DSFM Manual

Version January 21, 2005
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This software estimates dynamic single-factor index models of the state of an economy using the Kalman filter. The structure of the model, its estimation, and the transformation from the estimated state to the economic index are described in several articles by James H. Stock and Mark W. Watson that are listed in the references section.

The numerical maximization routines are quasi-Newton algorithms that employ the BFGS positive definite secant update of the Hessian, and line search methods. These routines are primarily an implementation of the pseudo code from Dennis and Schnabel (1983).

Installation of the Software

Unzip the file to any folder. It is best to maintain the directory structure, as this will make the example easier to follow. There are two versions of the application, one for the Windows 95/98/XP platform; the other for the Windows NT 4.0 platform. The application files are named *dsfm95.exe* and *dsfmnt40.exe* respectively. There is no installation program.

Running the Program

To run the program, double click on the file in the Windows Explorer application. The application will prompt you for the file specification of the command file. Respond with the filename and extension, and include the path (e.g., drive and folders) as part of the file specification if needed, for example c:\temp\command.txt. You may find it convenient to create a shortcut to the application. If any file specifications do not include paths (folders and/or drive specifications), the application assumes they reside in the "Start In" location, which by default is the folder in which the application resides. You can change this by setting the application's properties (right-click the application icon in Explorer, or right-click the shortcut, and choose Properties).

An example is included. The input files are located in the "input" folder, and the output files are located in the "output" folder.

Batch Processing

The program can also be run in batch mode. In order to do this, use the operating systems' Run command or open a command window. Type the name of the application (dsfm95 or dsfmnt40) followed by a space and then the filename and extension of the command file. Include the paths to the command name and command file if necessary. If either includes embedded blanks, enclose them in quotation marks. For example, "c:\program files\dsfm\dsfm95" c:\myfolder\mycommandfile.txt.

Alternatively, you can construct a ".bat" (for batch) file in a text editor and execute this file using the operating systems' Run command or command window. Each line of the batch file should have two entries. The first is the path and filename of the DSFM application (dsfm95 or dsfmnt40), and the second is the path and filename (with extension) of the command file. This is a convenient way to estimate several models, one after the other, without having to be present to wait until each one finishes before starting the next one.

The Dynamic Single-Factor (Stock/Watson) Model

The model discussed in this paper was developed by Stock and Watson (1989, 1991, and 1993). The structure of the model is:

(1) $\quad \Delta \mathbf{x}_t = \boldsymbol{\beta} + \boldsymbol{\gamma}(L)\Delta c_t + \boldsymbol{\mu}_t$,

(2) $\quad \mathbf{D}(L)\boldsymbol{\mu}_t = \mathbf{P}(L)\boldsymbol{\varepsilon}_t$,

(3) $\quad \phi(L)\Delta c_t = \delta + q(L)\eta_t$,

where time series variables are subscripted with an index "t". $\Delta \mathbf{x}_t$ is a $G \times 1$ vector of observable stationary series, usually series that have been logged and first-differenced to achieve stationarity. Δc_t is a scalar latent stationary series that is common to the G observable series and, in this context, has the interpretation as the underlying growth rate of the economy. The vector $\boldsymbol{\mu}_t$ consists of G mutually uncorrelated, mean zero, stationary autoregressive moving average (ARMA) processes. The $G \times 1$ vector $\boldsymbol{\varepsilon}_t$ and the scalar η_t comprise $G+1$ mutually uncorrelated white noise processes. The symbol L is the lag operator, i.e., $L^k x_t = x_{t-k}$.

The parameters of the model can be expressed as follows.

(4a) $\quad \boldsymbol{\gamma}(L) \equiv [\gamma_1(L), \gamma_2(L), \cdots, \gamma_G(L)]'$,

(4b) $\quad$ where $\gamma_g(L) \equiv \gamma_{g0} + \gamma_{g1}L + \gamma_{g2}L^2 + \cdots$.

(5a) $\quad \mathbf{D}(L) \equiv diag[d_1(L), d_2(L), \cdots, d_G(L)]'$,

(5b) $\quad$ where $d_g(L) \equiv 1 - d_{g1}L - d_{g2}L^2 - \cdots$.

(6) $\quad \phi(L) \equiv 1 - \phi_1 L - \phi_2 L^2 - \cdots$.

(7) $\quad \boldsymbol{\Sigma} \equiv \mathrm{cov}\left([\boldsymbol{\varepsilon}_t', \eta_t]'\right) = diag[\sigma_1^2, \sigma_2^2, \cdots, \sigma_G^2, \sigma_\eta^2]$

(8a) $\quad \mathbf{P}(L) \equiv diag[p_1(L), p_2(L), \cdots, p_G(L)]'$,

(8b) $\quad$ where $p_g(L) \equiv 1 + p_{g1}L + p_{g2}L^2 + \cdots$.

(9) $\quad q(L) \equiv 1 + q_1 L + q_2 L^2 + \cdots$.

The lag polynomial matrices $\mathbf{D}(L)$ and $\mathbf{P}(L)$ are diagonal, so that the μ_t's in different equations in (2) are contemporaneously and serially uncorrelated with one another.

The model can be interpreted as a time series version of a factor analysis model, where the first difference of the unobserved state, Δc_t, represents the common factor in the indicators, $\Delta \mathbf{x}_t$. The differenced state, hereinafter simply referred to as the common state, follows an ARMA process. The $\boldsymbol{\mu}_t$ components of the observed series in equation (2) comprise what are called the idiosyncratic portions of the observed series, or in factor analysis, the unique factors – as opposed to the common factor.

Identification and Estimation

In a typical application of this model, the $\Delta\mathbf{x}_t$ series are normalized to have mean zero, which identifies $\boldsymbol{\beta} = \mathbf{0}$ and $\delta = 0$ for purposes of estimation. In addition to these normalizations, this software application also standardizes each (differenced) series by dividing by its sample standard deviation. This is not necessary to identify the model, but is a convenience that scales the data and therefore also the parameters. This scaling is used in the construction of the retrended common state described below.

The scale of the $\gamma(L)$ coefficients is fixed by setting the variance of η_t to unity, i.e., $\sigma_\eta^2 = 1$, and the timing of the coincident index is fixed by setting all but one of the elements of $\gamma(L)$ to zero in one of the equations in (1). The software automatically does the former, but the user is responsible for the latter identification requirement.

(Quasi) maximum likelihood estimation of the parameters of the system in (1)-(3) and estimation of the smoothed state is accomplished by representing the system in state space form and using the Kalman filter. The formation of the state space system is described in detail by Stock and Watson (1991). The log file contains the state space parameter arrays, so the user can see how the software represented the model in state space form. Maximum likelihood estimation of the state space model is described in several sources, including Hamilton (1994).

The Kalman Filter and Smoother

Often, the purpose of "running" the model is to get estimates of the common state or forecasts of the common state. $\Delta\hat{c}_{t|s}$ refers to the estimate of Δc_t with information through time period *s*. These estimates are linear functions of the observable $\Delta\mathbf{x}_t$'s for $t \le s$. The coefficients of these linear functions, called scoring coefficients in factor analysis, are called filters in time series analysis. This linear function may be written as:

$$(10) \qquad \Delta c_{t|s} = \sum_{g=1}^{G} {}_{t,s}m_g(L)\Delta x_{g,t}, \text{ where } {}_{t,s}m_g(L) = \sum_{k=t-s}^{t} {}_{t,s}m_{g,k}L^k .$$

The prefix subscript "*t,s*" on the filter indicates that the coefficients of the filter depend on both t and s, although if $\Delta\mathbf{x}_t$ is stationary, the filter depends only on the difference $s - t$ as $t \to \infty$. In practice, the convergence of the filter to stationarity is quite rapid as $t >> 0$.

The term "Kalman filter" refers not only to the set of recursive equations used to calculate the common state, but also to the filter that yields $\Delta\hat{c}_{t|t}$, while "Kalman smoother" refers to the filter that yields $\Delta\hat{c}_{t|T}$, where *T* refers to the full set of information. Indeed, the state space model with its Kalman filter equations is a method for calculating the filter that extracts the common signal of the indicator series.

The user can request that several of these filters be output to a file. Fifty filters are output where $s = T$. For these 50 filters, the value of $t - T$, the lower index of the second summation in equation (10), varies from $t-T=0$ to $t-T=-49$. The first filter is one-sided, while the last, where $t-T=-49$, is two-sided and approximately symmetric. Filter coefficients are output only for values of $|k| \le 49$, which is usually sufficient since the coefficients usually approach zero rapidly as the absolute value of k increases.

Retrending the Common State

Integrating (reverse differencing) the common state gives an estimate of the underlying state of the economy. By construction, with $\delta = 0$, this state would be driftless. Furthermore, the identification restriction $\sigma_\eta^2 = 1$ affects the scale of either the change or growth rate (the latter if the indicators were logged and differenced in order to achieve stationarity) of the underlying state. If the model estimates are used to construct economic indexes, the estimates of the common state given by the Kalman filter need to be recalibrated in some useful way.

Two commonly used recalibration approaches each uses a linear transformation of the Kalman filter or smoother state estimates, e.g., $a + b\Delta\hat{c}_{t|t}$ or $a + b\Delta\hat{c}_{t|T}$, which is then integrated (and exponentiated if appropriate). One approach (Stock and Watson 1991), analogous to the method used by The Conference Board and developed at the Bureau of Economic Analysis (Green and Beckman 1993), gives the resulting index a trend that is a weighted average of the indicators' trends, with weights proportional to the contributions of the indicators in the Kalman filter or smoother. A second approach chooses the linear transformation that gives the resulting index the same trend and variance around the trend as some other series of interest. Both methods are explained in detail in Clayton-Matthews and Stock (1998/1999). This software implements the former recalibration method.

Handling Mixed Monthly and Quarterly Frequencies

The indicator series may be of different (mixed) frequencies. The current version of this software handles mixed monthly and quarterly frequencies. In this case, each quarterly series is treated as a moving three-month sum of an unobserved monthly series, i.e., $x_t = z_t + z_{t-1} + z_{t-2}$, a strategy described by Zadrozny (1990). The quarterly change, $\Delta x_t \equiv x_t - x_{t-3}$, is related to the monthly change in the underlying monthly series, $\Delta z_t \equiv z_t - z_{t-1}$, in the following way:

$$\begin{aligned}\Delta x_t &= (z_t + z_{t-1} + z_{t-2}) - (z_{t-3} + z_{t-4} + z_{t-5}) = (z_t - z_{t-3}) + (z_{t-1} - z_{t-4}) + (z_{t-2} - z_{t-5}) \\ &= \Omega(L)\Delta z_t\end{aligned},$$

where $\Omega(L) = 1 + 2L + 3L^2 + 2L^3 + L^4$. (Note that $z_t - z_{t-3} = \Delta z_t + \Delta z_{t-1} + \Delta z_{t-2}$, etc.)[1]

The common component of the unobserved monthly series z_t is $\gamma(L)\Delta c_t$, so the measurement equation for the quarterly change in wage and salary disbursements is

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[1] In his paper, Zadrozny (1990) defined the change in the quarterly series as the simple sum of three monthly changes in the underlying monthly data, i.e., $\Delta x_t = \Delta z_t + \Delta z_{t-1} + \Delta z_{t-2}$, apparently missing the subtlety involved in differenced data that results in the $\Omega(L)$ lag specification.

(1′) $\Delta x_t = \gamma(L)\Omega(L)\Delta c_t + \mu_t$.

The coefficients on the common state reported for these models are the estimates of the $\gamma(L)$ parameters, which estimate the effect of the common state, Δc_t (and its lags, if any), on the unobserved monthly series, Δz_t.

Defined in this way, the measurement series Δx_t is observed every third month, and is missing two out of every three months. The Kalman filter is modified to handle missing data by omitting the wage and salary disbursement measurement equation in the months for which the data are missing. The procedure, described in Zadrozny (1990), is implemented simply by changing the dimensions of the relevant state space matrices month by month during the Kalman filter recursion, as needed. The software does this automatically. The user only needs to specify which series are monthly and which are quarterly in the MEASUREMENT commands, as explained below.

The idiosyncratic component of the (quarterly change in the) quarterly series, μ_t, is modeled as a quarterly series, and so its estimated ARMA structure in equations (2), (5a,b), and (8a,b) above should be interpreted accordingly. Alternatively, the idiosyncratic component for the change in wage and salary disbursements could have been modeled as a monthly series in a manner analogous to its common component. This choice would have required a higher dimension of the state vector and longer computation time.

Missing Data

Observations that are missing for one or more series, or data that you want to mask out of the estimation for any reason, can be handled by supplying indicator data series in addition to the corresponding actual data series. One use of this feature is to enable estimating a composite index where all the indicator series do not end on the same date. Say one series is only available through month T-1, and you want to estimate an index through month T. Assign a numeric value -- is doesn't matter what value -- to month T for the short series, and also supply a binary indicator series that takes the value one through month T-1 and zero for month T. See the section on binary indicator files below.

Input Files

Command File

The command file is a text file that specifies the structure of the model, the data to be used as indicators, and the names and locations of the output files. When the program is launched, it will prompt you for the location of the command file. Specify the file name and extension, if any. There is no default extension, so you must specify one if the command file has one. An extension of “txt” is recommended, since Windows automatically associates this with Notepad, a text editor. The contents of the command file are more fully described in the Command Syntax section.

Data Files

Each data series must be supplied in a separate rectangular file, where the first column consists of dates, and the second column consists of the data. The first row must have a variable name in the second column. The variable name must begin with a letter and not contain any embedded blanks. The first row of the first column must be blank.

The dates in these files must be in the following (WEFA) format:

yyyypp

Where “yyyy” is a four-digit year, and “pp” is a two digit period indicator. For monthly data, "pp" is a two-digit number between one and twelve inclusive; for quarterly data, "pp" is a two-digit number between one and four inclusive. For annual data "pp" is the two-digit number one, "01". In each case, "pp" must contain two digits, as the software extracts the period by taking the modulus of the date with 100. For example, March 1998 would be specified as 199803.

No non-numeric values are allowed in the data file, and no gaps are allowed in the data, that is, the dates must be consecutive. If some of the data points in a series are missing, use arbitrary numeric values for these data points, and include a binary indicator data file for the series.

The fields in the data files can be delimited by tabs or by spaces. It is probably easiest to prepare the data file in a spreadsheet and save it as a text file delimited by either tabs or spaces.

It is not necessary that the data for several indicators span exactly the same dates. The software will use the intersection of the time spans present in the data files.

Binary Indicator Data Files

If a data series has one or more missing values in the period over which the index is to be estimated, a companion binary indicator data series must be supplied for it in a separate file. The indicator series must range over exactly the same period as its associated data file (and must, of course, have the same frequency). The indicator series consists of ones and zeros only. A zero indicates that the corresponding data point in the data series is missing; a one indicates that the corresponding data point in the data series is not missing. Indicator data files have the same format as regular data files.

Output Files

The software produces six output files:

1) A log file, best viewed if the file is opened in a spreadsheet as a space delimited file. The log file contains:
    a. Run-time messages, including error messages. These are best viewed in a text editor.
    b. The state space form of the parameter matrices. Two versions are presented: one using the parameter names, and the other, using the parameter estimates.

c. The sample means and standard deviations used to normalize the indicator series.

d. Dynamic and cumulative multipliers, that indicate the response of the estimated state to a unit pulse in each indicator. The dynamic multipliers are the Kalman filter. Each cumulative multiplier is the sum of the corresponding dynamic multipliers, and gives the relative importance of each indicator in forming the estimated state.

e. The linear function used to recalibrate the estimated state. The constant is "mu", and the coefficient on the estimated state is the inverse of "S".

f. A specification test described in Stock and Watson (1991, Table 4.2, p. 74). This tests whether the white noise components in equation (2) can be predicted from past values of the white noise components or from past values of the indicators. F-test statistics are reported for $2G^2$ regressions. Each one-step ahead forecast error for each measurement equation, $\hat{\varepsilon}_{g,t|t-1}$, is regressed on a constant and six lags of one of the forecast errors. Each one-step ahead forecast error is also regressed on a constant and six lags of one of the (differenced) indicators, $\Delta x_{g,t}$. For each of the regressions, the F-statistic and the degrees of freedom are reported for the test of the null hypothesis that all the regression coefficients, excluding the constant, are zero. One would want to be able to accept the set of these null hypotheses to pass this specification test.

2) An index file that contains the estimated economic index. This file is in comma separated value format, and is easily viewed in a spreadsheet application.

3) An output file from the numerical optimization part of the software. The end of this file contains the parameter estimates, their standard errors, and t-statistics. This file is best viewed if opened in a spreadsheet application as a space-delimited file.

4) A debug file that may contain information, depending on the version of the software. In this version, the debug file contains:

   a. The transformed, normalized, data series and lagged data series that are used to estimate the parameters of the model, in comma separated format.

   b. If mixed frequencies or indicator files are used, the indicator series that the program uses to estimate the parameters of the model, in comma separated format.

   c. The filtered and smoothed states from the Kalman filter, in comma separated values format.

   d. The specification test regression outputs.

5) An optional file that contains the Kalman filters described in the section "The Kalman Filter and Smoother" above.

6) A file of parameter estimates in machine code (not displayable in an ASCII editor), for use by future versions of the software.

The first five files are in text format and can be viewed in any text editor or spreadsheet program.

Command Syntax

The following notation is used to describe the syntax of the commands.

ABC	All items in uppercase are required. The spelling, but not the case, must match exactly.
abc	Italics represent a generic value that you replace with a specific value.
[abc]	The item ***abc*** is optional.
{abc}	The item ***abc*** may be repeated zero or more times.
"abc"	The characters ***abc*** are required.
a|b|c	One of ***a***, ***b***, or ***c*** may be specified.
a::=b	The item ***a*** is defined in terms of ***b***.

Notes:

1) Commands begin with a command name and end with a semicolon. The only exception is a comment, which is not really a command.
2) Most commands (the exception is the NORMDATE command) consist of one or more fields. Each field consists of a field name, followed by an equals sign, followed by an object consisting of one or more values. These fields can appear in any order.
3) Commands are not case sensitive, except for the object of the NAME field in the STATE and MEASUREMENT commands.
4) Commands may appear in any order, but it is recommended that the FILE command should come first, with the first field specifying the LOG file.

COMMENT

"*" *comment*

comment ::= any sequence of characters on a single line.

Example:

    * This is a comment

Notes:

1) The "*" must appear in the first column of a line. The entire line is a comment.
2) Comments can appear anywhere in the command file.

FILE command

FILE { LOG | INDEX | OPT | PARAMS | DEBUG | FILTER "=" *filespecification* } ";"

filespecification ::= a valid Windows file specification, optionally in quotes, including a filename, and optional extension, drive, and path. If the specification includes spaces, it must be enclosed in quotation marks.

Example:

```
file  log=c:\temp\log.txt  index="c:\temp\index.txt";
```

Notes:

1) This command specifies the output files of the model. It is recommended that the first command in the command file specify the log file, which is where error messages will appear. Before a log file is specified, all messages to be logged go to a file named "logtemp.txt".

2) The LOG file also contains the dynamic and cumulative weights on the measurement series, and a specification test. The INDEX file contains the integrated, retrended, normalized state that forms the economic index estimated by the model. The OPT file contains the estimated coefficients, standard errors, and t-statistics. The PARAMS file contains the estimated coefficients in machine format. This file maintains precision for updating the index, and will be used in future versions. The DEBUG file contains miscellaneous information useful for debugging. The FILTER file contains the estimated Kalman filters.

3) All files except FILTER are required. They can be supplied in a single FILE command, or in several FILE commands.

STATE command

STATE NAME "=" *name* [[ARI "=" *indicator_list*] [ARP "=" *parameter_list*]]
[[MAI "=" *indicator_list*] [MAP "=" *parameter_list*]]
[TYPE "=" LOGDIFFERENCED | DIFFERENCED] ";"

name ::= a case-sensitive string of alphabetic and numeric characters.

indicator_list ::= a list of zeros and ones, separated by commas or blanks.

parameter_list ::= a list of real numbers, separated by commas or blanks. Scientific (exponential) notation is not allowed.

Example:

```
state  name=c  ari=1,1  arp=.5,0;
```

Notes:

1) This command specifies the structure of the state equation. The state is modeled as a linear, stationary, zero mean, autoregressive stochastic process.

2) The name is used to form names for the parameters of the model. The autoregressive parameter names are formed from the supplied name by adding "ar#" as a suffix, where "#" is a digit indicating the order of the autoregressive parameter. The moving average parameter names are formed from the supplied name by adding "ma#" as a suffix, where "#" is a digit indicating the order of the moving average parameter.

3) The optional ARI and MAI indicator lists serve to set the autoregressive and moving average orders, respectively, of the state equation. A one means that the corresponding lag is present; a zero that it is not. The last item in each list must be a one. If the autoregressive order is zero, omit the ARI and ARP fields. If the moving average order is zero, omit the MAI and MAP fields.

4) The ARP parameter list initializes the autoregressive parameters, $\phi_1, \phi_2, \cdots$ in equation (6) above, corresponding to the ARI list of indicators. Specify a zero in the ARP list if the corresponding ARI element is zero. The MAP parameter list initializes the moving average parameters, $q_1, q_2, \cdots$ in equation (9) above, corresponding to the MAI list of indicators. Specify a zero in the MAP list if the corresponding MAI element is zero. The example indicates a second order autoregressive process, where the coefficient on the first order term is initialized to .5 and the coefficient on the second order term is initialized to zero.

5) On the indicator and parameter fields in the STATE and MEASUREMENT commands: The ARI, MAI, and SI indicator fields are used to indicate which parameters are present in a specification; and the ARP, MAP, and SP parameter fields are used to initialize these parameters. If an indicator field is present but its corresponding parameter field is not, the parameters implied by the indicator field are initialized to default values. These are zeros for autoregressive and moving average parameters, and ones for indicated state parameters. If a parameter field is present but its corresponding indicator field is not, the indicator field is implicity set to ones.

6) The TYPE field indicates the type of the transformation applied to the state of the economy to yield the Δc of equations (1) and (3). LOGDIFFERENCED indicates that Δc is the first difference of the log of the state, while DIFFERENCED indicates that Δc is the first difference of the state. This field is optional. If it is omitted, the default of LOGDIFFERENCED is assumed.

MEASUREMENT command

MEASUREMENT NAME “=” *name* [FREQUENCY "=" *frequency*]
[SI “=” *indicator_list*] [SP “=” *parameter_list*]
[[ARI “=” *indicator_list*] [ARP “=” *parameter_list*]]
[[MAI “=” *indicator_list*] [MAP “=” *parameter_list*]] STD “=” *real_number*
[TRANSFORM “=” *transformation*] FILE “=” *filespecification*
[IFILE "=" *filespecification*] “;”

frequency ::= M | Q | A, which specify monthly, quarterly, and annual frequencies respectively.

real_number ::= a real number. Scientific (exponential) notation is not allowed.

transformation ::= D | DLN

Example:

```
measurement name=UN si=1,1,1 sp=-.4,-.1,0 ari=0,1 arp=0,.2 std=.7 transform=d
file="e:\temp\input\paun.txt";
```

Notes:

1) This command specifies the structure of a measurement equation, where the dependent variable is an observed indicator that is a linear function of the latent state and one or more lags of the state, plus an autoregressive, zero mean, disturbance.

2) The frequency field is optional. If it is omitted, monthly is assumed.

3) Not all measurement commands have to specify the same frequency. Mixed frequencies are allowed. However, in this version of the software, the only combination of mixed frequencies allowed is monthly and quarterly.

4) The name is used to form names for the parameters of the model. The names for the state coefficient parameters are formed from the supplied name by prefixing the name with “b” and suffixing the name with “#”, where “#” is a digit indicating the lag on the state. The parameter name for the standard deviation of the disturbance is formed by prefixing the name with “s”. The autoregressive parameter names are formed from the supplied name by prefixing the name with “ar” and suffixing the name with “#”, where “#” is a digit indicating the order of the autoregressive parameter. The moving average parameter names are formed from the supplied name by prefixing the name with “ma” and suffixing the name with “#”, where “#” is a digit indicating the order of the moving average parameter.

5) The ARI indicator list serves to set the autoregressive order of the disturbance, and the ARP parameter list initializes the corresponding parameters $d_{g1}, d_{g2}, \cdots$, of equation (5b). Similarly, the MAI indicator list serves to set the moving average order of the disturbance, and the MAP parameter list initializes the corresponding parameters $p_{g1}, p_{g2}, \cdots$, of equation (8b). In the example, the

disturbance is specified to be a second order autoregressive process, where the coefficient on the first order term is constrained to be zero (unusual, but this example illustrates how to implement such a constraint), and the coefficient on the second order term is initialized at .2.

6) The SI indicator list specifies the way in which the state enters the measurement equation, and the SP parameter list initializes the coefficients on the state variables $\gamma_{g0}, \gamma_{g1}, \cdots$, of equation (4b). In the example, the state enters contemporaneously, and with lags of one and two periods. The coefficient on the contemporaneous term is initialized to -.4, the coefficient on the first order lag is initialized to -.1, and the coefficient on the second order lag is initialized at zero. In this example, the indicator is assumed to move in the opposite direction of the state.

7) The STD field initializes the standard deviation of the disturbance term, σ_g, of equation (7).

8) The TRANSFORM field specifies the transformation, if any, to be applied to the indicator data series after it is read from the specified file. Two transformations are allowed, a first-difference, "d", and a first difference of a natural logarithm, "dln".

9) The FILE field supplies the location of the data for the series being modeled in the measurement equation.

10) The optional IFILE field supplies the location of the indicator data series.

ESTPERIOD command

ESTPERIOD [BEGIN "=" *date*] [END "=" *date*] ";"

date ::= a date in mm/dd/yyyy or mm/dd/yy format, optionally enclosed in quotes, where "mm", "dd", and "yy" are digits indicating the month, day, and year respectively. No spaces are allowed in the date. "mm" and "dd" may be expressed as single digits.

Example:

```
estperiod begin=1/1/78 end=12/1/97;
```

Notes:

1) This command indicates the observations over which the coefficients of the model are estimated.

2) A date indicates the beginning of the period in question. For example, for a quarterly model, indicate the 4^{th} quarter of 1995 by "10/1/95". Since the highest frequency of data for this version is monthly, the day, "dd", should always be "1".

3) This command is optional. If not supplied, the most observations possible, given by the intersection of the date ranges of the data, will be used.

STDPERIOD command

STDPERIOD [BEGIN "=" *date*] [END "=" *date*] ";"

Example:

stdperiod begin="1/1/78" end="8/1/97";

Notes:

1) This command indicates the observations over which the mean and standard deviation of the (transformed) data are calculated. These in turn are used to normalize the data for identification, and also to "denormalize" the state in its transformation to an economic index.

2) A date indicates the beginning of the period in question. For example, for a quarterly model, indicate the 4^{th} quarter of 1995 by "10/1/95". Since the highest frequency of data for this version is monthly, the day, "dd", should always be "1".

3) This command is optional. If not supplied, the most observations possible, given by the intersection of the date ranges of the data, will be used.

NORMDATE command

NORMDATE *date* ";"

Example:

normdate 7/1/92;

Notes:

1) The resultant economic index will be normalized at 100 at the specified date. A date indicates the beginning of the period in question. For example, for a quarterly model, indicate the 4^{th} quarter of 1995 by "10/1/95". Since the highest frequency of data for this version is monthly, the day, "dd", should always be "1".

2) This command is optional. If not supplied, a normalization date of July 1992 will be used.

FILTERED command

FILTERED ";"

Example:

filtered;

Notes:

1) This command instructs the application to construct the economic index using the filtered state rather than the smoothed state. If this command is omitted, the smoothed state, which is the default, is used. Therefore only include this command if you want to use the filtered, instead of the smoothed, state.

DEBUG command

DEBUG ";"

Example:

debug;

Notes:

1) This command turns the debugger on for the likelihood function evaluation. This command produces massive amounts of output to the OPT file, and is only recommended if the software fails to report an initial function value or stops in the first iteration. Furthermore, the output produced may be meaningless unless you are familiar with both the numerical maximization procedure used in this software and the Kalman filter recursion of the state space model.

Technical Support

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This software is new and is likely to have remaining bugs in addition to "features". Comments and suggestions are welcome.

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January 19, 2004