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MODLER Seasonal Adjustment Routines

Seasonal Adjustment of Weekly Frequency Data

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Technical Support

Europe

Alphametrix Limited
Heath House
Princes Mews
Royston, Herts SG8 9RT
United Kingdom

Tel: +44 (0) 1763 242 277
Fax: +44 (0) 1763 243 988
Email: Support@modler.com

North America and Elsewhere

Alphametrix Corporation
PO Box 2566
Bala Cynwyd, PA 19004-6566
USA

Tel: +1 (215) 252-9271
Fax: +1 (215) 252-9279
Email: Support@modler.com

Introduction

The weekly data frequency seasonal adjustment program described in this document was designed and written by William Cleveland of the research staff of the Board of Governors of the Federal Reserve System. It was modified for use with the MODLER and DataView software packages by Benjamin Gord.

In common with the methodology adopted for other seasonal adjustment procedures, particularly the Census X-11 monthly and quarterly frequency packages, this weekly program operates as a side-by-side utility in the MODLER context and is automatically “called” as needed. That is, it operates in conjunction with the MODLER and DataView packages, being invoked as a sub-task, rather than being embedded in these packages as an integrated component. This method of operation will be almost transparent to you as you work, inasmuch as the command syntax and program response has been incorporated into the common MODLER family program interface in such a way that the software linkages are entirely implicit. But particularly when you install the software or make changes to the installation, it can be important to realize that the seasonal adjustment routines actually exist as separate executables. The filename for the weekly seasonal adjustment component is MODSAWK.EXE.

As a matter of software design, there are at least two ways to incorporate particular functionality into a multi-function software package. One way is to write new code that implements the relevant algorithms as part of the integral code of the package. An alternative, which is particularly attractive when these algorithms have previously been embodied in a separate single-purpose program, is simply to link the programs dynamically. The program changes required are then limited to those that relate directly to program control, specifically the way in which the subordinate program is invoked and the results transferred. This type of dynamic linking avoids the need to rewrite the original time-tested code and at the same time minimizes the possibility that new “bugs” will be introduced.

It is long-standing policy to make as few changes as possible to the seasonal adjustment programs distributed with the MODLER and DataView packages. This policy was instituted first for the Census X-11 monthly and quarterly frequency packages, which for the past nearly 40 years have been widely used both by individual researchers and government statistical agencies. Even under the best of circumstances, re-writing the algorithms of any program can lead to operational changes, including “bugs,” with the result that the re-written program may not replicate the results that would be obtained on the same machine using the original. But, in addition, in the case of the Census X-11 packages, there is the issue of familiarity: the long form output consists of many familiar tables that although dated in appearance are nevertheless an essential part of the program from many peoples’ perspective. The result of effectively retaining the original code is to almost entirely remove the learning curve for long-time users.

MODSAWK

Weekly Frequency Seasonal Adjustment Program

As indicated earlier, MODSAWK, the MODLER-compatible version of the Federal Reserve Board's weekly seasonal adjustment program, operates as a side-by-side utility. As needed, it is automatically called by any of the major MODLER programs whenever you execute the appropriate command. The only particular requirement that relates to its manner of operation is that you keep MODSAWK.EXE located either on the execution directory or in the path. This requirement is described further in the appendix, which explains the installation process.

Once MODSAWK.EXE has been properly installed on your machine, weekly frequency seasonal adjustment can be invoked from the main menu simply by clicking the menu choice **Data|Seasonal Adjustment** *provided* that the default observation frequency has been set to true weekly. In this case, the form shown just below will be displayed. You need only to fill in the blanks and make your choice of the various options. The Help button provides context-sensitive assistance.

The screenshot shows a Windows-style dialog box titled "Weekly Seasonal Adjustment Facility". The dialog is divided into several sections:

- Data Series:** Contains two text input fields labeled "Resulting Series:" and "Original Series:". To the right of the "Resulting Series:" field is a checkbox labeled "Save Seasonal Factors".
- Options:** Contains a group box with two radio buttons: "Multiplicative" (selected) and "Additive". To the right are two numeric input fields: "Upper Sigma Limit" (value: 2.5) and "Annual Cyclical Patterns" (value: 3). Below these are two more numeric input fields: "Monthly Cyclical Patterns" (value: 0) and a "Send Output to Printer" checkbox.
- Supplementary Tables:** Contains two dropdown menus labeled "Printer" and "Disk File", both currently set to "None".
- Weighting Options:** A list of specific day adjustments with checkboxes: "April Tax Deadline" (unchecked), "Christmas" (checked), "Easter" (checked), "February Holiday" (checked), "Independence Day" (checked), "Labor Day" (checked), "Memorial Day" (checked), "New Year's Day" (checked), "Thanksgiving Day" (checked), and "Alternate Day Weight Pattern" (unchecked).

At the bottom of the dialog are five buttons: "Index", "Find", "OK", "Cancel", and "Help".

As an alternative to using this dialogue form, you can instead issue an explicit command. This command can be issued interactively or it can be placed in the context of a macro, thus potentially

allowing a number of series to be seasonally adjusted as a group. The most basic form of the SEASonal Adjustment command is:

adjname = SEAS(unadjname)

In response to this command, the unadjusted series (denoted “unadjname”) will be retrieved, by name, from an open data bank or the Memory File. The new, adjusted series (denoted “adjname”) once computed will in turn be stored automatically either in the Memory File or a data bank open for update (if any). As indicated, the currently set frequency must of course be weekly for weekly seasonal adjustment to take place.

This action is part of a MODLER or DataView general procedure: whenever you issue a SEAS command explicitly or by clicking the relevant menu item or icon button, the program will attempt to invoke one of the seasonal adjustment programs, which one depending upon the frequency currently set.

Brief Description of Method

An essential characteristics of MODSAWK is that it is specifically designed to be used with so-called *true weekly* frequency time series data. This orientation determines the particular seasonal adjustment methodology, for it implies that the number of weeks per year will vary from year to year. As you can quickly determine, dividing 365 by 7 yields 52 with a remainder of 1. Similarly, dividing 366 by 7 yields 52 with a remainder of 2. In the case of an ordinary year, the day of the week the year begins on (the day of the week that is January 1st) occurs 53 times that year. In the case of a leap year, the days of the week that are January 1st and 2nd each occur 53 times that year. True weekly frequency data are defined by (centered on) a particularly day of the week and, as a consequence, for those years in which that day of the week begins the year (or, in the case of a leap year, is the second day of the year) there are 53 observations. In other years, there are 52 observations. Because of this variability, it is not appropriate when using true weekly data either to model regular seasonal patterns with simple dummy variables in the context of an ordinary regression, or to specify the trend cycle as a moving average of fixed length.

MODSAWK uses implicitly constructed seasonality variables and sinusoidal regression methods. It operates by first constructing a regression design matrix incorporating dummy variables to isolate various holiday effects as well as variables referencing points along sine and cosine curves intended to isolate various kinds of regular seasonal patterns in the data. The regular seasonal components of the data are viewed as points of these functions at regular time intervals that are independent of the fundamental period of the functions. Like other seasonal adjustment methods, MODSAWK also takes into account the effect of outliers, but this complicating aspect will be ignored initially.

The regression design matrix is composed of three types of variables to capture seasonal effects. The first kind of seasonal variable is represented by a set of dummy variables that are used to capture the effects of any or all the nine separate holidays, or otherwise special days, that are listed

in the menu-invoked command form displayed above. Each point in the pattern represents the weight to be given to the corresponding week-defining day in relation to the position of the special day. A default weight pattern can be used to model this or the pattern can be specified by the user, as indicated by the checkbox in right-most section of the form. The weight in each dummy variable vector for a given week is the sum of all elements in the weight patterns related to that week. For example, given a weight pattern with 5 elements of (1.0,1.0,1.0,1.0,1.0) where the 4th weight corresponds to the special day itself, if that day falls on a Thursday and the data are “Friday” data then a weight of 4 is given to the week containing the special day and a weight of 1 is given to the following week. As you will see above, the special days and holidays MODSAWK takes into account are Christmas, Easter, the February holiday (Presidents’ day), Independence day (July 4th), Labor Day, Memorial Day, New Year, Thanksgiving, and the April tax deadline date. The default is to construct dummy variables for all these days, except the April tax deadline, with weight pattern of (0.0,1.0,0.0) so that each dummy variable contains 1.0 for weeks in which the holiday occurs and 0.0 elsewhere.

The second kind of seasonal variable in the design matrix is intended to account for annual cyclical patterns. These patterns are represented by pairs of columns of points along sine and cosine functions. When you use the above form, the number in the text box labeled “Annual Cycle Patterns” specifies the number of such pairs of columns (corresponding to parameter S in the extended command syntax, described below). If, say, N pairs are specified, then the regression model contains one pair of sine and cosine curves for each associated frequency per year, 1,2,...,N. The annual seasonal component is then the sum of the individual sine and cosine patterns weighted by the regression coefficients corresponding to those individual patterns. The default is 3 pairs of sine and cosine curves.

At your option, MODSAWK can also be used to determine monthly patterns in the same way since the number of weeks changes from month to month as well. The third kind of seasonal variable thus accounts for monthly cyclical patterns. MODSAWK models these monthly patterns in the same way as the annual except that the common period of the individual patterns is a month rather than a year. The default is 0 pairs of sine and cosine curves, as shown in the midsection of the form displayed above: the textbox labeled “Monthly Cyclical Patterns.”

Finally, as mentioned earlier, in addition to the seasonal variables, dummy variables are constructed to take outliers into account. Outliers are defined to be observations farther than the upper sigma limit number of standard deviations away from the linearly detrended series. As shown, the default upper sigma limit is 2.5.

Once the design matrix is defined, regression coefficients are computed using Ordinary Least Squares methods in conjunction with the constructed variables. If the adjustment is multiplicative, which is the default, the log of the original series is regressed on the several types of seasonal variables just described. The seasonal factors are thereby computed as the variability of the original series explained by as many as three kinds of seasonal component variables—that is, the sum of the seasonal variables weighted by their regression coefficients.

The seasonally adjusted series is computed by subtracting the seasonal factors from the original series. If the adjustment is multiplicative, the exponential operator is applied to the seasonally

adjusted series and the seasonal factors. Subtracting the log of the seasonal factors from the log of the original series is of course equivalent to dividing the original series by the seasonal factors.

Two sets of results are reported. First, standard Analysis of Variance measures are provided for the entire set of regression variables: Sum of squares, mean square, and adjusted R-square. Second, an F-test is performed to test the significance of the seasonal parameters to determine whether seasonality is present in the data. Specifically, the test performed is a likelihood ratio test with null hypothesis of jointly zero coefficients of the holiday, annual, and monthly seasonal regression variables. The significance level is predetermined at one percent. The value of the test statistic is compared with the critical value at the one percent level given the degrees of freedom. Rejection of the null hypothesis implies significant seasonal patterns in the data represented by some or all the seasonal variables.

MODSAWK allows for a great deal of variation in the choice of a model of seasonality. The user may wish to do some experimentation by choosing different numbers of annual or monthly seasonal patterns or different combinations of holidays and holiday weight patterns and then compare the adjusted R-square values or plots of the resulting series.

Command Language

Basic Command Syntax

As shown earlier, the most basic form of the SEASonal Adjustment command is:

adjname = SEAS(unadjname)

where:

adjname - name to be given to the seasonally adjusted series

unadjname - name of the original, unadjusted series

Note that this command has the syntactic characteristics of a function, with an associated argument in parentheses. You must always identify by name both the original unadjusted series and the adjusted. These must be legal series names, beginning with an alphabetic character and containing one to twelve characters, no blanks, and no inadmissible non-alphabetic characters. Note also that these must be simple series; neither may be an expression. Furthermore, the SEAS function cannot be used in any mathematical, statistical, relational, or logical function.

The unadjusted series will *not* be affected by the seasonal adjustment process. Moreover, it will automatically be retrieved from an open Memory File or Data Bank. In contrast, the adjusted series will be stored either in the Memory File or a Data Bank. As usual, the choice between these will

be made on the basis of whether or not the master program is in UPDATE mode. You have the same storage options and capabilities with the MODSAWK results as with other transformations.

Extended Command Syntax

MODSAWK also allows you to control the particulars of the way in which the seasonal adjustment is performed--such as choosing between additive and multiplicative adjustment--and to gain access to the decomposition of the series--such as the seasonal and nonseasonal components of the series. These and other options are invoked using additional arguments. In general, the augmented seasonal adjustment command is:

adjname=SEAS(unadjname,opt1,opt2,....,optn)

where opt1,opt2,....,optn are the selected options, separated by commas. Note, in particular, that the options must *follow* the name of the original, unadjusted series.

The options are:

- S# Sets the number of annual seasonal patterns or frequencies. That is, pairs of columns of sine and cosine curves in the regression design matrix (default = 3). See the description of method below for further information. Where # is a non-negative integer number.
- M# Sets the number of monthly cyclical patterns (default = 0). Where # is a non-negative integer number.
- A Specifies Additive seasonal adjustment. The default is multiplicative.
- Hx Specifies holidays to adjust for, where x is one of the following:
 - 1 Easter
 - 2 Labor Day
 - 3 New Year
 - 4 Memorial Day
 - 5 Christmas
 - 6 Independence Day
 - 7 February holiday
 - 8 Thanksgiving
 - 9 April taxes
 - A All holidays
 - blank No holidays

Multiple days may be specified. The default is H1 through H8

- W Allows user to specify from the keyboard alternative holiday weight patterns (default is 0.0,1.0,0.0)
- O Allows user to specify alternative upper sigma limit for outliers. (default = 2.5)
- F Specifies that the seasonal factors of the original series is to be returned and given the label S_adjname (if adjname is longer than 10 characters, only the first 10 are used). Alternatively, the option can be written F:name to give this series the label "name".
- G# Specifies the number of periods the seasonal factors are to be projected (default = 52). Where # is an integer number.
- P Sends program output to the printer rather than to the screen.

The combination of options are limited only by the restriction that the number of regression variables be less than or equal to 75. That is:

of outliers + # of annual seasonal frequencies x 2 + # of monthly frequencies x 2 + # Holidays

must be equal or less than 75.

Examples:

SGNP=SEAS(GNP,A,H)

Invokes additive seasonal adjustment model with no holiday adjustment, returning adjusted series as SGNP.

SGNP=SEAS(GNP,H1,H3,H6)

Invokes multiplicative seasonal adjustment model taking into account only Easter, New Year, and Independence Day.

SGNP=SEAS(GNP,S5,M2,HA)

Invokes multiplicative seasonal adjustment model with 5 annual and 2 monthly seasonal frequencies and adjusting for all holiday effects.

SGNP=SEAS(GNP,A,W,F:FGNP)

Invokes additive seasonal adjustment model with an alternative holiday weight pattern, returning the seasonal factors as series FGNP. Alternative weight pattern is asked for after command is given.

`SGNP=SEAS(GNP,O,G104)`

Invokes additive seasonal adjustment model with alternative upper sigma limit and forward factors to be forecasted for 104 weeks rather than 52. Alternative upper sigma limit is asked for once command is given.

Appendix: Installation of the Software

The MODSAWK side-by-side program described in this document should normally be loaded after the main program or programs used to call it. In this case, you should already have on your hard disk a directory called:

`\MODLER`

or

`\MODWIN`

Furthermore, this directory should be included in the PATH, usually by the execution of a PATH command located in the AUTOEXEC.BAT file. If you are using DOS applications, for information on setting up the PATH command see your PC or MS-DOS Reference Manual. If you use Windows as your operating system, Windows automatically sets the default path to include the \Windows and \Windows\System directories (in the case of NT, \WinNT and \WinNT\System or \WinNT32 and \WinNT32\System), but you can also either configure AUTOEXEC.BAT to include an appropriate Path statement or else run WINSET, to do effectively the same thing.

Assuming that you have a directory called \MODLER, before attempting to load the program described in this document, you should first transfer control to that directory, using a command of the form:

```
CD \MODLER
```

Then insert the diskette containing the programs into your A: drive (assuming that this is your floppy disk drive) and type:

```
COPY A:*.*
```

This diskette will be labeled MODSAWK Seasonal Adjustment Program and this copy command will load its entire contents into the MODLER directory. Once the MODSAWK program has been loaded in this way, provided that you have properly set up your path command, you can forget all about it; it will automatically be used as needed.

However, do not be befuddled by science. MODSAWK consists only of a single file, MODSAWK.EXE. This file should be copied either to the same directory as the MODLER or DataView executable or to a directory in the path. Nothing more is involved.

Execution Errors

Generally speaking, any errors that occur will be trapped within the seasonal adjustment program and will cause an error message to be printed. However, there are one or two errors that indicate your operating system's inability to locate a program for execution, such as:

Bad Command or file name

These message may indicate that you have not correctly specified the Path. To verify the Path setting, type:

PATH

Alternatively, the message indicate that the seasonal adjustment program is not resident in the \MODLER directory or that the name of the program has for some reason been changed. All the MODLER family programs that offer the capability to seasonally adjust series expect for the quarterly seasonal adjustment program to be called MODX11Q.EXE, the monthly seasonal adjustment program to be called MODX11M.EXE, and the weekly seasonal adjustment program to be called MODSAWK.EXE.