguish variables that are generated by different series on one procedure. For example, if two series are specified on an ARIMA command, the variables automatically generated are *FIT#1*, *ERR#1*, *LCL#1*, *UCL#1*, *SEP#1*, *FIT#2*, *ERR#2*, *LCL#2*, *UCL#2* and *SEP#2*. If these variables already exist from a previous procedure, their values are replaced.
 - If TSET NEWVAR=ALL is in effect, all variables generated during the session are saved in the working data file. Variables are named using the extension *_n*, where *n* increments by 1 for each new variable of a given type. For example, if two series are specified on an EXSMOOTH command, the *FIT* variables generated would be *FIT_1* and *FIT_2*. If an AREG command with one series followed, the *FIT* variable would be *FIT_3*.
 - A third TSET NEWVAR option, NONE, allows you to display statistical results from a procedure without creating any new variables. This option can result in faster processing time.

TO Keyword

The order in which new variables are added to the working data file dictionary is *ERR*, *SAS*, *SAF*, and *STC* for SEASON and X11ARIMA, and *FIT*, *ERR*, *LCL*, *UCL*, and *SEP* for the other procedures. For this reason, the TO keyword should be used with caution for specifying lists of these generated variables. For example, the specification ERR#1 TO ERR#3 indicates more than just *ERR#1*, *ERR#2*, and *ERR#3*. If the residuals are from an ARIMA procedure, ERR#1 TO ERR#3 indicates *ERR#1*, *LCL#1*, *UCL#1*, *SEP#1*, *FIT#2*, *ERR#2*, *LCL#2*, *UCL#2*, *SEP#2*, *FIT#3*, and *ERR#3*.

Maximum Number of New Variables

TSET MXNEWVAR specifies the maximum number of new variables that can be generated by a procedure. The default is 60.

Periodicity

Trends provides several ways to specify the periodicity of your series.

- Many Trends commands have a subcommand such as PERIOD that can set the periodicity for that specific procedure.
- TSET PERIOD can be used to set the periodicity to be used globally. This specification can be changed by another TSET PERIOD command.
- The DATE command assigns date variables to the observations. Most of these variables have periodicities associated with them.

If more than one of these periodicities are in effect when a procedure that uses periodicity is executed, the following precedence determines which periodicity is used:

- First, the procedure uses any periodicity specified within the procedure.
- Second, if the periodicity has not been specified within the command, the procedure uses the periodicity established on TSET PERIOD.
- Third, if periodicity is not defined within the procedure or on TSET PERIOD, the periodicity established by the DATE variables is used.

If periodicity is required for execution of the procedure (SEASON) or a subcommand of a procedure (SDIFF) and the periodicity has not been established anywhere, the procedure or subcommand will not be executed.

APPLY Subcommand

On most Trends procedures (and on some Base system and Professional Statistics procedures) you can specify the APPLY subcommand. APPLY allows you to use specifications from a previous execution of the same procedure. This provides a convenient shorthand for developing and modifying models. Specific rules and examples on how to use APPLY with a given procedure are described under the individual procedures. The following are some general rules about using the APPLY subcommand:

- In general, the only specification on APPLY is the name of the model to be reapplied in quotes. If no model is specified, the model and series from the previous specification of that procedure is used.
- For procedures AREG and ARIMA, three additional keywords, INITIAL, SPECIFICATIONS, and FIT, can be specified on APPLY. These keywords are discussed under those procedures.
- To change the series used with the model, enter new series names before or after APPLY. If series names are specified before APPLY, a slash is required to separate the series names and the APPLY subcommand.
- To change one or more specifications of the model, enter the subcommands of only those portions you want to change before or after the keyword APPLY.

- Model names are either the default *MOD_n* names assigned by Trends or the names assigned on the MODEL NAME command.
- Models can be applied only to the same type of procedure that generated them. For example, you cannot apply a model generated by ARIMA to the AREG procedure.
- The following procedures can generate models and apply models: AREG, ARIMA, EXSMOOTH, SEASON, SPECTRA, and X11ARIMA in SPSS Trends; ACF, CASEPLOT, CCF, CURVEFIT, NPLOT, PACF, and TSPLIT in the SPSS Base system; and WLS and 2SLS in SPSS Professional Statistics.

Models

The models specified on the APPLY subcommand are automatically generated by Trends procedures. Models created within a Trends session remain active until the end of the session or until the READ MODEL command is specified.

Each model includes information such as the procedure that created it, the model name assigned to it, the series names specified, the subcommands and specifications used, parameter estimates, and TSET settings.

Four Trends commands are available for use with models:

- TDISPLAY displays information about the active models, including model name, model label, the procedure that created each model, and so forth.
- MODEL NAME allows you to specify names for models.
- SAVE MODEL allows you to save any or all of the models created in a session in a model file.
- READ MODEL reads in any or all of the models contained in a previously saved model file. These models replace currently active models.

Default Model Names

The default model name is *MOD_n*, where *n* increments by 1 each time an unnamed model is created in the session.

- *MOD_n* reinitializes at the start of every session or when the READ MODEL subcommand is specified.
- If any *MOD_n* names already exist (for example, if they are read in using READ MODEL), those numbers are skipped when new names are assigned.
- Alternatively, you can assign model names on the MODEL NAME command.

AREG

AREG [VARIABLES=] dependent series name WITH independent series names

```
[ /METHOD={PW** }
           {CO }
           {ML }

[ / {CONSTANT† }
   {NOCONSTANT }

[ /RHO={0** }
      {value }

[ /MXITER={10** }
         {n }

[ /APPLY [= 'model name' ] [ {SPECIFICATIONS } ] ]
                           {INITIAL }
                           {FIT }
```

**Default if the subcommand is omitted.

†Default if the subcommand or keyword is omitted and there is no corresponding specification on the TSET command.

Method definitions:

PW Prais-Winsten (GLS) estimation
CO Cochrane-Orcutt estimation
ML Exact maximum-likelihood estimation

Example:

```
AREG VARY WITH VARX
/METHOD=ML.
```

Overview

AREG estimates a regression model with AR(1) (first-order autoregressive) errors. (Models whose errors follow a general ARIMA process can be estimated using the ARIMA procedure.) AREG provides a choice among three estimation techniques.

For the Prais-Winsten and Cochrane-Orcutt estimation methods (keywords PW and CO), you can obtain the rho values and statistics at each iteration, and regression statistics for the ordinary least-square and final Prais-Winsten or Cochrane-Orcutt estimates. For the maximum-likelihood method (keyword ML), you can obtain the adjusted sum of squares and Marquardt constant at each iteration and, for the final parameter estimates, regression statistics, correlation and covariance matrices, Akaike's information criterion (AIC) (Akaike, 1974), and Schwartz's Bayesian criterion (SBC) (Schwartz, 1978).

Options

Estimation Technique. You can select one of three available estimation techniques (Prais-Winsten, Cochrane-Orcutt, or exact maximum-likelihood) on the METHOD subcommand. You can request regression through the origin or inclusion of a constant in the model by specifying NOCONSTANT or CONSTANT to override the setting on the TSET command.

Rho Value. You can specify the value to be used as the initial rho value (estimate of the first autoregressive parameter) on the RHO subcommand.

Iterations. You can specify the maximum number of iterations the procedure is allowed to cycle through in calculating estimates on the MXITER subcommand.

Statistical Output. To display estimates and statistics at each iteration in addition to the default output, specify TSET PRINT=DETAILED before AREG. To display only the final parameter estimates, use TSET PRINT=BRIEF (see TSET in the *SPSS Base Syntax Reference Guide*).

New Variables. To evaluate the regression summary table without creating new variables, specify TSET NEWVAR=NONE prior to AREG. This can result in faster processing time. To add new variables without erasing the values of previous Trends-generated variables, specify TSET NEWVAR=ALL. This saves all new variables generated during the session in the working data file and may require extra processing time.

Basic Specification

The basic specification is one dependent series name, the keyword WITH, and one or more independent series names.

- By default, procedure AREG estimates a regression model using the Prais-Winsten (GLS) technique. The number of iterations is determined by the convergence value set on TSET CNVERGE (default of 0.001), up to the default maximum number of 10 iterations. A 95% confidence interval is used unless it is changed by a TSET CIN command prior to the AREG procedure.
- Unless the default on TSET NEWVAR is changed prior to AREG, five variables are automatically created, labeled, and added to the working data file: fitted values (*FIT#1*), residuals (*ERR#1*), lower confidence limits (*LCL#1*), upper confidence limits (*UCL#1*), and standard errors of prediction (*SEP#1*). (For variable naming and labeling conventions, see “New Variables” on p. 3.)

Subcommand Order

- VARIABLES must be specified first.
- The remaining subcommands can be specified in any order.

Syntax Rules

- VARIABLES can be specified only once.
- Other subcommands can be specified more than once, but only the last specification of each one is executed.

Operations

- AREG cannot forecast beyond the end of the regressor (independent) series (see PREDICT in the *SPSS Base Syntax Reference Guide*).
- Method ML allows missing data anywhere in the series. Missing values at the beginning and end are skipped and the analysis proceeds with the first non-missing case using Melard's algorithm. If imbedded missing values are found, they are noted and the Kalman filter is used for estimation.
- Methods PW and CO allow missing values at the beginning or end of the series but not within the series. Missing values at the beginning or end of the series are skipped. If imbedded missing values are found, a warning is issued suggesting the ML method be used instead and the analysis terminates. (See RMV in the *SPSS Base Syntax Reference Guide* for information on replacing missing values.)
- Series with missing cases may require extra processing time.

Limitations

- Maximum 1 VARIABLES subcommand.
- Maximum 1 dependent series in the series list. There is no limit on the number of independent series.

Example

```
AREG VARY WITH VARX
/METHOD=ML.
```

- This command performs an exact maximum-likelihood (ML) regression using series *VARY* as the dependent variable and series *VARX* as the independent variable.

VARIABLES Subcommand

VARIABLES specifies the series list and is the only required subcommand. The actual keyword VARIABLES can be omitted.

- The dependent series is specified first, followed by keyword WITH and one or more independent series.

METHOD Subcommand

METHOD specifies the estimation technique. Three different estimation techniques are available.

- If METHOD is not specified, the Prais-Winsten method is used.
- Only one method can be specified on the METHOD subcommand.

The available methods are:

- PW** *Prais-Winsten method.* This generalized least-squares approach is the default (see Johnston, 1984).
- CO** *Cochrane-Orcutt method.* (See Johnston, 1984.)
- ML** *Exact maximum-likelihood method.* This method can be used when one of the independent variables is the lagged dependent variable. It can also handle missing data anywhere in the series (see Kohn & Ansley, 1986).

Example

```
AREG VARY WITH VARX
/METHOD=CO.
```

In this example, the Cochrane-Orcutt method is used to estimate the regression model.

CONSTANT and NOCONSTANT Subcommands

CONSTANT and NOCONSTANT indicate whether a constant term should be estimated in the regression equation. The specification overrides the corresponding setting on the TSET command.

- CONSTANT indicates that a constant should be estimated. It is the default unless changed by TSET NOCONSTANT prior to the current procedure.
- NOCONSTANT eliminates the constant term from the model.

RHO Subcommand

RHO specifies the initial value of rho, an estimate of the first autoregressive parameter.

- If RHO is not specified, the initial rho value defaults to 0 (equivalent to ordinary least squares).
- The value specified on RHO can be any value greater than -1 and less than 1 .
- Only one rho value can be specified per AREG command.

Example

```
AREG VAR01 WITH VAR02 VAR03
/METHOD=CO
/RHO=0.5.
```

- In this example, the Cochrane-Orcutt (CO) estimation method with an initial rho value of 0.5 is used.

MXITER Subcommand

MXITER specifies the maximum number of iterations of the estimation process.

- If MXITER is not specified, the maximum number of iterations defaults to 10.
- The specification on MXITER can be any positive integer.

- Iteration stops either when the convergence criterion is met or when the maximum is reached, whichever occurs first. The convergence criterion is set on the TSET CNVERGE command. The default is 0.001.

Example

```
AREG VARY WITH VARX
/MXITER=5.
```

- In this example, AREG generates Prais-Winsten estimates and associated statistics with a maximum of 5 iterations.

APPLY Subcommand

APPLY allows you to use a previously defined AREG model without having to repeat the specifications. For general rules on APPLY, see the APPLY subcommand on p. 5.

- The specifications on APPLY can include the name of a previous model in quotes and one of three keywords. All of these specifications are optional.
- If a model name is not specified, the model specified on the previous AREG command is used.
- To change one or more specifications of the model, specify the subcommands of only those portions you want to change after the APPLY subcommand.
- If no series are specified on the AREG command, the series that were originally specified with the model being reapplied are used.
- To change the series used with the model, enter new series names before or after the APPLY subcommand. If a series name is specified before APPLY, the slash before the subcommand is required.
- APPLY with keyword FIT sets MXITER to 0. If you apply a model that used FIT and want to obtain estimates, you will need to respecify MXITER.

The keywords available for APPLY with AREG are:

SPECIFICATIONS	<i>Use only the specifications from the original model. AREG should create the initial values. This is the default.</i>
INITIAL	<i>Use the original model's final estimates as initial values for estimation.</i>
FIT	<i>No estimation. Estimates from the original model should be applied directly.</i>

Example

```

AREG VARY WITH VARX
/METHOD=CO
/RHO=0.25
/MXITER=15.
AREG VARY WITH VARX
/METHOD=ML.
AREG VARY WITH VAR01
/APPLY.
AREG VARY WITH VAR01
/APPLY='MOD_1'
/MXITER=10.
AREG VARY WITH VAR02
/APPLY FIT.

```

- The first command estimates a regression model for *VARY* and *VARX* using the Cochrane-Orcutt method, an initial rho value of 0.25, and a maximum of 15 iterations. This model is assigned the name *MOD_1*.
- The second command estimates a regression model for *VARY* and *VARX* using the ML method. This model is assigned the name *MOD_2*.
- The third command displays the regression statistics for the series *VARY* and *VAR01* using the same method, ML, as in the second command. This model is assigned the name *MOD_3*.
- The fourth command applies the same method and rho value as in the first command but changes the maximum number of iterations to 10. This new model is named *MOD_4*.
- The last command applies the last model, *MOD_4*, using the series *VARY* and *VAR02*. The FIT specification means the final estimates of *MOD_4* should be applied directly to the new series with no new estimation.

References

- Akaike, H. 1974. A new look at the statistical model identification. *IEEE Transaction on Automatic Control* AC-19: 716–723.
- Harvey, A. C. 1981. *The econometric analysis of time series*. Oxford: Philip Allan.
- Johnston, J. 1984. *Econometric methods*. New York: McGraw-Hill.
- Kohn, R., and C. Ansley. 1986. Estimation, prediction, and interpolation for ARIMA models with missing data. *Journal of the American Statistical Association* 81: 751–761.
- Schwartz, G. 1978. Estimating the dimensions of a model. *Annals of Statistics* 6: 461–464.

ARIMA

```
ARIMA [VARIABLES=] dependent series name [WITH independent series names]

[/MODEL =[(p,d,q)[(sp,sd,sq)[period]]]
      [{{CONSTANT†}}] [{{NOLOG†}}]
      {{NOCONSTANT}} {{LG10 or LOG}}
                      {{LN}}
[/P={value} ] [D={value}] [/Q={value} ]
  {(value list)} {(value list)}
[/SP={value} ] [/SD={value}] [/SQ={value} ]
  {(value list)} {(value list)}
[/AR=value list] [/MA=value list]
[/SAR=value list] [/SMA=value list]
[/REG=value list] [/CON=value]
[/MXITER={10**} ] [MXLAMB={1.0E9**} ]
  {value} {value}
[/SSQPCT={0.001**} ] [/PAREPS={0.001†} ]
  {value} {value}
[/CINPCT={95†} ]
  {value}
[/APPLY [= 'model name'] [{{SPECIFICATIONS}}] ]
  {{INITIAL}}
  {{FIT}}
[/FORECAST [{{EXACT}} ] ]
  {{CLS}}
  {{AUTOINIT}}
```

**Default if the subcommand is omitted.

†Default if the subcommand or keyword is omitted and there is no corresponding specification on the TSET command.

Example:

```
ARIMA SALES WITH INTERVEN
  /MODEL=(0,1,1)(0,1,1).
```

Overview

ARIMA estimates nonseasonal and seasonal univariate ARIMA models with or without fixed regressor variables. The procedure uses a subroutine library written by Craig Ansley that produces maximum-likelihood estimates and can process time series with missing observations.

Options

Model Specification. The traditional ARIMA (p,d,q)(sp,sd,sq) model incorporates nonseasonal and seasonal parameters multiplicatively and can be specified on the MODEL subcommand. You can also specify ARIMA models and constrained ARIMA models by using the separate parameter-order subcommands P, D, Q, SP, SD, and SQ.

Parameter Specification. If you specify the model in the traditional (p,d,q) (sp,sd,sq) format on the MODEL subcommand, you can additionally specify the period length, whether a constant should be included in the model (using keyword CONSTANT or NOCONSTANT), and whether the series should first be log transformed (using keyword NOLOG, LG10, or LN). You can fit single or nonsequential parameters by using the separate parameter-order subcommands to specify the exact lags. You can also specify initial values for any of the parameters using the AR, MA, SAR, SMA, REG, and CON subcommands.

Iterations. You can specify termination criteria using the MXITER, MXLAMB, SSQPCT, and PAREPS subcommands.

Confidence Intervals. You can control the size of the confidence interval using the CINPCT subcommand.

Statistical Output. To display only the final parameter statistics, specify TSET PRINT=BRIEF before ARIMA. To include parameter estimates at each iteration in addition to the default output, specify TSET PRINT=DETAILED.

New Variables. To evaluate model statistics without creating new variables, specify TSET NEWVAR=NONE prior to ARIMA. This could result in faster processing time. To add new variables without erasing the values of Trends-generated variables, specify TSET NEWVAR=ALL. This saves all new variables generated during the current session in the working data file and may require extra processing time.

Forecasting. To specify the forecasting method, use the FORECAST subcommand. To specify a range for forecasts beyond the end of the series, use ARIMA with PREDICT (see PREDICT in the *SPSS Base Syntax Reference Guide*).

Basic Specification

The basic specification is the dependent series name. To estimate an ARIMA model, the MODEL subcommand and/or separate parameter-order subcommands (or the APPLY subcommand) must also be specified. Otherwise, only the constant will be estimated.

- ARIMA estimates the parameter values of a model using the parameter specifications on the MODEL subcommand and/or the separate parameter-order subcommands P, D, Q, SP, SD, and SQ.
- A 95% confidence interval is used unless it is changed by a TSET CIN command prior to the ARIMA procedure.
- Unless the default on TSET NEWVAR is changed prior to ARIMA, five variables are automatically created, labeled, and added to the working data file: fitted values (*FIT#1*), residuals (*ERR#1*), lower confidence limits (*LCL#1*), upper confidence limits (*UCL#1*), and

standard errors of prediction (*SEP#1*). (For variable naming and labeling conventions, see “New Variables” on p. 3.)

- By default, ARIMA will iterate up to a maximum of 10 unless one of three termination criteria is met: the change in all parameters is less than the TSET CNVERGE value (the default value is 0.001); the sum-of-squares percentage change is less than 0.001%; or the Marquardt constant exceeds 10^9 (1.0E9).
- At each iteration, the Marquardt constant and adjusted sum of squares are displayed. For the final estimates, the displayed results include the parameter estimates, standard errors, *t* ratios, estimate of residual variance, standard error of the estimate, log likelihood, Akaike’s information criterion (AIC) (Akaike, 1974), Schwartz’s Bayesian criterion (SBC) (Schwartz, 1978), and covariance and correlation matrices.

Subcommand Order

- Subcommands can be specified in any order.

Syntax Rules

- VARIABLES can be specified only once.
- Other subcommands can be specified more than once, but only the last specification of each one is executed.
- The CONSTANT, NOCONSTANT, NOLOG, LN, and LOG specifications are optional keywords on the MODEL subcommand and are not independent subcommands.

Operations

- If differencing is specified in models with regressors, both the dependent series and the regressors are differenced. To difference only the dependent series, use the DIFF or SDIFF function on CREATE to create a new series (see CREATE in the *SPSS Base Syntax Reference Guide*).
- When ARIMA is used with the PREDICT command to forecast values beyond the end of the series, the original series and residual variable are assigned the system-missing value after the last case in the original series.
- The USE and PREDICT ranges cannot be exactly the same; at least one case from the USE period must precede the PREDICT period. (See USE and PREDICT in the *SPSS Base Syntax Reference Guide*.)
- If a LOG or LN transformation is specified, the residual (error) series is reported in the logged metric; it is not transformed back to the original metric. This is so the proper diagnostic checks can be done on the residuals. However, the predicted (forecast) values *are* transformed back to the original metric. Thus, the observed value minus the predicted value will not equal the residual value. A new residual variable in the original metric can be computed by subtracting the predicted value from the observed value.
- Specifications on the P, D, Q, SP, SD, and SQ subcommands override specifications on the MODEL subcommand.

- For ARIMA models with a fixed regressor, the number of forecasts and confidence intervals produced cannot exceed the number of observations for the regressor (independent) variable. Regressor series cannot be extended.
- Models of series with imbedded missing observations can take longer to estimate.

Limitations

- Maximum 1 VARIABLES subcommand.
- Maximum 1 dependent series. There is no limit on the number of independent series.
- Maximum 1 model specification.

Example

```
ARIMA SALES WITH INTERVEN
/MODEL=(0,1,1)(0,1,1).
```

- This example specifies a multiplicative seasonal ARIMA model with a fixed regressor variable.
- The dependent series is *SALES*, the regressor series is *INTERVEN*, and an ARIMA (0,1,1)(0,1,1) model with a constant term is estimated.

VARIABLES Subcommand

VARIABLES specifies the dependent series and regressors, if any, and is the only required subcommand. The actual keyword VARIABLES can be omitted.

- The dependent series is specified first, followed by keyword WITH and the regressors (independent series).

MODEL Subcommand

MODEL specifies the ARIMA model, period length, whether a constant term should be included in the model, and whether the series should be log transformed.

- The model parameters are listed using the traditional ARIMA (p,d,q) (sp,sd,sq) syntax.
- Nonseasonal parameters are specified with the appropriate *p*, *d*, and *q* values separated by commas and enclosed in parentheses.
- The value *p* is a positive integer indicating the order of nonseasonal autoregressive parameters, *d* is a positive integer indicating the degree of nonseasonal differencing, and *q* is a positive integer indicating the nonseasonal moving-average order.
- Seasonal parameters are specified after the nonseasonal parameters with the appropriate *sp*, *sd*, and *sq* values. They are also separated by commas and enclosed in parentheses.
- The value *sp* is a positive integer indicating the order of seasonal autoregressive parameters, *sd* is a positive integer indicating the degree of seasonal differencing, and *sq* is a positive integer indicating the seasonal moving-average order.

- After the seasonal model parameters, a positive integer can be specified to indicate the length of a seasonal period.
- If the period length is not specified, the periodicity established on TSET PERIOD is in effect. If TSET PERIOD is not specified, the periodicity established on the DATE command is used. If periodicity was not established anywhere and a seasonal model is specified, the ARIMA procedure is not executed.

The following optional keywords can be specified on MODEL:

CONSTANT	<i>Include a constant in the model.</i> This is the default unless the default setting on the TSET command is changed prior to the ARIMA procedure.
NOCONSTANT	<i>Do not include a constant.</i>
NOLOG	<i>Do not log transform the series.</i> This is the default.
LG10	<i>Log transform the series before estimation using the base 10 logarithm.</i> Keyword LOG is an alias for LG10.
LN	<i>Log transform the series before estimation using the natural logarithm (base e).</i>

- Keywords can be specified anywhere on the MODEL subcommand.
- CONSTANT and NOCONSTANT are mutually exclusive. If both are specified, only the last one is executed.
- LG10 (LOG), LN, and NOLOG are mutually exclusive. If more than one is specified, only the last one is executed.
- CONSTANT and NOLOG are generally used as part of an APPLY subcommand to turn off previous NOCONSTANT, LG10, or LN specifications

Example

```
ARIMA SALES WITH INTERVEN
  /MODEL=(1,1,1)(1,1,1) 12 NOCONSTANT LN.
```

- This example specifies a model with a first-order nonseasonal autoregressive parameter, one degree of nonseasonal differencing, a first-order nonseasonal moving average, a first-order seasonal autoregressive parameter, one degree of seasonal differencing, and a first-order seasonal moving average.
- The 12 indicates that the length of the period for SALES is 12.
- The keywords NOCONSTANT and LN indicate that a constant is not included in the model and that the series is log transformed using the natural logarithm before estimation.

Parameter-Order Subcommands

P, D, Q, SP, SD, and SQ can be used as additions or alternatives to the MODEL subcommand to specify particular lags in the model and degrees of differencing for fitting single or non-sequential parameters. These subcommands are also useful for specifying a constrained model. The subcommands represent the following parameters:

P	<i>Autoregressive order.</i>
D	<i>Order of differencing.</i>
Q	<i>Moving-average order.</i>
SP	<i>Seasonal autoregressive order.</i>
SD	<i>Order of seasonal differencing.</i>
SQ	<i>Seasonal moving-average order.</i>

- The specification on P, Q, SP, or SQ indicates which lags are to be fit and can be a single positive integer or a list of values in parentheses.
- A single value n denotes lags 1 through n .
- A single value *in parentheses*, for example (n) , indicates that only lag n should be fit.
- A list of values in parentheses (i, j, k) denotes lags i, j , and k only.
- You can specify as many values in parentheses as you want.
- D and SD indicate the degrees of differencing and can be specified only as single values, not value lists.
- Specifications on P, D, Q, SP, SD, and SQ override specifications for the corresponding parameters on the MODEL subcommand.

Example

```
ARIMA SALES
  /P=2
  /D=1.
ARIMA INCOME
  /MODEL=LOG NOCONSTANT
  /P=(2).
ARIMA VAR01
  /MODEL=(1,1,4)(1,1,4)
  /Q=(2,4)
  /SQ=(2,4).
ARIMA VAR02
  /MODEL=(1,1,0)(1,1,0)
  /Q=(2,4)
  /SQ=(2,4).
```

- The first command fits a model with autoregressive parameters at lags 1 and 2 ($P=2$) and one degree of differencing ($D=1$) for the series *SALES*. This command is equivalent to:

```
ARIMA SALES
  /MODEL=(2,1,0).
```

- In the second command, the series *INCOME* is log transformed and no constant term is estimated. There is one autoregressive parameter at lag 2, as indicated by $P=(2)$.
- The third command specifies a model with one autoregressive parameter, one degree of differencing, moving-average parameters at lags 2 and 4, one seasonal autoregressive parameter, one degree of seasonal differencing, and seasonal moving-average parameters at lags 2 and 4. The 4's in the MODEL subcommand for moving average and seasonal moving average are ignored because of the Q and SQ subcommands.

- The last command specifies the same model as the previous command. Even though the MODEL command specifies no nonseasonal or seasonal moving-average parameters, these parameters are estimated at lags 2 and 4 because of the Q and SQ specifications.

Initial Value Subcommands

AR, MA, SAR, SMA, REG, and CON specify initial values for parameters. These subcommands refer to the following parameters:

AR	<i>Autoregressive parameter values.</i>
MA	<i>Moving-average parameter values.</i>
SAR	<i>Seasonal autoregressive parameter values.</i>
SMA	<i>Seasonal moving-average parameter values.</i>
REG	<i>Fixed regressor parameter values.</i>
CON	<i>Constant value.</i>

- Each subcommand specifies a value or value list indicating the initial values to be used in estimating the parameters.
- CON can be specified only as a single value, not a value list.
- Values are matched to parameters in sequential order. That is, the first value is used as the initial value for the first parameter of that type, the second value is used as the initial value for the second parameter of that type, and so forth.
- Specify only the subcommands for which you can supply a complete list of initial values (one for every lag to be fit for that parameter type).
- If you specify an inappropriate initial value for AR, MA, SAR, or SMA, ARIMA will reset the value and issue a message.
- If MXITER=0, these subcommands specify final parameter values to use for forecasting.

Example

```
ARIMA VARY
  /MODEL (1,0,2)
  /AR=0.5
  /MA=0.8, -0.3.
ARIMA VARY
  /MODEL (1,0,2)
  /AR=0.5.
```

- The first command specifies initial estimation values for the autoregressive term and for the two moving-average terms.
- The second command specifies the initial estimation value for the autoregressive term only. The moving-average initial values are estimated by ARIMA.

Termination Criteria Subcommands

ARIMA will continue to iterate until one of four termination criteria is met. The values of these criteria can be changed using any of the following subcommands followed by the new value:

MXITER *Maximum number of iterations.* The value specified can be any integer equal to or greater than 0. If MXITER equals 0, initial parameter values become final estimates to be used in forecasting. The default value is 10.

PAREPS *Parameter change tolerance.* The value specified can be any real number greater than 0. A change in all of the parameters by less than this amount causes termination. The default is the value set on TSET CNVERGE. If TSET CNVERGE is not specified, the default is 0.001. A value specified on PAREPS overrides the value set on TSET CNVERGE.

SSQPCT *Sum of squares percentage.* The value specified can be a real number greater than 0 and less than or equal to 100. A relative change in the adjusted sum of squares by less than this amount causes termination. The default value is 0.001%.

MXLAMB *Maximum lambda.* The value specified can be any integer. If the Marquardt constant exceeds this value, estimation is terminated. The default value is 1,000,000,000 (10^9).

CINPCT Subcommand

CINPCT controls the size of the confidence interval.

- The specification on CINPCT can be any real number greater than 0 and less than 100.
- The default is the value specified on TSET CIN. If TSET CIN is not specified, the default is 95.
- CINPCT overrides the value set on the TSET CIN command.

APPLY Subcommand

APPLY allows you to use a previously defined ARIMA model without having to repeat the specifications. For general rules on APPLY, see the APPLY subcommand on p. 5.

- The specifications on APPLY can include the name of a previous model in quotes and one of three keywords. All of these specifications are optional.
- If a model name is not specified, the model specified on the previous ARIMA command is used.
- To change one or more of the specifications of the model, specify the subcommands of only those portions you want to change after the subcommand APPLY.
- If no series are specified on the ARIMA command, the series that were originally specified with the model being reapplied are used.
- To change the series used with the model, enter new series names before or after the APPLY subcommand. If a series name is specified before APPLY, the slash before the subcommand is required.
- APPLY with keyword FIT sets MXITER to 0. If you apply a model that used FIT and want to obtain estimates, you will need to respecify MXITER.

The keywords available for APPLY with ARIMA are:

SPECIFICATIONS	<i>Use only the specifications from the original model. ARIMA should create the initial values. This is the default.</i>
INITIAL	<i>Use the original model's final estimates as initial values for estimation.</i>
FIT	<i>No estimation. Estimates from the original model should be applied directly.</i>

Example

```
ARIMA VAR1
  /MODEL=(0,1,1)(0,1,1) 12 LOG NOCONSTANT.
ARIMA APPLY
  /MODEL=CONSTANT.
ARIMA VAR2
  /APPLY INITIAL.
ARIMA VAR2
  /APPLY FIT.
```

- The first command specifies a model with one degree of differencing, one moving-average term, one degree of seasonal differencing, and one seasonal moving-average term. The length of the period is 12. A base 10 log of the series is taken before estimation and no constant is estimated. This model is assigned the name *MOD_1*.
- The second command applies the same model to the same series, but this time estimates a constant term. Everything else stays the same. This model is assigned the name *MOD_2*.
- The third command uses the same model as the previous command (*MOD_2*) but applies it to series *VAR2*. Keyword *INITIAL* specifies that the final estimates of *MOD_2* are to be used as the initial values for estimation.
- The last command uses the same model but this time specifies no estimation. Instead, the values from the previous model are applied directly.

FORECAST Subcommand

FORECAST allows you to specify the forecasting method used in producing the fitted and predicted values for the estimated model. To specify a forecasting range, use ARIMA with PREDICT.

The keywords available for FORECAST are:

EXACT	<i>Produce finite memory forecasts. Assuming that the estimated model parameters are the true parameters, this procedure computes the covariance function of the model and uses it to compute the exact least squares forecasts of the future values. This is the default.</i>
CLS	<i>Produce conditional least squares forecasts. These are least squares forecasts conditional on the assumption that the unobserved past errors are zero and the unobserved past values of the response series are equal to the mean.</i>
AUTOINIT	<i>Produce conditional least squares forecasts initialized using beginning series values. This variant of the CLS option uses beginning series values to initialize the recursive conditional least squares forecasting algorithm.</i>

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EXSMOOTH

```
EXSMOOTH [VARIABLES=] series names

[/MODEL={NN** or SINGLE } ]
      {NA
      {NM
      }
      {LN or HOLT
      {LA
      {LM or WINTERS
      }
      }
      {EN
      {EA
      {EM
      }
      }
      {DN
      {DA
      {DM
      }

[/PERIOD=n]

[/SEASFACT={{value list}}
            {varname
            }

[/ALPHA={0.1**
         {value
         {GRID ({0,1,0.1
                 {start, end, increment
                 }
         }

[/GAMMA={0.1**
         {value
         {GRID ({0,1,0.2
                 {start, end, increment
                 }
         }

[/DELTA={0.1**
         {value
         {GRID ({0,1,0.2
                 {start, end, increment
                 }
         }

[/PHI={0.1**
       {value
       {GRID ({0.1,0.9,0.2
               {start, end, increment
               }
       }

[/INITIAL={CALCULATE**
           {(start value, trend value)}
           ]

[/APPLY[='model name']]
```

**Default if the subcommand is omitted.

Example:

```
EXSMOOTH VAR2
  /MODEL=LN
  /ALPHA=0.2.
```

Overview

EXSMOOTH produces fit/forecast values and residuals for one or more time series. A variety of models differing in trend (none, linear, or exponential) and seasonality (none, additive, or multiplicative) are available (see Gardner, 1985).

Options

Model Specification. You can specify a model with any combination of trend and seasonality components using the MODEL subcommand. For seasonal models, you can specify the periodicity using the PERIOD subcommand.

Parameter Specification. You can specify values for the smoothing parameters using the ALPHA, GAMMA, DELTA, and PHI subcommands. You can also specify initial values using subcommand INITIAL and seasonal factor estimates using subcommand SEASFACT.

Statistical Output. To get a list of all the SSE's and parameters instead of just the 10 smallest, specify TSET PRINT=DETAILED prior to EXSMOOTH.

New Variables. Because of the number of parameter and value combinations available, EXSMOOTH can create many new variables (up to the maximum specified on the TSET MXNEWVARS command). To evaluate the sum of squared errors without creating and saving new variables in the working data file, use TSET NEWVAR=NONE prior to EXSMOOTH. To add new variables without erasing the values of previous Trends-generated variables, specify TSET NEWVAR=ALL. This saves all new variables generated during the current session in the working data file.

Forecasting. When used with the PREDICT command, EXSMOOTH can produce forecasts beyond the end of the series (see PREDICT in the *SPSS Base Syntax Reference Guide*).

Basic Specification

The basic specification is one or more series names.

- If a model is not specified, the NN (no trend and nonseasonal) model is used. The default value for each of the smoothing parameters is 0.1.
- Unless the default on the TSET NEWVAR is changed prior to the EXSMOOTH procedure, for each combination of smoothing parameters and series specified, EXSMOOTH creates two variables: *FIT#n* to contain the predicted values and *ERR#n* to contain residuals. These variables are automatically labeled and added to the working data file. (For variable naming and labeling conventions, see “New Variables” on p. 3.)
- The output displays the initial values used in the analysis (see Ledolter & Abraham, 1984), the error degrees of freedom (DFE), and an ascending list of the smallest sum of squared errors (SSE) next to the associated set of smoothing parameters, up to a maximum of 10. For seasonal series, initial seasonal factor estimates are also displayed.

Subcommand Order

- Subcommands can be specified in any order.

Syntax Rules

- VARIABLES can be specified only once.
- Other subcommands can be specified more than once, but only the last specification of each one is executed.
- The value list for subcommand SEASFACT and the grid values for the smoothing parameters must be enclosed within parentheses.

Operations

- If a smoothing parameter is specified for an inappropriate model, it is ignored (see “Smoothing Parameter Subcommands” on p. 28).
- EXSMOOTH cannot process series with missing observations. (You can use the RMV command to replace missing values, and USE to ignore missing observations at the beginning or end of a series. See RMV and USE in the *SPSS Base Syntax Reference Guide* for more information.)
- When EXSMOOTH is used with PREDICT, error series are assigned the system-missing value in the entire PREDICT range. The original series is system-missing beyond the last original case if the series is extended. (See the *SPSS Base Syntax Reference Guide* for more information on PREDICT.)

Limitations

- Maximum 1 VARIABLES subcommand. There is no limit on the number of series named on the list.
- Maximum 1 model keyword on the MODEL subcommand.

Example

```
EXSMOOTH VAR2
  /MODEL=LN
  /ALPHA=0.2.
```

- This example specifies a linear trend, nonseasonal model for the series VAR2.
- The ALPHA subcommand specifies a value of 0.2 for the general smoothing parameter.
- The default value of 0.1 is used for gamma.

VARIABLES Subcommand

VARIABLES specifies the series names and is the only required subcommand. The actual keyword VARIABLES can be omitted.

- For seasonal models, the series must contain at least four full seasons of data.

MODEL Subcommand

MODEL specifies the type of model to be used.

- The only specification on MODEL is a model keyword.
- Only one model keyword can be specified. If more than one is specified, only the first is used.

The following models are available. Table 1 summarizes the models by trend and seasonal component.

No trend models:

NN *No trend and no seasonality.* This is the default model. Keyword SINGLE is an alias for NN.

NA *No trend and an additive seasonal component.*

NM *No trend and a multiplicative seasonal component.*

Linear trend models:

LN *Linear trend component and no seasonality.* Keyword HOLT is an alias for LN.

LA *Linear trend component and an additive seasonal component.*

LM *Linear trend component and a multiplicative seasonal component.* Keyword WINTERS is an alias for LM.

Exponential trend models:

EN *Exponential trend component and no seasonality.*

EA *Exponential trend component and an additive seasonal component.*

EM *Exponential trend component and a multiplicative seasonal component.*

Damped trend models:

DN *Damped trend component and no seasonality.*

DA *Damped trend component and an additive seasonal component.*

DM *Damped trend component and a multiplicative seasonal component.*

Table 1 Models for different types of Trends and seasons

		Seasonal component		
		None	Additive	Multiplicative
Trend component	None	NN	NA	NM
	Linear	LN	LA	LM
	Exponential	EN	EA	EM
	Damped	DN	DA	DM

Example

```
EXSMOOTH VAR1 .
```

- This example uses the default model NN for series *VAR1*.

Example

```
EXSMOOTH VAR2
/MODEL=LN .
```

- This example uses model LN (linear trend with no seasonality) for series *VAR2*.

PERIOD Subcommand

PERIOD indicates the periodicity of the seasonal component for seasonal models.

- The specification on PERIOD indicates how many observations are in one period or season and can be any positive integer.
- PERIOD is ignored if it is specified with a nonseasonal model.
- If PERIOD is not specified, the periodicity established on TSET PERIOD is in effect. If TSET PERIOD is not specified, the periodicity established on the DATE command is used. If periodicity was not established anywhere and a seasonal model is specified, EXSMOOTH will terminate.

Example

```
EXSMOOTH VAR1
/MODEL=LA
/PERIOD=12 .
```

- This example specifies a periodicity of 12 for the seasonal *VAR1* series.

SEASFACT Subcommand

SEASFACT specifies initial seasonal factor estimates for seasonal models.

- The specification on SEASFACT is either a value list enclosed in parentheses or a variable name.

- If a value list is specified, the number of values in the list must equal the periodicity. For example, if the periodicity is 12, then 12 initial values must be specified.
- For multiplicative models, the sum of the values in the list should equal the periodicity. For additive models, the sum of the values should equal 0.
- A variable specification on SEASFACT indicates the name of a variable in the working data file containing the seasonal factor estimates (see SEASON).
- If the model is seasonal and SEASFACT is not specified, EXSMOOTH calculates the initial seasonal factors.
- The seasonal factor estimates of a SEASFACT subcommand are not used when the model is respecified using the APPLY subcommand (see the APPLY subcommand on p. 31).

Example

```
EXSMOOTH VAR2
  /MODEL=LA
  /PERIOD=8
  /SEASFACT=(-25.30 -3 -14.70 17 4 3 13 6).
```

- This command uses the list of values specified on the SEASFACT subcommand as the initial seasonal factor estimates.
- Eight values are specified, since the periodicity is 8.
- The eight values sum to 0, since this is an additive seasonal model.

Example

```
EXSMOOTH VAR3
  /MODEL=LA
  /SEASFACT=SAF#1.
```

- This command uses the initial seasonal factors contained in variable *SAF#1*, which was saved in the working data file by a previous SEASON command.

Smoothing Parameter Subcommands

ALPHA, GAMMA, DELTA, and PHI specify the values that are used for the smoothing parameters.

- The specification on each subcommand is either a value within the valid range, or the keyword GRID followed by optional range values.
- If GAMMA, DELTA, or PHI are not specified but are required for the model, the default values are used.
- ALPHA is applied to all models. If it is not specified, the default value is used.

ALPHA *General smoothing parameter.* This parameter is applied to all models. Alpha can be any value between and including 0 and 1. (For EM models, alpha must be greater than 0 and less than or equal to 1.) The default value is 0.1.

GAMMA *Trend smoothing parameter.* Gamma is used only with models that have a trend component, excluding damped seasonal (DA, DM) models. It is ignored if it is

specified with a damped seasonal or no-trend model. Gamma can be any value between and including 0 and 1. The default value is 0.1.

DELTA *Seasonal smoothing parameter.* Delta is used only with models that have a seasonal component. It is ignored if it is specified with any of the nonseasonal models. Delta can be any value between and including 0 and 1. The default value is 0.1.

PHI *Trend modification parameter.* Phi is used only with models that have a damped trend component. It is ignored if it is specified with models that do not have a damped trend. Phi can be any value greater than 0 and less than 1. The default value is 0.1.

Table 2 summarizes the parameters that are used with each EXSMOOTH model. An *X* indicates that the parameter is used for the model.

Table 2 Parameters that can be specified with EXSMOOTH models

		Smoothing parameter			
		ALPHA	DELTA	GAMMA	PHI
Model	NN	x			
	NA	x	x		
	NM	x	x		
	LN	x		x	
	LA	x	x	x	
	LM	x	x	x	
	EN	x		x	
	EA	x	x	x	
	EM	x	x	x	
	DN	x		x	x
	DA	x	x		x
	DM	x	x		x

Keyword GRID

Keyword GRID specifies a range of values to use for the associated smoothing parameter. When GRID is specified, new variables are saved only for the optimal set of parameters on the grid.

- The first value on GRID specifies the start value, the second value is the end value, and the last value is the increment.
- The start, end, and increment values on GRID are separated by commas or spaces and enclosed in parentheses.
- If you specify any grid values, you must specify all three.
- If no values are specified on GRID, the default values are used.
- Grid start and end values for alpha, gamma, and delta can range from 0 to 1. The defaults are 0 for the start value and 1 for the end value.

- Grid start and end values for phi can range from 0 to 1, exclusive. The defaults are 0.1 for the start value and 0.9 for the end value.
- Grid increment values must be within the range specified by start and end values. The default is 0.1 for alpha, and 0.2 for gamma, delta, and phi.

Example

```
EXSMOOTH VAR1
  /MODEL=LA
  /PERIOD=12
  /GAMMA=0.20
  /DELTA=0.20.
```

- This example uses a model with a linear trend and additive seasonality.
- The parameters and values are alpha = 0.10, gamma = 0.20, and delta = 0.20. Alpha is not specified but is always used by default.
- This command generates one *FIT* variable and one *ERR* variable to contain the forecasts and residuals generated by this one set of parameters.

Example

```
EXSMOOTH VAR2
  /MODEL=EA
  /ALPHA=GRID
  /DELTA=GRID(0.2,0.6,0.2).
```

- This example specifies a model with an exponential trend component and an additive seasonal component.
- The default start, end, and increment values (0, 1, and 0.1) are used for the grid search of alpha. Thus, the values used for alpha are 0, 0.1, 0.2, 0.3, . . . , 0.9, and 1.
- The grid specification for delta indicates a start value of 0.2, an end value of 0.6, and an increment of 0.2. Thus, the values used for delta are 0.2, 0.4, and 0.6.
- Since this is an exponential trend model, the parameter gamma will be supplied by EXSMOOTH with the default value of 0.1, even though it is not specified on the command.
- Two variables (*FIT* and *ERR*) will be generated for the parameters resulting in the best-fitting model.

INITIAL Subcommand

INITIAL specifies the initial start and trend values used in the models.

- The specification on INITIAL is the start and trend values enclosed in parentheses. You must specify both values.
- The values specified on INITIAL are saved as part of the model and can be reapplied with the APPLY subcommand (see the APPLY subcommand on p. 31).
- If INITIAL is not specified, the initial start and trend values are calculated by EXSMOOTH. These calculated initial values are *not* saved as part of the model.

- To turn off the values specified on INITIAL when the model is used on an APPLY subcommand, specify INITIAL=CALCULATE. New initial values will then be calculated by EXSMOOTH (see the APPLY subcommand on p. 31).

Example

```
EXSMOOTH VAR2
/MODEL=LA
/PERIOD=4
/SEASFACT=( 23 -14.4 7 -15.6)
/ALPHA=0.20
/GAMMA=0.20
/DELTA=0.30
/INITIAL=(112,17).
```

- In this example, an initial start value of 112 and trend value of 17 is specified for series VAR2.

APPLY Subcommand

APPLY allows you to use a previously defined EXSMOOTH model without having to repeat the specifications. For general rules on APPLY, see the APPLY subcommand on p. 5.

- The only specification on APPLY is the name of a previous model in quotes. If a model name is not specified, the model specified on the previous EXSMOOTH command is used.
- To change one or more model specifications, specify the subcommands of only those portions you want to change after the APPLY subcommand.
- If no series are specified on the command, the series that were originally specified with the model being reapplied are used.
- To change the series used with the model, enter new series names before or after the APPLY subcommand. If a series name is specified before APPLY, the slash before the subcommand is required.
- Initial values from the previous model's INITIAL subcommand are applied unless you specify INITIAL = CALCULATE or a new set of initial values. Initial values from the original model are not applied if they were calculated by EXSMOOTH.
- Seasonal factor estimates from the original model's SEASFACT subcommand are not applied. To use seasonal factor estimates, you must respecify SEASFACT.

Example

```
EXSMOOTH VAR1
/MODEL=NA
/PERIOD=12
/ALPHA=0.2
/DELTA=0.2.
EXSMOOTH APPLY
/DELTA=0.3.
EXSMOOTH VAR2
/APPLY.
```

- The first command uses a model with no trend but additive seasonality for series *VAR1*. The length of the season (PERIOD) is 12. A general smoothing parameter (ALPHA) and a seasonal smoothing parameter (DELTA) are used, both with values set equal to 0.2.
- The second command applies the same model to the same series but changes the delta value to 0.3. Everything else stays the same.
- The last command applies the model and parameter values used in the second EXSMOOTH command to series *VAR2*.

Example

```
EXSMOOTH VAR3
  /MOD=NA
  /ALPHA=0.20
  /DELTA=0.4
  /INITIAL=(114,20).
EXSMOOTH VAR4
  /APPLY
  /INITIAL=CALCULATE.
```

- The first command uses a model with no trend and additive seasonality model with alpha set to 0.2 and delta set to 0.4. Initial start and trend values of 114 and 20 are specified.
- The second command applies the previous model and parameter values to a new variable, *VAR4*, but without the initial starting values. The initial starting values will be calculated by EXSMOOTH.

References

- Abraham, B., and J. Ledolter. 1983. *Statistical methods of forecasting*. New York: John Wiley & Sons.
- Gardner, E. S. 1985. Exponential smoothing: The state of the art. *Journal of Forecasting* 4: 1–28.
- Ledolter, J., and B. Abraham. 1984. Some comments on the initialization of exponential smoothing. *Journal of Forecasting* 3: 79–84.
- Makridakis, S., S. C. Wheelwright, and V. E. McGee. 1983. *Forecasting: Methods and applications*. New York: John Wiley & Sons.

MODEL NAME

```
MODEL NAME [model name] ['model label']
```

Example:

```
MODEL NAME PLOT1 'PLOT OF THE OBSERVED SERIES'.
```

Overview

MODEL NAME specifies a model name and label for the next procedure in the session.

Basic Specification

The specification on MODEL NAME is either a name, a label, or both.

- The default model name is *MOD_n*, where *n* increments by 1 each time an unnamed model is created. This default is in effect if it is not changed on the MODEL NAME command, or if the command is not specified. There is no default label.

Syntax Rules

- If both a name and label are specified, the name must be specified first.
- Only one model name and label can be specified on the command.
- The model name must be unique. It can contain up to 8 characters and must begin with a letter (A–Z).
- The model label can contain up to 60 characters and must be specified in apostrophes.

Operations

- MODEL NAME is executed at the next model-generating procedure.
- If the MODEL NAME command is used more than once before a procedure, the last one is in effect.
- If a duplicate model name is specified, the default *MOD_n* name will be used instead.
- *MOD_n* reinitializes at the start of every session and when the READ MODEL command is specified (see READ MODEL). If any models in the working data file are already named *MOD_n*, those numbers are skipped when new *MOD_n* names are assigned.

Examples

```
MODEL NAME ARIMA1 'First ARIMA model'.
ARIMA VARX
  /MODEL=(0,1,1).
ARIMA VARY
  /MODEL=(1,1,1).
ARIMA VARZ
  /APPLY 'ARIMA1' .
```

- In this example, the model name *ARIMA1* and the label *First ARIMA model* are assigned to the first ARIMA command.
- The second ARIMA command has no MODEL NAME command before it, so it is assigned the name *MOD_1*.
- The third ARIMA command applies the model named *ARIMA1* to the series *VARZ*. This model is named *MOD_2*.

READ MODEL

```
READ MODEL FILE='filename'  
  
[ /KEEP={ALL** } ]  
          {model names}  
          {procedures}  
  
[ /DROP={model names} ]  
         {procedures}  
  
[ /TYPE={MODEL** } ]  
        {COMMAND}  
  
[ /TSET={CURRENT** } ]  
        {RESTORE }
```

**Default if the subcommand is omitted.

Example:

```
READ MODEL FILE='ACFMOD.DAT'  
 /DROP=MOD_1.
```

Overview

READ MODEL reads a model file that has been previously saved on the SAVE MODEL command (see SAVE MODEL). A model file contains the models generated by Trends procedures for use with the APPLY subcommand.

Options

You can restore a subset of models from the model file using the DROP and KEEP subcommands. You can control whether models are specified by model name or by the name of the procedure that generated them using the TYPE subcommand. With the TSET subcommand you can restore the TSET settings that were in effect when the model file was created.

Basic Specification

The basic specification is the FILE subcommand specifying the name of a previously saved model file.

- By default, all models contained in the specified file are restored, replacing all models that are currently active. The restored models have their original *MOD_n* default names or names assigned by the MODEL NAME command.

Subcommand Order

- Subcommands can be specified in any order.

Syntax Rules

- If a subcommand is specified more than once, only the last one is executed.

Operations

- READ MODEL is executed immediately.
- Models that are currently active are erased when READ MODEL is executed. To save these models for later use, specify the SAVE MODEL command before READ MODEL.
- Model files are designed to be read by Trends only and should not be edited.
- DATE specifications are not saved in model files. Therefore, the DATE specifications from the current session are applied to the restored models.
- The following procedures can generate models: AREG, ARIMA, EXSMOOTH, SEASON, SPECTRA, and X11ARIMA in SPSS Trends; ACF, CASEPLOT, CCF, CURVEFIT, NPLOT, PACF, and TSPLOT in the SPSS Base system; and WLS and 2SLS in SPSS Professional Statistics.

Limitations

- Maximum 1 filename can be specified.

Example

```
READ MODEL FILE='ACFMODE.DAT'  
/DROP=MOD_1.
```

- In this example, all models except *MOD_1* in the model file *ACFMODE.DAT* are restored.

FILE Subcommand

FILE names the model file to be read and is the only required subcommand.

- The only specification on FILE is the name of the model file.
- The filename must be enclosed in apostrophes.
- Only one filename can be specified.
- Only files saved with the SAVE MODEL command can be read.
- You can specify files residing in other directories by supplying a fully qualified filename.

KEEP and DROP Subcommands

DROP and KEEP allow you to restore a subset of models. By default, all models in the model file are restored.

- KEEP specifies the models to be restored.
- DROP specifies the models to be excluded.
- Models can be specified using either individual model names or the names of the procedures that created them. To use procedure names, you must specify COMMAND on the TYPE subcommand.
- Model names are either the default *MOD_n* names or the names assigned with MODEL NAME.
- If a procedure name is specified on KEEP, all models created by that procedure are restored; on DROP, all models created by the procedure are dropped.
- Model names and procedure names cannot be mixed on a single READ MODEL command.
- If more than one KEEP or DROP subcommand is specified, only the last one is executed.
- You can specify keyword ALL on KEEP to restore all models in the model file. This is the default.
- The stored model file is not affected by the KEEP or DROP specification on READ MODEL.

Example

```
READ MODEL FILE='ACFCCF.DAT'
  /KEEP=ACF1 ACF2.
```

- In this example, only models *ACF1* and *ACF2* are restored from model file *ACFCCF.DAT*.

TYPE Subcommand

TYPE indicates whether models are specified by model name or procedure name on DROP and KEEP.

- One keyword, MODEL or COMMAND, can be specified after TYPE.
- MODEL is the default and indicates that models are specified as model names.
- COMMAND indicates that models are specified by procedure name.
- TYPE has no effect if KEEP or DROP is not specified.
- The TYPE specification applies only to the current READ MODEL command.

Example

```
READ MODEL FILE='ARIMA1.DAT'
  /KEEP=ARIMA
  /TYPE=COMMAND.
```

- In this example, all models created by ARIMA are restored from model file *ARIMA1.DAT*.

TSET Subcommand

TSET allows you to restore the TSET settings that were in effect when the model was created.

- The specification on TSET is either CURRENT or RESTORE.
- CURRENT (the default) indicates you want to continue to use the current TSET settings.
- RESTORE indicates you want to restore the TSET settings that were in effect when the model file was saved. The current TSET settings are replaced with the model file settings when the file is restored.

SAVE MODEL

```
SAVE MODEL OUTFILE='filename'
```

```
[ /KEEP={ALL** } ]  
         {model names }  
         {procedures }
```

```
[ /DROP={model names } ]  
         {procedures }
```

```
[ /TYPE={MODEL** } ]  
         {COMMAND }
```

**Default if the subcommand is omitted.

Example:

```
SAVE MODEL OUTFILE='ACFMODE.DAT'  
 /DROP=MOD_1.
```

Overview

SAVE MODEL saves the models created by Trends procedures into a model file. The saved model file can be read later on in the session or in another session with the READ MODEL command.

Options

You can save a subset of models into the file using the DROP and KEEP subcommands. You can control whether models are specified by model name or by the name of the procedure that generated them using the TYPE subcommand.

Basic Specification

The basic specification is the OUTFILE subcommand followed by a filename.

- By default, SAVE MODEL saves all currently active models in the specified file. Each model saved in the file includes information such as the procedure that created it, the model name, the variable names specified, subcommands and specifications used, and parameter estimates. The names of the models are either the default *MOD_n* names or the names assigned on the MODEL NAME command. In addition to the model specifications, the TSET settings currently in effect are saved.

Subcommand Order

- Subcommands can be specified in any order.

Syntax Rules

- If a subcommand is specified more than once, only the last one is executed.

Operations

- SAVE MODEL is executed immediately.
- Model files are designed to be read and written by Trends only and should not be edited.
- The active models are not affected by the SAVE MODEL command.
- DATE specifications are not saved in the model file.
- Models are not saved in SPSS data files.
- The following procedures can generate models: AREG, ARIMA, EXSMOOTH, SEASON, SPECTRA, and X11ARIMA in SPSS Trends; ACF, CASEPLOT, CCF, CURVEFIT, NPLOT, PACF, and TSPLIT in the SPSS Base system; and WLS and 2SLS in SPSS Professional Statistics.

Limitations

- Maximum 1 filename can be specified.

Example

```
SAVE MODEL OUTFILE='ACFMOD.DAT'  
/DROP=MOD_1.
```

- In this example, all models except *MOD_1* that are currently active are saved in the file *ACFMOD.DAT*.

OUTFILE Subcommand

OUTFILE names the file where models will be stored and is the only required subcommand.

- The only specification on OUTFILE is the name of the model file.
- The filename must be enclosed in apostrophes.
- Only one filename can be specified.
- You can store models in other directories by specifying a fully qualified filename.

KEEP and DROP Subcommands

DROP and KEEP allow you to save a subset of models. By default, all currently active models are saved.

- KEEP specifies models to be saved in the model file.
- DROP specifies models that are not saved in the model file.

- Models can be specified using either individual model names or the names of the procedures that created them. To use procedure names, you must specify `COMMAND` on the `TYPE` subcommand.
- Model names are either the default `MOD_n` names or the names assigned with `MODEL NAME`.
- If you specify a procedure name on `KEEP`, all models created by that procedure are saved; on `DROP`, any models created by that procedure are not included in the model file.
- Model names and procedure names cannot be mixed on a single `SAVE MODEL` command.
- If more than one `KEEP` or `DROP` subcommand is specified, only the last one is executed.
- You can specify keyword `ALL` on `KEEP` to save all models that are currently active. This is the default.

Example

```
SAVE MODEL OUTFILE='ACFCCF.DAT'
/KEEP=ACF1 ACF2
```

- In this example, only models `ACF1` and `ACF2` are saved in model file `ACFCCF.DAT`.

TYPE Subcommand

`TYPE` indicates whether models are specified by model name or procedure name on `DROP` and `KEEP`.

- One keyword, `MODEL` or `COMMAND`, can be specified after `TYPE`.
- `MODEL` is the default and indicates that models are specified as model names.
- `COMMAND` indicates that the models are specified by procedure name.
- `TYPE` has no effect if `KEEP` or `DROP` is not specified.
- The `TYPE` specification applies only to the current `SAVE MODEL` command.

Example

```
SAVE MODEL OUTFILE='ARIMA1.DAT'
/KEEP=ARIMA
/TYPE=COMMAND.
```

- This command saves all models that were created by the `ARIMA` procedure into the model file `ARIMA1.DAT`.

SEASON

```
SEASON [VARIABLES=] series names  
  
[ /MODEL={MULTIPLICATIVE**}  
          {ADDITIVE} ]  
  
[ /MA={EQUAL }  
       {CENTERED} ]  
  
[ /PERIOD=n ]  
  
[ /APPLY [= 'model name' ] ]
```

**Default if the subcommand is omitted.

Example:

```
SEASON VARX  
  /MODEL=ADDITIVE  
  /MA=EQUAL.
```

Overview

SEASON estimates multiplicative or additive seasonal factors for time series using any specified periodicity. SEASON is an implementation of the Census Method I, otherwise known as the ratio-to-moving-average method (see Makridakis et al., 1983, and McLaughlin, 1984).

Options

Model Specification. You can specify either a multiplicative or additive model on the MODEL subcommand. You can specify the periodicity of the series on the PERIOD subcommand.

Computation Method. Two methods of computing moving averages are available on the MA subcommand for handling series with even periodicities.

Statistical Output. Specify TSET PRINT=BRIEF to display only the initial seasonal factor estimates. TSET PRINT=DETAILED produces the same output as the default.

New Variables. To evaluate the displayed averages, ratios, factors, adjusted series, trend-cycle, and error components without creating new variables, specify TSET NEWVAR=NONE prior to SEASON. This can result in faster processing time. To add new variables without erasing the values of previous Trends-generated variables, specify TSET NEWVAR=ALL. This saves all new variables generated during the current session in the working data file and may require extra processing time.

Basic Specification

The basic specification is one or more series names.

- By default, SEASON uses a multiplicative model to compute and display moving averages, ratios, seasonal factors, the seasonally adjusted series, the smoothed trend-cycle components, and the irregular (error) component for each series (variable) specified. The default periodicity is the periodicity established on TSET or DATE.
- Unless the default on TSET NEWVAR is changed prior to the procedure, SEASON creates four new variables for each series specified: *SAF#n* to contain the seasonal adjustment factors, *SAS#n* to contain the seasonally adjusted series, *STC#n* to contain the smoothed trend-cycle components, and *ERR#n* to contain the irregular (error) component. These variables are automatically named, labeled, and added to the working data file. (For variable naming and labeling conventions, see “New Variables” on p. 3.)

Subcommand Order

- Subcommands can be specified in any order.

Syntax Rules

- VARIABLES can be specified only once.
- Other subcommands can be specified more than once, but only the last specification of each one is executed.

Operations

- The endpoints of the moving averages and ratios are displayed as system-missing in the output.
- Missing values are not allowed anywhere in the series. (You can use the RMV command to replace missing values, and USE to ignore missing observations at the beginning or end of a series. See RMV and USE in the *SPSS Base Syntax Reference Guide* for more information.)

Limitations

- Maximum 1 VARIABLES subcommand. There is no limit on the number of series named on the list.

Example

```
SEASON VARX
  /MODEL=ADDITIVE
  /MA=EQUAL.
```

- In this example, an additive model is specified for the decomposition of *VARX*.
- The moving average will be computed using the EQUAL method.

VARIABLES Subcommand

VARIABLES specifies the series names and is the only required subcommand. The actual keyword VARIABLES can be omitted.

- Each series specified must contain at least four full seasons of data.

MODEL Subcommand

MODEL specifies whether the seasonal decomposition model is multiplicative or additive.

- The specification on MODEL is keyword MULTIPLICATIVE or ADDITIVE.
- If more than one keyword is specified, only the first is used.
- MULTIPLICATIVE is the default if the MODEL subcommand is not specified or if MODEL is specified without any keywords.

Example

```
SEASON VARX
  /MODEL=ADDITIVE .
```

- This example uses an additive model for the seasonal decomposition of *VARX*.

MA Subcommand

MA specifies how to treat an even-periodicity series when computing moving averages.

- MA should be specified only when the periodicity is even. When periodicity is odd, the EQUAL method is always used.
- For even-periodicity series, keyword EQUAL or CENTERED can be specified. CENTERED is the default.
- EQUAL calculates moving averages with a span (number of terms) equal to the periodicity and all points weighted equally.
- CENTERED calculates moving averages with a span (number of terms) equal to the periodicity plus 1 and endpoints weighted by 0.5.
- The periodicity is specified on the PERIOD subcommand (see the PERIOD subcommand on p. 45).

Example

```
SEASON VARY
  /MA=CENTERED
  /PERIOD=12 .
```

- In this example, moving averages are computed with spans of 13 terms and endpoints weighted by 0.5.

PERIOD Subcommand

PERIOD indicates the size of the period.

- The specification on PERIOD indicates how many observations are in one period or season and can be any positive integer.
- If PERIOD is not specified, the periodicity established on TSET PERIOD is in effect. If TSET PERIOD is not specified, the periodicity established on the DATE command is used. If periodicity was not established anywhere, the SEASON command will not be executed.

Example

```
SEASON SALES
  /PERIOD=12.
```

- In this example, a periodicity of 12 is specified for *SALES*.

APPLY Subcommand

APPLY allows you to use a previously defined SEASON model without having to repeat the specifications. For general rules on APPLY, see the APPLY subcommand on p. 5.

- The only specification on APPLY is the name of a previous model in quotes. If a model name is not specified, the model specified on the previous SEASON command is used.
- To change one or more model specifications, specify the subcommands of only those portions you want to change after the APPLY subcommand.
- If no series are specified on the command, the series that were originally specified with the model being reapplied are used.
- To change the series used with the model, enter new series names before or after the APPLY subcommand. If a series name is specified before APPLY, the slash before the subcommand is required.

Example

```
SEASON X1
  /MODEL=ADDITIVE.
SEASON Z1
  /APPLY.
```

- The first command specifies an additive model for the seasonal decomposition of *X1*.
- The second command applies the same type of model to series *Z1*.

Example

```
SEASON X1 Y1 Z1
  /MODEL=MULTIPLICATIVE.
SEASON APPLY
  /MODEL=ADDITIVE.
```

- The first command specifies a multiplicative model for the seasonal decomposition of *X1*, *Y1*, and *Z1*.
- The second command applies an additive model to the same three variables.

References

- Makridakis, S., S. C. Wheelwright, and V. E. McGee. 1983. *Forecasting: Methods and applications*. New York: John Wiley & Sons.
- McLaughlin, R. L. 1984. *Forecasting techniques for decision making*. Rockville, Md.: Control Data Management Institute.

SPECTRA

```
SPECTRA [VARIABLES=] series names

[/{CENTER NO**}]
{CENTER}

[/{CROSS NO**}]
{CROSS}

[/WINDOW={HAMMING** [( {5 } )]}]
{span}
{BARTLETT [(span)]}
{PARZEN [(span)]}
{TUKEY [(span)]}
{UNIT or DANIELL [(span)]}
{NONE}
{wp, ..., w0, ..., wp}

[/PLOT= [P] [S] [CS] [QS] [PH] [A]
[G] [K] [ALL] [NONE]
[BY {FREQ }]]
{PERIOD}]

[/SAVE = [FREQ (name)] [PER (name)] [SIN (name)]
[COS (name)] [P (name)] [S (name)]
[RC (name)] [IC (name)] [CS (name)]
[QS (name)] [PH (name)] [A (name)]
[G (name)] [K (name)]]

[/APPLY [= 'model name']]
```

**Default if the subcommand is omitted.

Example:

```
SPECTRA HSTARTS
/CENTER
/PLOT P S BY FREQ.
```

Overview

SPECTRA plots the periodogram and spectral density function estimates for one or more series. You can also request bivariate spectral analysis. Moving averages, termed *windows*, can be used for smoothing the periodogram values to produce spectral densities.

Options

Output. In addition to the periodogram, you can produce a plot of the estimated spectral density with the PLOT subcommand. You can suppress the display of the plot by frequency or the plot by period using keyword BY on PLOT. To display intermediate values and the plot legend, specify TSET PRINT=DETAILED before SPECTRA. To reduce the range of values displayed in the plots, you can center the data using the CENTER subcommand.

Cross-Spectral Analysis. You can specify cross-spectral (bivariate) analysis with the CROSS subcommand and select which bivariate plots are produced using PLOT.

New Variables. Variables computed by SPECTRA can be saved in the working data file for use in subsequent analyses with the SAVE subcommand.

Spectral Windows. You can specify a spectral window and its span for calculation of the spectral density estimates.

Basic Specification

The basic specification is one or more series names.

- By default, SPECTRA plots the periodogram for each series specified. The periodogram is shown first by frequency and then by period. No new variables are saved by default.

Figure 1 and Figure 2 show the default plots produced by the basic specification.

Figure 1 SPECTRA=PRICE (by frequency)

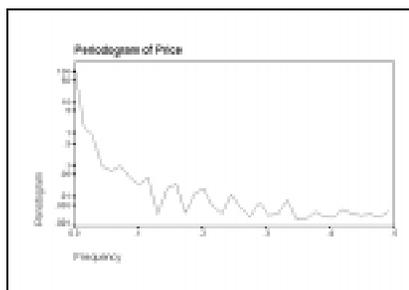
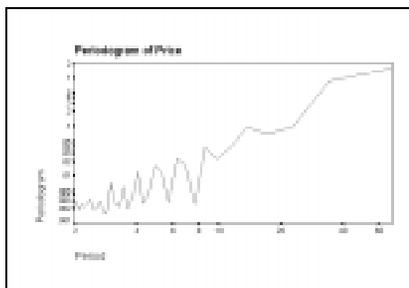


Figure 2 SPECTRA=PRICE (by period)



Subcommand Order

- Subcommands can be specified in any order.

Syntax Rules

- VARIABLES can be specified only once.
- Other subcommands can be specified more than once, but only the last specification of each one is executed.

Operations

- SPECTRA cannot process series with missing observations. (You can use the RMV command to replace missing values, and USE to ignore missing observations at the beginning or end of a series. See RMV and USE in the *SPSS Base Syntax Reference Guide* for more information.)
- If the number of observations in the series is odd, the first case is ignored.
- If the SAVE subcommand is specified, new variables are created for each series specified. For bivariate analyses, new variables are created for each series pair.
- SPECTRA requires memory both to compute variables and to build plots. Requesting fewer plots may enable you to analyze larger series.

Limitations

- Maximum 1 VARIABLES subcommand. There is no limit on the number of series named on the list.

Example

```
SPECTRA HSTARTS
  /CENTER
  /PLOT P S BY FREQ.
```

- This example produces a plot of the periodogram and spectral density estimate for series *HSTARTS*.
- CENTER adjusts the series to have a mean of 0.
- PLOT specifies that the periodogram (P) and the spectral density estimate (S) should be plotted against frequency (BY FREQ).

VARIABLES Subcommand

VARIABLES specifies the series names and is the only required subcommand. The actual keyword VARIABLES can be omitted.

- VARIABLES must be specified before the other subcommands.
- Each series specified is analyzed separately unless the CROSS subcommand is specified.
- The series must contain at least six cases.

Example

SPECTRA VARX VARY .

- This command produces the default display for two series, VARX and VARY.

CENTER Subcommand

CENTER adjusts the series to have a mean of 0. This reduces the range of values displayed in the plots.

- If CENTER is not specified, the ordinate of the first periodogram value is $2n$ times the square of the mean of the series, where n is the number of cases.
- You can specify CENTER NO to suppress centering when applying a previous model with APPLY.

Example

SPECTRA VARX VARY
/CENTER.

- This example produces the default display for VARX and VARY. The plots are based on the series after their means have been adjusted to 0.

WINDOW Subcommand

WINDOW specifies a spectral window to use when the periodogram is smoothed to obtain the spectral density estimate. If WINDOW is not specified, the Tukey-Hamming window with a span of 5 is used.

- The specification on WINDOW is a window name and a span in parentheses, or a sequence of user-specified weights.
- The window name can be any one of the keywords listed below.
- Only one window keyword is accepted. If more than one is specified, the first is used.
- The span is the number of periodogram values in the moving average and can be any integer. If an even number is specified, it is decreased by 1.
- Smoothing near the end of series is accomplished via reflection. For example, if the span is 5, the second periodogram value is smoothed by averaging the first, third, and fourth values and twice the second value.

The following data windows can be specified. Each formula defines the upper half of the window. The lower half is symmetric with the upper half. In all formulas, p is the integer part of the number of spans divided by 2, D_p is the Dirichlet kernel of order p , and F_p is the Fejer kernel of order p (Priestley, 1981).

HAMMING *Tukey-Hamming window.* The weights are

$$W_k = 0.54D_p(2\pi f_k) + 0.23D_p\left(2\pi f_k + \frac{\pi}{p}\right) + 0.23D_p\left(2\pi f_k + \frac{\pi}{p}\right)$$

where $k=0, \dots, p$. This is the default.

TUKEY	<i>Tukey-Hanning window.</i> The weights are $W_k = 0.5D_p(2\pi f_k) + 0.25D_p\left(2\pi f_k + \frac{\pi}{p}\right) + 0.25D_p\left(2\pi f_k - \frac{\pi}{p}\right)$ where $k=0, \dots, p$.
PARZEN	<i>Parzen window.</i> The weights are $W_k = \frac{1}{p}(2 + \cos(2\pi f_k))(F_{p/2}(2\pi f_k))^2$ where $k=0, \dots, p$.
BARTLETT	<i>Bartlett window.</i> The weights are $W_k = F_p(2\pi f_k)$ where $k=0, \dots, p$.
UNIT	<i>Equal-weight window.</i> The weights are $w_k = 1$ where $k=0, \dots, p$. DANIELL is an alias for UNIT.
NONE	<i>No smoothing.</i> If NONE is specified, the spectral density estimate is the same as the periodogram.
$w_p, \dots, w_0, \dots, w_p$	<i>User-specified weights.</i> W_0 is applied to the periodogram value being smoothed, and the weights on either side are applied to preceding and following values. If the number of weights is even, it is assumed that w_p is not supplied. The weight after the middle one is applied to the periodogram value being smoothed. W_0 must be positive.

Example

```
SPECTRA VAR01
  /WINDOW=TUKEY(3)
  /PLOT=P S.
```

- In this example, the Tukey window weights with a span of three are used.
- The PLOT subcommand plots both the periodogram and the spectral density estimate, both by frequency and period.

PLOT Subcommand

PLOT specifies which plots are displayed.

- If PLOT is not specified, only the periodogram is plotted for each series specified. Each periodogram is shown both by frequency and by period.
- You can specify more than one plot keyword.
- Keywords can be specified in any order.
- Plot keywords K, CS, QS, PH, A, and G apply only to bivariate analyses. If subcommand CROSS is not specified, these keywords are ignored.
- The period (horizontal) axis on a plot BY PERIOD is scaled in natural logarithms from 0.69 to $\ln(n)$, where n is the number of cases.
- The frequency (horizontal) axis on a plot BY FREQ is scaled from 0 to 0.5, expressing the frequency as a fraction of the length of the series.

- The periodogram and estimated spectrum (vertical axis) are scaled in natural logs.

The following plot keywords are available:

- P** *Periodogram*. This is the default.
- S** *Spectral density estimate*.
- K** *Squared coherency*. Applies only to bivariate analyses.
- CS** *Cospectral density estimate*. Applies only to bivariate analyses.
- QS** *Quadrature spectrum estimate*. Applies only to bivariate analyses.
- PH** *Phase spectrum*. Applies only to bivariate analyses.
- A** *Cross amplitude*. Applies only to bivariate analyses.
- G** *Gain*. Applies only to bivariate analyses.
- ALL** *All plots*. For bivariate analyses, this includes all plots listed above. For univariate analyses, this includes the periodogram and the spectral density estimate.

BY Keyword

By default, SPECTRA displays both frequency and period plots. You can use BY to produce only frequency plots or only period plots.

- BY FREQ indicates that all plots are plotted by frequency only. Plots by period are not produced.
- BY PERIOD indicates that all plots are plotted by period only. Plots by frequency are not produced.

Example

```
SPECTRA SER01
/PLOT=P S BY FREQ.
```

- This command plots both the periodogram and the spectral density estimate for *SER01*. The plots are shown by frequency only.

CROSS Subcommand

CROSS is used to specify bivariate spectral analysis.

- When CROSS is specified, the first series named on the VARIABLES subcommand is the independent variable. All remaining variables are dependent.
- Each series after the first is analyzed with the first series independently of other series named.
- Univariate analysis of each series specified is still performed.
- You can specify CROSS NO to turn off bivariate analysis when applying a previous model with APPLY.

Example

```
SPECTRA VARX VARY VARZ
/CROSS.
```

- In this example, bivariate spectral analyses of series *VARX* with *VARY* and *VARX* with *VARZ* are requested in addition to the usual univariate analyses of *VARX*, *VARY*, and *VARZ*.

SAVE Subcommand

SAVE saves computed SPECTRA variables in the working data file for later use. SPECTRA displays a list of the new variables and their labels, showing the type and source of those variables.

- You can specify any or all of the output keywords listed below.
- A name to be used for generating variable names must follow each output keyword. The name must be enclosed in parentheses.
- For each output keyword, one variable is created for each series named on SPECTRA and for each bivariate pair.
- Keywords RC, IC, CS, QS, PH, A, G, and K apply only to bivariate analyses. If CROSS is not specified, these keywords are ignored.
- SAVE specifications are not used when models are reapplied using APPLY. They must be specified each time variables are to be saved.
- The output variables correspond to the Fourier frequencies. They do not correspond to the original series.
- Since each output variable has only $(n/2 + 1)$ cases (where n is the number of cases), the values for the second half of the series are set to system-missing.
- Variable names are generated by adding $_n$ to the specified name, where n ranges from 1 to the number of series specified.
- For bivariate variables, the suffix is $_n_n$, where the n 's indicate the two variables used in the analysis.
- The frequency (FREQ) and period (PER) variable names are constant across all series and do not have a numeric suffix.
- If the generated variable name is longer than eight characters, or if the specified name already exists, the variable is not saved.

The following output keywords are available:

```
FREQ  Fourier frequencies.
PER   Fourier periods.
SIN   Value of a sine function at the Fourier frequencies.
COS   Value of a cosine function at the Fourier frequencies.
P     Periodogram values.
S     Spectral density estimate values.
```

- RC *Real part values of the cross-periodogram.* Applies only to bivariate analyses.
- IC *Imaginary part values of the cross-periodogram.* Applies only to bivariate analyses.
- CS *Cospectral density estimate values.* Applies only to bivariate analyses.
- QS *Quadrature spectrum estimate values.* Applies only to bivariate analyses.
- PH *Phase spectrum estimate values.* Applies only to bivariate analyses.
- A *Cross-amplitude values.* Applies only to bivariate analyses.
- G *Gain values.* Applies only to bivariate analyses.
- K *Squared coherency values.* Applies only to bivariate analyses.

Example

```
SPECTRA VARIABLES=STRIKES RUNS
  /SAVE= FREQ (FREQ) P (PGRAM) S (SPEC).
```

- This example creates five variables: *FREQ*, *PGRAM_1*, *PGRAM_2*, *SPEC_1*, and *SPEC_2*.

APPLY Subcommand

APPLY allows you to use a previously defined SPECTRA model without having to repeat the specifications. For general rules on APPLY, see the APPLY subcommand on p. 5.

- The only specification on APPLY is the name of a previous model in quotes. If a model name is not specified, the model specified on the previous SPECTRA command is used.
- To change one or more model specifications, specify the subcommands of only those portions you want to change after the APPLY subcommand.
- If no series are specified on the command, the series that were originally specified with the model being reapplied are used.
- To change the series used with the model, enter new series names before or after the APPLY subcommand. If a variable name is specified before APPLY, the slash before the subcommand is required.
- The SAVE specifications from the previous model are *not* reused by APPLY. They must be specified each time variables are to be saved.

Examples

```
SPECTRA VAR01
  /WINDOW=DANIELL (3)
  /CENTER
  /PLOT P S BY FREQ.
SPECTRA APPLY
  /PLOT P S.
```

- The first command plots both the periodogram and the spectral density estimate for *VAR01*. The plots are shown by frequency only.
- Since the PLOT subcommand is respecified, the second command produces plots by both frequency and period. All other specifications remain the same as in the first command.

References

- Bloomfield, P. 1976. *Fourier analysis of time series*. New York: John Wiley & Sons.
- Fuller, W. A. 1976. *Introduction to statistical time series*. New York: John Wiley & Sons.
- Gottman, J. M. 1981. *Time-series analysis: A comprehensive introduction for social scientists*. Cambridge: Cambridge University Press.
- Priestley, M. B. 1981. *Spectral Analysis and Time Series*. Volumes 1 & 2. London: Academic Press.

TDISPLAY

```
TDISPLAY [ { ALL           } ]  
          { model names   }  
          { command names }  
  
[ /TYPE={ MODEL** } ]  
         { COMMAND }
```

**Default if the subcommand is omitted.

Example:

```
TDISPLAY MOD_2 MOD_3  
/TYPE=MODEL.
```

Overview

TDISPLAY displays information about currently active Trends models. These models are automatically generated by many Trends procedures for use with the APPLY subcommand (see the APPLY subcommand on p. 5).

Options

If models are specified on TDISPLAY, information about just those models is displayed. You can control whether models are specified by model name or by the name of the procedure that generated them using the TYPE subcommand.

Basic Specification

The basic specification is simply the command keyword TDISPLAY.

- By default, TDISPLAY produces a list of all currently active models. The list includes the model names, the commands that created each model, model labels if specified, and creation dates and times.

Syntax Rules

- To display information on a subset of active models, specify those models after TDISPLAY.
- Models can be specified using either individual model names or the names of the procedures that created them. To use procedure names, you must specify the TYPE subcommand with keyword COMMAND.
- Model names are either the default *MOD_n* names or the names assigned with MODEL NAME.
- If procedure names are specified, all models created by those procedures are displayed.

- Model names and procedure names cannot be mixed on the same TDISPLAY command.
- You can specify keyword ALL after TDISPLAY to display all models that are currently active. This is the default.

Operations

- Only models currently active are displayed.
- The following procedures can generate models: AREG, ARIMA, EXSMOOTH, SEASON, SPECTRA, and X11ARIMA in SPSS Trends; ACF, CASEPLOT, CCF, CURVEFIT, NPLOT, PACF, and TSPLIT in the SPSS Base system; and WLS and 2SLS in SPSS Professional Statistics.

Example

```
TDISPLAY.
```

- The command keyword by itself displays information about all currently active models.

TYPE Subcommand

TYPE indicates whether models are specified by model name or procedure name.

- One keyword, MODEL or COMMAND, can be specified after TYPE.
- MODEL is the default and indicates that models are specified as model names.
- COMMAND specifies that models are specified by procedure name.
- TYPE has no effect if model names or command names are not listed after TDISPLAY.
- If more than one TYPE subcommand is specified, only the last one is used.
- The TYPE specification applies only to the current TDISPLAY command.

Example

```
TDISPLAY ACF ARIMA
 /TYPE=COMMAND.
```

- This command displays all currently active models that were created by procedures ACF and ARIMA.

X11ARIMA

```

X11ARIMA [VARIABLES=] series names [/APPLY [= 'model name']]

[/TITLE={ 'title' } ] [/MODEL={MULTIPLICATIVE**}]
      {ADDITIVE}
      {LOGARITHMIC}

[/PERIOD={MONTHLY or 12 } ] [/{NO SUMMARY
      {QUARTERLY or 4 } ] {SUMMARY [=varlist]}]

[/{NOARIMA
  {ARIMA=[EXTREMES ( {ACCEPT**} )] [ {BACKCAST } ] ]
    {REPLACE } {NOBACKCAST}}]

[/{NOUSERMODEL
  {USERMODEL=(p,d,q) [(sp,sd,sq)] [MXITER ( {30 } )] ] }]

  [ {NOINITIAL } ] [ {NOCONSTANT } ]
    {INITIAL (values)} {MACONSTANT}
    {ARCONSTANT}

  [ {NOTRANSFORM } ]
    {LN [ ( {0 } ) ] }
    {value }
    {POWER (value [, {0 } ] ) }
    {value }

  [ {NOORDERS
    { [ARORDER (values)] [MAORDER (values)] [SARORDER (values)] [SMAORDER (values)] } ] ]

[/FORMAT=[TABLES ( {0** } )] [D10 ( {2** } )] ]
      {value } {value }

[/PRINT=[ {STANDARD**} ] [ {NOEXTRA**} ] ]
      {BRIEF } {EXTRA }
      {ANALYSIS }
      {SHORT }
      {LONG }
      {FULL }

[/PLOTS={STANDARD**} ] [/{NOYEARTOTAL**} ] [/{EXTREMETC**} ] ]
      {NONE } {YEARTOTAL } {NOEXTREMETC}
      {ALL }

[/LOWSIGMA={1.5**} ] [/{HISIGMA={2.5**} } ]
      {value } {value }

[/MONTHLEN={SEASONAL**} ] [/{NOPRVARS** } ]
      {TRADEDAY } {PRVARS=varlist}

[/{NODAYWGTS**
  {DAYWGTS=[MON (value) . . . SUN (value)] } ] ]

[/{NOTRADAYREG**
  {TRADAYREG=[ {NOADJUST } ] [TDSIGMA ( {2.5 } )] } ]
    {ADJUST } {value }
    {SIGNIF } ]

  [ {NO COMPUTE } ] [ {NO BEGIN } ]
    {COMPUTE (year)} {BEGIN (year)}

```

```

[/MACURVES= [SEASFACT ( {HYBRID**} )] [TR20DCYC ( {4††} )]]
                {3X3}
                {3X5}
                {3X9}
                {STABLE}
                {SELECT}

[HENDERSON ( {SELECT**} )]
                {9}
                {13}
                {23}
                {5}
                {7}

[ {NOPERMONTH**}
  {PREMONTH [ (JAN {3X3} ) ... (DEC {3X3} ) ] }
                {3X5}
                {3X9}
                {STABLE}
                {3X5}
                {3X9}
                {STABLE}
]

[ {NOPERQUARTER**}
  {PERQUARTER} [ (FIRST {3X3} ) ... (FOURTH {3X3} ) ] ]
                {3X5}
                {3X9}
                {STABLE}
                {3X5}
                {3X9}
                {STABLE}

[DEFAULTS]]

```

**Default if the subcommand or keyword is not specified.

†† Default is 12 for monthly data and 4 for quarterly data.

Example:

```

X11ARIMA PRICES
  /PERIOD=4
  /ARIMA
  /USERMODEL=(0,1,1)(0,1,1).

```

Overview

X11ARIMA estimates multiplicative or additive seasonal factors for monthly or quarterly series. ARIMA forecasts and backcasts can be added to the series before seasonal decomposition. The procedure is based on the Statistics Canada version of the U.S. Bureau of Labor Statistics Census-II X-11 program.

Options

Seasonal Adjustment. You can select one of three seasonal adjustment models (multiplicative, additive, or log additive) on the MODEL subcommand. You can use the SUMMARY subcommand to specify that you want summary statistics on already adjusted series and that no seasonal adjustment is to be done. On the PERIOD subcommand you can specify the periodicity of the series.

ARIMA Adjustment. You can add ARIMA forecasts and, optionally, backcasts, to the series before seasonal adjustment using the ARIMA subcommand. You can specify the ARIMA model on the USERMODEL subcommand or let the program select the best one from three default models.

Other Adjustments. A wide variety of other optional adjustments can be made, such as a yearly total adjustment (YEARTOTAL), replacement of extreme values (NOEXREMETC), length of month allowances (MONTHLEN), prior adjustment based on specified variables (PRVARS), prior daily weights adjustment (DAYWGTS), trading-day regression (TRADAYREG), and application of many different types of moving averages (MACURVES). You can specify the upper and lower sigma limits for generating extreme values using HISIGMA and LOWSIGMA.

Output. Depending on the subcommands and specifications you use, you can display from 3 to 76 tables. The PRINT subcommand provides control over the general number and type of tables. You can specify the number of decimal places displayed using FORMAT. In addition to the standard plots, you can request the irregular (error) series chart, seasonal factors plot, and the Kolmogorov-Smirnov cumulative periodogram using the PLOTS subcommand. You can also suppress all plots. You can specify a title for the X11ARIMA output using the TITLE subcommand.

Basic Specification

The basic specification is one or more series names.

- By default, X11ARIMA estimates a multiplicative seasonal model without doing any prior ARIMA adjustment. The default periodicity is the periodicity established on the DATE command (the DATE command must be specified before X11ARIMA; see “Operations” on p. 61). Extreme values are included in estimating the trend-cycle curve. The trend-cycle moving average is based on 12 if the series are monthly and 4 if the series are quarterly. A Henderson moving average appropriate for the series is selected by the program. In estimating the seasonal factors, the length-of-month allowance is included. A 3×3 moving average is used for the first estimate and a 3×5 moving average is used for the final estimate.
- Default output consists of 19 to 40 tables, depending on the subcommands and specifications chosen. Values are displayed as integers in most tables except D10 (final seasonal factors), where values are displayed with two decimal places by default. Original series, seasonal, and trend-cycle plots are produced.
- For each series specified, four new variables are automatically created, labeled, and added to the working data file: the seasonal adjustment factors, the seasonally adjusted series, the smoothed trend-cycle components, and the irregular (error) component. (For variable naming and labeling conventions, see “New Variables” on p. 3.)

Subcommand Order

- If the SUMMARY subcommand is used, the VARIABLES subcommand must be specified before it. Otherwise, subcommands can be specified in any order.

Syntax Rules

- VARIABLES can be specified only once.
- Other subcommands can be specified more than once, but only the last specification of each one is executed.

Operations

- The starting year and month (or quarter) must be specified on the DATE command before the X11ARIMA procedure is used. The year specification must be in the range 1900 to 1999 and *cannot* be abbreviated to the last two digits. (See DATE in the *SPSS Base Syntax Reference Guide*.)
- The PREDICT command has no effect on X11ARIMA. X11ARIMA provides one-year forecasts/backcasts where relevant. (See PREDICT in the *SPSS Base Syntax Reference Guide*.)
- Missing data are not allowed anywhere in the series. (You can use the RMV command to replace missing values, and USE to ignore missing observations at the beginning or end of a series. See RMV and USE in the *SPSS Base Syntax Reference Guide* for more information.)

Limitations

- Maximum 1 VARIABLES subcommand. There is no limit on the number of series named on the list.
- Each series must contain at least three full years of data. Five full years of data are required for ARIMA extrapolation and some MACURVES specifications.

Example

```
X11ARIMA PRICES
  /PERIOD=4
  /ARIMA
  /USERMODEL=(0,1,1)(0,1,1).
```

- This command seasonally adjusts the series *PRICES* using a multiplicative seasonal model after forecasts and backcasts generated from the specified ARIMA model have been added.

VARIABLES Subcommand

VARIABLES specifies the series names and is the only required subcommand. The actual keyword VARIABLES is optional.

TITLE Subcommand

Use TITLE to specify a title for the first page of the X11ARIMA output.

- The title can be up to 77 characters in length and must be specified in single quotes.
- The default title is *X11ARIMA*.
- The TITLE subcommand on X11ARIMA is unrelated to the TITLE command in the SPSS Base system, which prints a heading at the top of every page of output for the entire session.

Example

```
X11ARIMA PRHSTART
  /TITLE='New Private Housing Starts'.
```

- The TITLE subcommand assigns the title *New Private Housing Starts*, which will appear on the first page of the X11ARIMA output.

MODEL Subcommand

MODEL specifies whether the seasonal adjustment is multiplicative, additive, or logarithmic (log additive).

- The specification on MODEL is one of three keywords: MULTIPLICATIVE, ADDITIVE, or LOGARITHMIC.
- MULTIPLICATIVE is the default if the MODEL subcommand is not specified.
- The series must contain only positive values for MULTIPLICATIVE or LOGARITHMIC models.

Example

```
X11ARIMA PRHSTART
  /TITLE='New Private Housing Starts'
  /MODEL=ADDITIVE.
```

- The MODEL subcommand requests an additive model of seasonal adjustment.

PERIOD Subcommand

PERIOD indicates the size of the period.

- The specification on PERIOD indicates how many data points are in one period or season. You can specify one of two keywords, MONTHLY or QUARTERLY, or one of two values, 12 or 4. The value 12 is an alias for MONTHLY and the value 4 is an alias for QUARTERLY.
- If the PERIOD subcommand is not specified, the periodicity established on the DATE command is used. (See DATE in the *SPSS Base Syntax Reference Guide*.)

Example

```
X11ARIMA PRHSTART
  /MODEL=MULTIPLICATIVE
  /PERIOD=MONTHLY.
```

- The PERIOD subcommand specifies that the data in the series have a monthly periodicity.

SUMMARY and NOSUMMARY Subcommands

SUMMARY indicates that the series are already seasonally adjusted and should be summarized without seasonal adjustment. NOSUMMARY indicates that the series should be seasonally adjusted. NOSUMMARY is the default.

- Following **SUMMARY**, a series or series list can be specified to indicate which series should not be seasonally adjusted.
- The series named on **SUMMARY** must first be specified on the **VARIABLES** subcommand.
- If no series are specified, the **SUMMARY** subcommand applies to all series specified on **VARIABLES**. None of the series will be seasonally adjusted.
- There are no additional specifications on **NOSUMMARY**.
- **NOSUMMARY** is generally used with an **APPLY** subcommand to turn off a previous **SUMMARY** specification.

Example

```
X11ARIMA ADJSTART
/SUMMARY.
```

- The **SUMMARY** subcommand indicates that the series *ADJSTART* has already been seasonally adjusted. Only summary measures of the series will be produced.

ARIMA and NOARIMA Subcommands

ARIMA indicates that an **ARIMA** model should be used to generate forecasts. **NOARIMA** is the default and indicates that no **ARIMA** adjustment is done to the series before seasonal decomposition.

- There are no additional specifications for **NOARIMA**.
- **NOARIMA** is generally used with an **APPLY** subcommand to turn off a previous **ARIMA** specification.
- If **ARIMA** is specified, the series must contain at least 5 and not more than 29 years of observations.

The following optional keywords can be specified on subcommand **ARIMA**. **BACKCAST** and **NOBACKCAST** are alternatives.

EXTREMES *Treatment of extreme values (outliers).* The specification on **EXTREMES** is either **ACCEPT** or **REPLACE**, enclosed in parentheses. With **ACCEPT**, extreme values are used in the **ARIMA** extrapolation. **ACCEPT** is the default. With **REPLACE**, extreme values in the original series are replaced with fitted values generated by the **ARIMA** model. The same **ARIMA** model is then retested with the modified series to obtain the extrapolated values. No replacements are made, however, for any extreme values in the first $2(p + sp + d + sd(\text{period}))$ observations of the series.

BACKCAST *Backcast the series.* **ARIMA**-extrapolated values are added to the beginning of the series as well as the end of the series. **BACKCAST** is the default.

NOBACKCAST *No backcasting.* Values will not be added to the beginning of the series.

Example

```
X11ARIMA PRHSTART
/ARIMA.
```

- This command specifies that **ARIMA** modeling should be done.

- Forecasts and backcasts from the ARIMA model are added to the original series before the seasonal adjustment process begins. Extreme values are used in the ARIMA extrapolation.

USERMODEL Subcommand

USERMODEL specifies an ARIMA model used in ARIMA adjustment.

- The ARIMA subcommand must be specified for USERMODEL to be executed. If you specify USERMODEL without ARIMA in effect, the procedure terminates with an error message.
- The ARIMA parameters (p,d,q) (sp,sd,sq) must be specified on USERMODEL.
- (p,d,q) specifies the nonseasonal ARIMA parameters. These values must be integers ranging from 0 to 4, inclusive. The (p,d,q) specification is required. If p , d , and q are not to be included in the model, specify them as (0,0,0).
- (sp,sd,sq) specifies the seasonal ARIMA parameters. These values must be integers ranging from 0 to 4, inclusive. The (sp,sd,sq) specification is optional. If sp , sd , and sq are omitted, they are set to (0,0,0) by default.
- If the model does not have a deterministic constant, the sum of p , q , sp , and sq must be less than or equal to 10. If the model has a deterministic constant, the sum of p , q , sp , and sq must be less than or equal to 9.

Transformation Keywords

Use one of the following keywords on USERMODEL to transform the series before modeling:

- LN** *Natural (base e) logarithmic transformation.* After LN, you can optionally specify a constant value to be added to the series before the transformation. The default constant is 0.
- POWER** *Power transformation.* After POWER, specify the power to which the series is raised. After the power value, you can optionally specify a constant value to be added to the series before the transformation. The default constant is 0. There is no default power value.
- NOTTRANSFORM** *No transformation.* NOTTRANSFORM is the default and is generally used on an APPLY subcommand to turn off a previous LN or POWER specification.

Termination Criteria Keyword

Use the following keyword on USERMODEL to indicate the maximum number of iterations:

- MXITER** *Maximum number of iterations.* The value specified on MXITER must be an integer between 1 and 50, inclusive. The default number of iterations is 30.

Constant Parameter Keywords

Use one of the following keywords on USERMODEL to include deterministic constants in the model:

- MACONSTANT** *Use a constant deterministic moving-average parameter.*
- ARCONSTANT** *Use a constant deterministic autoregressive parameter.*
- NOCONSTANT** *No deterministic constant. NOCONSTANT is the default and is generally used with an APPLY subcommand to turn off a previous MACONSTANT or ARCONSTANT specification.*

Initial Value Keywords

Use keyword INITIAL on USERMODEL to specify initial values for the parameters in the model:

- INITIAL** *Use the specified initial values for the model parameters. The list of values is enclosed in parentheses following keyword INITIAL. You must specify one initial value for every parameter in the model.*
- NOINITIAL** *Do not use initial values. NOINITIAL is the default and is generally used with the APPLY subcommand to turn off a previous INITIAL specification.*

Parameter-Order Keywords

Use one or more of the parameter-order keywords to specify the orders of the ARIMA model parameters or turn off all previously specified orders with NOORDERS, which is the default.

- ARORDER** *Order values of the regular autoregressive parameters.*
- MAORDER** *Order values of the regular moving-average parameters.*
- SARORDER** *Order values of the seasonal autoregressive parameters.*
- SMAORDER** *Order values of the seasonal moving-average parameters.*
- NOORDERS** *No orders. NOORDERS is the default and is generally used with an APPLY subcommand to turn off previously specified orders.*

- Orders are specified by listing the order values, one for each parameter, enclosed in parentheses following the keyword.
- If the model contains a deterministic constant, the order of the constant is automatically zero.
- The order of every parameter in the model (except the constant) must be specified after the order keyword.
- The order values must be integers. A single value n indicates that only lag n should be fit. A list of values denotes specific lags.
- The maximum number of orders that can be specified across all lists is 10.
- For seasonal parameters, the values denote *seasonal lags*. Thus, a seasonal parameter of 1 indicates lag 12 for monthly data, and a seasonal parameter of 2 indicates lag 24.

Example

```
X11ARIMA PRHSTART
/ARIMA
/USERMODEL=( 0 , 1 , 1 ) ( 0 , 1 , 1 ) LN.
```

- An ARIMA (0,1,1)(0,1,1) model is specified. The series is transformed using the natural logarithm before modeling.

NOUSERMODEL Subcommand

NOUSERMODEL indicates that a user-specified model is not supplied and that one of three default ARIMA models is used. The three default models are automatically fit to the series and X11ARIMA selects the one that fits best. NOUSERMODEL is the default.

- For series that are seasonally adjusted multiplicatively or logarithmically, the three models are:

```
(0,1,1) (0,1,1) LN
(0,2,2) (0,1,1) LN
(2,1,2) (0,1,1)
```

For series that are seasonally adjusted additively, the default models are:

```
(0,1,1) (0,1,1)
(0,2,2) (0,1,1)
(2,1,2) (0,1,1)
```

- NOUSERMODEL is generally used with an APPLY subcommand to turn off a previous USERMODEL specification.
- If the series is not fit adequately by one of the default models, no ARIMA modeling will be done. The criteria used to judge the models is displayed in case you want to specify one of the models anyway.
- The ARIMA subcommand must be specified for NOUSERMODEL to be executed. If you specify NOUSERMODEL without ARIMA in effect, the procedure terminates with an error message.

FORMAT Subcommand

FORMAT controls the number of decimal places displayed in output tables. The specification on FORMAT is either or both of the following keywords:

TABLES (n) *The number of decimal places displayed in most tables except Table D10.* The integer specified after TABLES indicates the number of digits to the right of the decimal point. The integer can range from 0 to 5. The default is 0.

D10 (n) *The number of decimal places displayed in Table D10 (Final Seasonal Factors).* The integer specified after D10 indicates the number of digits to the right of the decimal point. The integer can range from 1 to 5. The default is 2.

Example

```
X11ARIMA PRHSTART
  /FORMAT=TABLES (2) D10 (4).
```

- This command specifies that the values in all tables except D10 will display two decimal places.
- In Table D10, the values are displayed with four decimal places.

PRINT Subcommand

PRINT provides control over the general number and type of tables displayed. The exact tables displayed depend on other subcommand specifications. Table 1 lists all of the available tables.

You can specify any one of the following keywords on PRINT:

BRIEF	<i>Print 3 to 13 tables.</i> Depending on other subcommand specifications, these tables can include tables from group A, B1, C16A, C16B, C16C, D10, D10A, D11, D11A, D16, D16A, and group F.
ANALYSIS	<i>Print 7 to 29 tables.</i> The tables displayed are mainly from groups A, D, E, and F.
SHORT	<i>Print 7 to 26 tables.</i> The tables displayed are mainly from groups A, D, and F.
LONG	<i>Print 28 to 60 tables.</i> The tables that are omitted are a few of the intermediate ratio, seasonal factor, and seasonally adjusted series tables from the B, C, and D groups.
FULL	<i>Print 45 to 76 tables.</i> All possible tables given other subcommand specifications are displayed.
STANDARD	<i>Print 19 to 40 tables.</i> This is the default.

In addition to the keywords above, one of the following two keywords can also be specified:

EXTRA	<i>Additional information in Tables A5 and A6.</i> The forecasted values for the last 36 months and the absolute percent differences between forecasted values for the last 36 months are added to Table A5. The backcasted values for the last 36 months and the absolute percent differences between backcasted values for the last 36 months are added to Table A6.
NOEXTRA	<i>No additional information in Tables A5 and A6.</i> NOEXTRA is generally used with an APPLY subcommand to turn off a previous EXTRA specification.

Example

```
X11ARIMA PRHSTART
  /PRINT=BRIEF EXTRA.
```

- The PRINT subcommand limits output to BRIEF
- Keyword EXTRA specifies extra output for Tables A5 and A6.

Table 1 Tables produced by X11ARIMA

Table	Contents
A1	Original series
A2	Prior monthly adjustment factors
A3	Adjusted original series, modified by prior monthly adjustment factors
A4A	Prior trading-day adjustment daily weights
A4B	Prior trading-day adjustment factors without length of month adjustment
A4C	Prior trading-day adjustment factors, one year ahead
A5	ARIMA extrapolation model (forecast)
A6	ARIMA extrapolation model (backcast)
B1	Prior adjusted original series
B2	Trend cycle: centered 12-term moving average
B3	Modified SI ratios
B4	Replacement ratios
B5	Seasonal factors
B6	Seasonally adjusted series
B7	Trend cycle: Henderson curve
B8	Modified SI ratios
B9	Replacement ratios
B10	Seasonal factors
B11	Seasonally adjusted series
B13	Irregular series
B14	Extreme irregular values excluded from trading-day regression
B15	Preliminary trading-day regression
B16	Trading-day adjustment factors derived from regression coefficients
B17	Preliminary weights for irregular component
B18	Trading-day factors derived from the combined daily weights
B19	Adjusted original series, modified for trading-day variation
B20	Extreme values
C1	Adjusted original series modified by preliminary weights
C2	Trend cycle: centered 12-term moving average
C4	Modified SI ratios
C5	Seasonal factors
C6	Seasonally adjusted series
C7	Trend cycle: Henderson curve
C9	Modified SI ratios
C10	Seasonal factors
C11	Seasonally adjusted series

Table 1 Tables produced by X11ARIMA (Continued)

Table	Contents
C13	Irregular series
C14	Extreme irregular values excluded from trading-day regression
C15	Final trading-day regression
C16A	Regression coefficients used to derive trading-day adjustment factors
C16B	Regression trading-day adjustment factors
C16C	Regression trading-day adjustment factors, one year ahead
C17	Final weights for irregular component
C18A	Combined daily weights
C18B	Combined trading-day adjustment factors without length-of-month adjustment
C18C	Combined trading-day adjustment factors, one year ahead
C19	Adjusted original series, modified for trading-day variation
C20	Extreme values
D1	Adjusted original series modified by final weights
D2	Trend cycle: centered 12-term moving average
D4	Modified SI ratios
D5	Seasonal factors
D6	Seasonally adjusted series
D7	Trend cycle: Henderson curve
D8	Final modified SI ratios
D9	Final replacement ratios
D9A	Yearly change in error, seasonal components, and moving seasonality ratio
D10	Final seasonal factors
D10A	Seasonal factors, one year ahead
D11	Final seasonally adjusted series
D11A	Final seasonally adjusted series with revised yearly totals
D12	Final trend cycle—Henderson curve
D13	Final irregular series
D16	Combined seasonal and trading-day factors
D16A	Combined seasonal and trading-day factors, one year ahead
E1	Original series modified for extremes with 0 final weights
E2	Final seasonally adjusted series modified for extremes with 0 weight
E3	Modified irregular series
E4	Ratios of annual totals, original and adjusted series
E5	Month-to-month changes in the original series
E6	Month-to-month changes in the final seasonally adjusted series (D11)
E6A	Month-to-month changes in the final seasonally adjusted series (D11A)

Table 1 Tables produced by X11ARIMA (Continued)

Table	Contents
F1	MCD moving average
F2A	Average percent change without regard to sign over the indicated span
F2B	Contributions of the percent change in the components of the original series
F2C	Average percent change with regard to sign and standard deviation
F2D	Average duration of run
F2E	I/C ratio for months span
F2F	Contribution of the components to the stationary portion of variance
F2G	Autocorrelation of the irregulars for spans 1 to 14
F2H	Final I/C ratio and the final I/S ratio
F2I	Statistical tests of trading-day regressions and seasonality
F3	Monitoring and quality assessment statistics

PLOTS Subcommand

PLOTS controls which plots are displayed. You can specify any one of the following keywords on PLOTS:

STANDARD	<i>Standard plots.</i> These include a plot of the original series, the original series with ARIMA-extrapolated values, and the original series modified for extremes with 0 final weights; a plot of the final seasonally adjusted series and the final trend-cycle; and a plot of the final seasonal factors, final unmodified seasonal-irregular ratios, final ratios modified for extremes, and extrapolated seasonal factors for each month or quarter. STANDARD is the default.
ALL	<i>All available plots.</i> These include all the standard plots plus a plot of the final seasonal factors, final unmodified seasonal-irregular ratios, final ratios modified for extremes, and extrapolated seasonal factors for the series; a plot of the final irregular series and the final modified irregular series; and a list of the values and plot of the cumulative periodogram bounded by 95% confidence limits from the Kolmogorov-Smirnov significance tests of the final irregulars.
NONE	<i>No plots.</i>

Example

```
X11ARIMA PRHSTART
/PLOT=ALL.
```

- The PLOTS subcommand of this X11ARIMA procedure produces standard plots plus three additional plots.

YEARTOTAL and NOYEARTOTAL Subcommands

YEARTOTAL indicates that the seasonally adjusted series in Table D11 should be adjusted to make the yearly totals the same as those of the original series. NOYEARTOTAL indicates that the series should not be adjusted and is the default.

- There are no additional specifications on YEARTOTAL or NOYEARTOTAL.
- If YEARTOTAL is specified, the seasonally adjusted series with the revised yearly totals is presented in Table D11A.
- NOYEARTOTAL is generally used with an APPLY subcommand to turn off a previous YEARTOTAL specification.

Example

```
X11ARIMA PRHSTART
/YEARTOTAL.
```

- The seasonally adjusted series will be adjusted so that its yearly totals are the same as those of the original series.

EXTREMETC and NOEXTREMETC Subcommands

EXTREMETC and NOEXTREMETC specify whether extreme values should be modified before computing the trend-cycle estimates in Table B7.

- NOEXTREMETC indicates that extreme values should be modified before computing the trend-cycle estimates. This is useful when unusual events such as strikes or catastrophes cause major irregularities in the series. Modifying the extreme values reduces the effect of these events on the trend-cycle estimates.
- EXTREMETC is the default and indicates that extreme values should be included in the trend-cycle estimates without any modification.
- EXTREMETC is generally used with an APPLY subcommand to turn off a previous NOEXTREMETC specification.
- There are no additional specifications on EXTREMETC or NOEXTREMETC.

Example

```
X11ARIMA PRHSTART
/NOEXTREMETC.
```

- In this X11ARIMA analysis, extreme scores will be modified before seasonal adjustment.

MONTHLEN Subcommand

MONTHLEN controls whether the differences in the number of days in each month are accounted for in the seasonal factors or in the trading-day factors.

- MONTHLEN is ignored unless it is used with monthly series and MODEL=MULTIPLICATIVE is in effect.

The specification on MONTHLEN is one of the following two keywords:

SEASONAL *Include length-of-month variation in the seasonal factors.* SEASONAL is the default.

TRADEDAY *Include length-of-month variation in the trading-day factors.*

Example

```
X11ARIMA PRHSTART
/MONTHLEN=TRADEDAY.
```

- Here the length-of-month differences are accounted for in the trading-day factors rather than in the seasonal factors.

HISIGMA and LOWSIGMA Subcommands

HISIGMA and LOWSIGMA set the upper and lower sigma limits for graduating extreme values in estimating seasonal and trend-cycle components.

- The specification on LOWSIGMA is a value ranging from 0.1 to 9.9. The default is 1.5.
- The specification on HISIGMA is a value ranging from 0.1 to 9.9. The default is 2.5.
- The value of HISIGMA must be larger than the value of LOWSIGMA.

Example

```
X11ARIMA PRHSTART
/NOEXTREME*TC
/LOWSIGMA 2.5
/HISIGMA 3.5.
```

- The LOWSIGMA and HISIGMA subcommands set the sigma limits for graduating extreme values to 2.5 and 3.5.

PRVARS and NOPRVARS Subcommands

PRVARS specifies the variables to be used in adjusting the series before the seasonal adjustment process. NOPRVARS is the default and indicates that there is no PRVARS adjustment.

- The specification on PRVARS is one or more variable names.
- The variables specified on PRVARS adjust the series specified on the VARIABLES subcommand on a one-to-one basis: the first variable named on PRVARS adjusts the first series named on VARIABLES, the second variable adjusts the second series, and so forth.
- You do not have to specify a PRVARS variable for every series named on VARIABLES.
- The maximum number of variables specified on PRVARS is the number of series named on the VARIABLES subcommand.
- When MODEL=MULTIPLICATIVE or LOGARITHMIC, the PRVARS variables are divided into the original series before seasonal adjustment.
- When MODEL=ADDITIVE, the PRVARS variables are subtracted from the original series before seasonal adjustment.

- There are no additional specifications on NOPRVARS.
- NOPRVARS is generally used with an APPLY subcommand to turn off a previous PRVARS specification.

Example

```
X11ARIMA PRHSTART
  /PRVARS=ADJINDEX.
```

- In this example, the variable *ADJINDEX* is used to make a prior adjustment to the *PRHSTART* series.

DAYWGTS and NODAYWGTS Subcommands

DAYWGTS allows you to specify prior daily weights to adjust for trading-day variation before seasonal adjustment. NODAYWGTS is the default and indicates that prior daily weights should not be applied.

- DAYWGTS can only be used with monthly series and with MODEL=MULTIPLICATIVE or LOGARITHMIC.
- The specification on DAYWGTS is one or more day keywords (MON, TUES, WED, THUR, FRI, SAT, and SUN) with their weights.
- Each weight is specified in parentheses following the day keyword to which it applies.
- The weights must be in the range 0 to 9.999.
- Days that are not specified are assigned a weight of 0. The weights of specified days are adjusted, if necessary, to total 7.0. The weights may also be adjusted by trading-day regression calculations.
- There are no additional specifications on NODAYWGTS. NODAYWGTS is equivalent to setting all day weights to 0.
- NODAYWGTS is generally used with an APPLY subcommand to turn off a previous DAYWGTS specification.

Example

```
X11ARIMA PRHSTART
  /DAYWGTS=MON(1.4) TUES(1.4) WED(1.4) THUR(1.4) FRI(1.4).
```

- The DAYWGTS subcommand in this example assigns equal weights to Monday through Friday. Saturday and Sunday are assigned weights of 0 by default.

TRADAYREG and NOTRADAYREG Subcommands

TRADAYREG computes and displays trading-day regression estimates. NOTRADAYREG indicates trading-day regression estimates should not be computed. NOTRADAYREG is the default.

- There are no additional specifications on NOTRADAYREG.
- NOTRADAYREG is generally used with an APPLY command to turn off a previous TRADAYREG specification.

The following keywords on TRADAYREG control whether and how the regression estimates are used to adjust the series. You can specify only one of these keywords:

- NOADJUST** *Do not adjust the series by the factors computed.* This is the default specification for TRADAYREG.
- ADJUST** *Adjust the series by the regression estimates.* If prior daily weights have been supplied on a DAYWGTS subcommand, they are corrected on the basis of these estimates.
- SIGNIF** *Adjust the series by the regression estimates or prior factors corrected by the regression estimates to obtain preliminary estimates for the error series in B tables.* In C tables, SIGNIF uses the regression estimates only if they explain significant variation on the basis of the *F* test.

The following additional keywords can be specified on TRADAYREG: COMPUTE or NOCOMPUTE, BEGIN or NOBEGIN, and TDSIGMA:

- COMPUTE** *Starting date for computing the trading-day regression.* The specification after COMPUTE is a year in the range 1900 to 1999 in parentheses. The estimates are derived using only the part of the series from January of the year specified to the end of the series (or the end of the USE period).
- NOCOMPUTE** *Use the entire series in the regression.* NOCOMPUTE is the default and is generally used with an APPLY subcommand to override a previous COMPUTE specification.
- BEGIN** *Starting date for applying the trading-day regression.* BEGIN can be specified only if TRADAYREG=ADJUST or SIGNIF. The specification on BEGIN is a year in the range 1900 to 1999 in parentheses. BEGIN applies the estimates only to the part of the series from January of the year specified to the end of the series (or the end of the USE period). If prior daily weights are supplied on the DAYWGTS subcommand, BEGIN adjusts the part of the series before the specified date by the prior weights only. The part of the series after the specified date is adjusted by the prior weights corrected by the regression estimates.
- NOBEGIN** *Apply trading-day corrections to the entire series.* NOBEGIN is the default and is generally used with an APPLY subcommand to override a previous BEGIN specification.
- TDSIGMA** *Sigma limit for excluding extreme values from the trading-day regression.* The specification on TDSIGMA is a value in the range 0.1 to 9.9 in parentheses. The default value is 2.5.

Example

```
X11ARIMA PRHSTART
/ TRADAYREG=ADJUST.
```

- The TRADAYREG subcommand indicates that a trading-day regression is to be calculated.
- The ADJUST keyword after TRADAYREG indicates the series is to be adjusted by the computed regression coefficients.

MACURVES Subcommand

MACURVES specifies the types of seasonal and trend-cycle moving averages. The following keywords are available for MACURVES:

- SEASFACT** *Moving average for the seasonal factor curves.* Specify one of the following types in parentheses after SEASFACT: HYBRID, which uses a 3×3 average for the first estimate and a 3×5 average for the final estimate; 3X3, which uses a 3×3 average for all iterations; 3X5, which uses a 3×5 average for all iterations; 3X9, which uses a 3×9 average for all iterations; STABLE, which is an average of all values; or SELECT, which chooses a different moving average for each month based on the I/S ratio. The default is HYBRID.
- TRENDCYC** *Trend-cycle moving average.* The specification after TRENDCYC is 12 or 24 in parentheses for monthly series, and 4 or 8 in parentheses for quarterly series. The defaults are 12 for monthly and 4 for quarterly.
- HENDERSON** *Moving average for variable trend-cycles.* The specification after HENDERSON is a moving-average value or keyword SELECT in parentheses. For monthly series, 9 specifies a 9-term Henderson moving average, 13 specifies a 13-term moving average, and 23 specifies a 23-term moving average. For quarterly series, 5 specifies a 5-term Henderson moving average and 7 specifies a 7-term moving average. SELECT requests that Trends select an appropriate moving average based on the randomness in the series. SELECT is the default.
- PERMONTH** *Seasonal moving-average method per month for monthly series.* The specification on PERMONTH is followed by one or more month keywords (JAN, FEB, MAR, APR, MAY, JUN, JUL, AUG, SEP, OCT, NOV, DEC) and their averages in parentheses. The averages that can be specified are 3X3, 3X5, 3X9, and STABLE.
- PERQUARTER** *The seasonal moving-average method per quarter for quarterly series.* The specification on PERQUARTER is one or more quarter keywords (FIRST, SECOND, THIRD, FOURTH) and their averages in parentheses. The averages that can be specified are 3X3, 3X5, 3X9, and STABLE.
- DEFAULT** *Reset all MACURVES specifications to their defaults.* DEFAULT is in effect if MACURVES is not specified.
- Any month or quarter that is not included on a PERMONTH or PERQUARTER specification will be averaged according to the method specified by the SEASFACT entry of the MACURVES subcommand. 3×3, 3×5, and 3×9 specify those moving averages. STABLE specifies that the program should average all of the values.
 - Monthly and quarterly specifications cannot be mixed.
 - NOPERMONTH and NOPERQUARTER can be used to turn off PERMONTH or PERQUARTER specifications from a previous model.

Example

```
X11ARIMA PRHSTART
/MACURVES=SEASFACT (SELECT).
```

- In this example, a different seasonal moving average is chosen for each month based on the Irregular/Seasonal ratio.

APPLY Subcommand

APPLY allows you to use a previously defined X11ARIMA model without having to repeat the specifications. For general rules on APPLY, see the APPLY subcommand on p. 5.

- The only specification on APPLY is the name of a previous model in quotes. If a model name is not specified, the model specified on the previous X11ARIMA command is used.
- To change one or more of the specifications of the model, specify the subcommands of only those portions you want to change after the subcommand APPLY.
- If no series are specified, the series that were originally specified with the model being reapplied are used.
- To change the series used with the model, enter new series names before or after the APPLY subcommand. If a series name is specified before APPLY, the slash before the subcommand is required.

Example

```
X11ARIMA TOTALHS
/ARIMA
/USERMODEL=(0,1,1)(0,1,1)
/TRADAYREG=SIGNIF.
X11ARIMA APPLY
/NOTRADAYREG.
```

- In this example, the same X11ARIMA procedure is done a second time without making any trading-day regression adjustments.

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