_____

BJFRCST (CONBOUND=*probability for forecasting bounds*,
CONSTANT, EXP, NAR=*number of AR parameters*,
NBACK =*number of back-forcasting residuals*,
NDIFF=*degree of ordinary differencing*,
NHORIZ=*length of forecasting horizon*,
NLAG=*number of lagged observations to plot*,
NMA=*number of MA parameters*,
NSAR=*number of seasonal AR parameters*,
NSDIFF=*degree of seasonal differencing*,
NSMA=*number of seasonal MA parameters*,
NSPAN=*seasonal frequency*,
ORGBEG=*first forecasting origin*,
ORGEND=*final forecasting origin*,
PLOT, PRINT, RETRIEVE)
series name [S *standard error of disturbance*]
[*parameter name parameter value ...*] ;

_____

Function:

BJFRCST calculates the forecasts of a time series that are implied by an ARIMA model (see the description of BJEST for more information of ARIMA models). The forecasts and other statistics are calculated using the equations in Chapter 5 and Part V, program 4 of Box and Jenkins.

Usage:

The entry for the BJEST procedure describes the ARIMA model and its notation in some detail. To obtain forecasts for such a model, use the BJFRCST command followed by the options you want (in parentheses) and then the name of the series.

If the BJFRCST command immediately follows the BJEST command for the desired model, no parameter values need to be specified; BJFRCST will automatically use the final estimates generated by BJEST. Alternatively, any or all of the model parameters can be specified by listing the parameters and their values following the series name (as in BJEST). If no value is supplied for S, the standard error of the disturbance, (and if no estimate from BJEST is available), BJFRCST will calculate an estimate of S using the values of the time series up to and including the ORGBEG-th observation.

BJFRCST calculates forecasts for the time series for the NHORIZ periods following the current "origin". The "origin" is the final period for which (conceptually) the time series is observed, i.e., the final period for which no forecast is required. In practice, it is often useful to generate forecasts for periods that have already been observed. These forecasts provide evidence on the reliability of the estimated time series model. It is also useful to generate sets of forecasts for different origins. BJFRCST calculates a complete set of forecasts and associated confidence bounds for each of the origins from ORGBEG to ORGEND inclusive.

Options:

CONBOUND= specifies the probability for the confidence bounds about the forecasts. The default* is 0.95.

CONSTANT/**NOCONST** specifies whether there is a constant term in the model.

BJFRCST

EXP/**NOEXP** is used when BJEST was used to model log(y), and you want to forecast the original y. The forecast is increased by using the forecast variance for each observation, to make it unbiased, and the forecast confidence interval will be asymmetric. See the Nelson reference for more details.

NAR= the number of ordinary autoregressive parameters in the model. The default* is zero.

NBACK= the number of back-forecasted residuals to be calculated. The default* is 100.

NDIFF= the degree of ordinary differencing required to obtain stationarity. Note that the <u>undifferenced</u> series is forecasted. The default* is zero.

NHORIZ= the number of periods ahead to forecast the series. The default* is 20.

NLAG= the number of periods prior to the forecasting origin to include in the plot of the series and the forecasts. The default* is 20.

NMA= the number of ordinary moving average parameters in the model. The default* is zero.

NSAR= the number of seasonal autoregressive parameters in the model. The default* is zero.

NSDIFF= the degree of seasonal differencing required to obtain stationarity. Note that the <u>undifferenced</u> series is forecasted. The default* is zero.

NSMA= the number of seasonal moving average parameters in the model. The default* is zero.

NSPAN= the span (length) of the seasonal cycle. For example, with quarterly data, NSPAN should be 4. The default is the current frequency (that is, 1 for annual, 4 for quarterly, 12 for monthly). If the current FREQ is 0, the default* is the value from the last BJ command.

ORGBEG= the first origin to use in forecasting. The default* is the final observation in the current sample. This option should be specified as a TSP date, e.g., 82:4. Note that this date must lie within the current SMPL.

ORGEND= the final origin to use in forecasting. The default* is ORGBEG. This option should also be specified as a TSP date. Like ORGBEG, this date must lie within the current SMPL.

PLOT/NOPLOT specifies whether the series and the forecasts are plotted.

PRINT/**NOPRINT** specifies whether the results will be printed (versus just stored in @FIT).

RETRIEVE/NORETR specifies whether BJFRCST should try to find parameter values from an immediately preceding BJEST procedure.

* For all the Box-Jenkins procedures (BJIDENT, BJEST, BJFRCST), TSP remembers the options from the previous Box-Jenkins command, so that you only need to specify the ones you want to change.

Examples:

The first example produces one set of forecasts for the Nelson auto sales data. The log of the original series is forecasted.

```
BJFRCST(PRINT,NMA=2,NSMA=1,NDIFF=1,NSDIFF=1,NSPAN=12,
   NHORIZ=24,ORGBEG=264) LOGAUTO
   S 0.111068 THETA(1) 0.2114 THETA(2) 0.2612
   DELTA(1) 0.8471 ;
```

The second example produces the same forecasts, but the model parameters are provided by the immediately preceding

BJEST procedure. Notice that the options describing the model do not need to be repeated for the BJFRCST procedure. Also, the *level* of the original series, rather than its log, are forecasted.

```
BJEST(NMA=2,NSMA=1,NDIFF=1,NSDIFF=1,NSPAN=12)
   LOGAUTO START THETA(1) 0.12
   THETA(2) 0.20 DELTA(1) 0.82 ;
BJFRCST(EXP,PRINT,NHORIZ=24,ORGBEG=264) LOGAUTO ;
```

Output:

The output of BJFRCST starts with a printout of the option settings. The parameter values are also printed. This is followed by a printout of the expanded phi* and theta* polynomials implied by these parameters. The phi* and theta* polynomials are the generalized autoregressive and moving average polynomials, respectively, that are obtained by taking the product of the ordinary, seasonal, and pure difference polynomials. Next a table is printed of the forecast standard errors, and the psi weights. Note that the standard error in the N-th row of the table is the standard error of the forecast for the N-th period following the origin (the "N-th step ahead"). The psi weights are the coefficients obtained by expressing the model as a pure moving average. The N-th row entry for psi, phi* or theta* gives the coefficient for the N-th lag.

The next feature of the output is a table of the forecasts, their upper and lower confidence bounds, the actual values of the time series (when available), and the discrepancies between the forecasts and the realizations of the time series. If PLOT is specified, the values in this table are plotted. The following variables are stored:

Name	Type	Length	Variable Description
@FIT	series	NHORIZ	Forecast (for last origin, if there was more than one).
@FITSE	series	NHORIZ	Forecast standard errors (still in logs for EXP).

Method:

BJFRCST forms the generalized autoregressive and moving average lag polynomials, phi* and theta*. These lag polynomials define a simple difference equation for the time series. The forecasts are generated using this difference equation. As in BJEST, backcasted residuals are calculated to obtain initial conditions for the difference equation. Chapter 5 of Box and Jenkins (1976) contains a detailed explanation and analysis of this procedure.

References:

Box, George P. and Gwilym M. Jenkins, **Time Series Analysis: Forecasting and Control,** Holden-Day, New York, 1976.

Nelson, Charles, **Applied Time Series Analysis for Managerial Forecasting,** Holden-Day, New York, 1973.

Pindyck, Robert S. and Daniel L. Rubinfeld, **Econometric Models and Economic Forecasts,** McGraw-Hill Book Co., New York, 1976, Chapter 15.