Update on the Development of X-13ARIMA-SEATS

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Abstract

This paper provides an update to Monsell (2007) to give details of new features found in the current prototype of X-13ARIMA-SEATS, a seasonal adjustment program that allows the user to produce either an X-11 or a SEATS seasonal adjustment. These features include expanded options for generating spectral diagnostics, improved model-based seasonal adjustment diagnostics, an AICC based test for length of month regressors, a new regressor for end-of-month stock Easter based on Findley (2009), a technique for specifying groupings for user defined holiday regressors, and a new regression testing procedure based on the chi-square statistic for determining if regression groups should be included in the regARIMA model.

Key Words: RegARIMA models; stock holiday models; spectral diagnostics; likelihood diagnostics; model based signal extraction.

Disclaimer

This report is released to inform interested parties of ongoing research and to encourage discussion of work in progress. Any views expressed on statistical, methodological, technical, or operational issues are those of the author and not necessarily those of the U.S. Census Bureau.

1. Introduction

Monsell (2007) gave a description of an ongoing collaboration between the U. S. Census Bureau and the developers of the SEATS seasonal adjustment procedure to produce a program that would allow users to generate X-11 and SEATS seasonal adjustments using the same interface and to compare these seasonal adjustments using a common set of diagnostics. For more details on the SEATS seasonal adjustment method, see Maravall (1995), Gómez and Maravall (1996), Gómez and Maravall (2001a), and Gómez and Maravall (2001b).

This paper will document new features and developments for this software. For an overview of the features of X-13ARIMA-SEATS, the reader is referred to Section 1 of Monsell (2007).

2. The spectrum spec

In X-12-ARIMA, options related to generating spectral plots are spread among several input specifications - global spectral options could be specified in the `series` and `composite` specs, while the `series`, `composite`, `x11` and `check` specs are used to control the printing and saving of individual spectral plots.

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In the current version of X-13ARIMA-SEATS, the global spectrum options and control of the tables related to the spectrum plots are now contained in a separate `spectrum` spec. This is an optional spec; spectral plots are still part of the default printout, regardless of whether the spectrum spec is specified or not. The plots actually generated by the program depend on the options specified within the spec file; if no regARIMA model is specified, the program will not produce a spectrum of the model residuals.

Table 1 shows sample X-12-ARIMA and X-13ARIMA-SEATS input files, with the same spectral options in each: setting a starting date for the spectrum, saving spectral peak information in the log file, and saving several spectrums in separate files.

Table 1: X-12-ARIMA and X-13A-S input specification files with options related to the spectrum

```
series{                            series{
  title= "Shoe store sales"          title= "Shoe store sales"
  format="datevalue"                 format="datevalue"
  file="shoe.dat"                    file="shoe.dat"
  name="shoe"                        name="shoe"
  spectrumstart = 1995.jan         }
  savelog = peaks                  arima {
  save = sp0                         model = (0 1 1)(0 1 1)
}                                  }
arima {                            regression {
  model = (0 1 1)(0 1 1)             variables = (td easter[8])
}                                    save = td
regression {                       }
  variables = (td easter[8])       check {   }
  save = td                        outlier {   }
}                                  forecast {
check { save = spr }                 maxlead = 24
outlier {   }                      }
forecast {                         x11 {   }
  maxlead = 24                     spectrum{
}                                    savelog = peaks
x11 {                                start = 1995.jan
  save = ( sp1 sp2 )                 save = (sp0 sp1 sp2 spr )
}                                  }
```

Note that some arguments have different names - for example, `spectrumstart` is now `start` within the `spectrum` spec. A conversion utility is available to convert old X-12-ARIMA spec files into the new format.

2.1 New options

There are a few new arguments to the spectrum spec; a summary is given below in Table 2.

Table 2: New arguments for the `spectrum` spec

Name	Description of argument
`altfreq`	Specifies whether an alternate set of trading day frequencies for quarterly series identified in Ladiray (2008) are used (`altfreq=yes`). The default value is (`altfreq=no`).
`decibel`	Controls whether or not the spectral estimates are expressed in terms of decibels (`decibels=yes`), which is the default.
`olsar`	Specify how the AR-coefficients that generate the autoregressive spectral estimates are generated, either by OLS regression (`olsreg=yes`) or the Yule=Walker equations (`olsreg=no`). The default value is (`olsreg=no`).

The first is `altfreq`, which specifies whether an alternate set of trading day frequencies for quarterly series identified in Ladiray (2008) are used. Setting `altfreq = yes` will utilize these new frequencies when searching for trading day peaks in quarterly data. The default is to use the frequencies from X-12-ARIMA.

Another new argument is `decibel`, which controls how the spectral estimates are expressed in the plots.

The default spectrum estimator is an autoregressive spectral estimator. For the series x_t whose spectrum is being estimated from data $x_1, \ldots, x_N$, autoregressive spectrum estimates (in decibel units) have the form

$$\hat{s}(\lambda) = 10 \log_{10} \left\{ \frac{\hat{\sigma}_m^2}{2\pi \left| 1 - \sum_{j=1}^m \hat{\phi}_j e^{i2\pi j\lambda} \right|^2} \right\}, 0 \leq \lambda \leq 0.5, \tag{1}$$

where the coefficient estimates $\hat{\phi}_j$ are those of the linear regression of $x_t - \bar{x}$ on $x_{t-j} - \bar{x}$, $1 \leq j \leq m$ for the data, with $\bar{x} = N^{-1} \sum_{t=1}^N x_t$, and where $\hat{\sigma}_m^2$ is the sample variance of the resulting regression residuals. The order m of the AR polynomial is set to be $30 \times \frac{Sp}{12}$, where Sp is the frequency of the time series (12 for monthly series, 4 for quarterly series, etc.).

By default, the spectral estimates are expressed in terms of decibel units (`decibel = yes`), as shown in equation (1) above. Users can also have the estimates plotted on the untransformed scale (`decibel = no`).

Users can also specify how the AR-coefficients that generate the autoregressive spectral estimates are generated using the `olsreg` argument. Users can choose between using ordinary least squares (`olsar = yes`) or using the estimation method based on the Yule-Walker equations (`olsar = no`). The program currently uses the Yule-Walker equations by default.

In addition, X-13ARIMA-SEATS handles the choice of whether to perform differencing on the original series or seasonally adjusted series before the spectrum is estimated differently than in X-12-ARIMA. This differencing is done to suppress the trend's effect on the lower spectral frequencies so that it will be easier to identify seasonal or trading day residual effects.

In the X-12-ARIMA program, the `diffspectrum` argument controls whether the program performs a first difference. In X-13ARIMA-SEATS, this is now the `difference` argument. By default, X-13ARIMA-SEATS uses the order of differencing for the ARIMA model to determine what level of differencing should be applied to the original series and the seasonally adjusted series.

If d is the order of regular differencing and D is the order of seasonal differencing, the program will use a $max(d + D - 1, 1)$ difference. If no ARIMA model is fit to the series, a first difference is done by default.

An additional option has been included for this argument (`difference = first`) to allow users to duplicate the functionality of X-12-ARIMA.

3. New regression variables and options

X-13ARIMA-SEATS has several new regressors and some new options for testing and evaluating regression effects. One regressor not mentioned here which is not currently found in X-12-ARIMA is the seasonal outlier regressor, a full description of which can be found in Monsell (2007).

3.1 Stock calendar regressors

As mentioned in Monsell (2007), X-13ARIMA-SEATS provides a simplified model for trading day variation of monthly or quarterly flow series that uses only one regressor, a weekday-weekend contrast variable:

$$TD(t) = N_t^{WD} - \frac{5}{2}(N_t^{SS}) \tag{2}$$

where N_t^{WD} is the number of weekdays in month/quarter t and N_t^{SS} is the number of Saturdays and Sundays in month/quarter t. The underlying assumption for this constraint is that all weekdays (Monday through Friday) have identical effects, and Saturday and Sunday have identical effects. This regressor originally appeared in the TRAMO modeling software - see Gómez and Maravall (2001b).

Cleveland and Grupe (1983), Bell (1984), and Bell (1995) developed regressors that could be used to estimate trading day effects for inventory series. For a given integer value w assumed to be the day of the month when inventory is taken, these regressors are defined as

$$
I_{1,t} = \begin{cases} 1 & \tilde{w}^{\text{th}} \text{ day of month } t \text{ is a Monday} \\ -1 & \tilde{w}^{\text{th}} \text{ day of month } t \text{ is a Sunday} \\ 0 & \text{otherwise} \end{cases},
$$
$$\tag{3}$$
$$
\cdots, \quad I_{6,t} = \begin{cases} 1 & \tilde{w}^{\text{th}} \text{ day of month } t \text{ is a Saturday} \\ -1 & \tilde{w}^{\text{th}} \text{ day of month } t \text{ is a Sunday} \\ 0 & \text{otherwise} \end{cases},
$$

where $\tilde{w}$ is the smaller of w and the length of month t; $w = 31$ assumes that inventory is taken at the end of the month.

Findley and Monsell (2009) shows how flow day-of-week constraints like the one used to generate the regressors in equation (2) can be imposed upon the stock trading day model,

and shows that a constrained stock trading day regressor based on the constraints in equation (2) can be generated from the regressors in equation (3):

$$D_t = -\frac{3}{5}I_{1,t} - \frac{1}{5}I_{2,t} + \frac{1}{5}I_{3,t} + \frac{3}{5}I_{4,t} + I_{5,t} \tag{4}$$

Findley and Monsell (2009) also gives the results of applying these regressors to a set of end-of-month inventory series, showing the constrained stock trading day regressors of (4) are preferred more often than the conventional stock trading day shown in (3). For this reason, the one-parameter stock trading day regressor has been incorporated into X-13ARIMA-SEATS (`tdstock1coef[d]`, where d is the stock day); there are plans to incorporate this feature into TRAMO as well. Users can specify this regressor in the `regression` spec; an example is shown in Table 3.

Another stock calendar regressor more recently implemented in X-13ARIMA-SEATS is an end-of-month Easter regressor (`easterstock[w]`). For stock series, the view of stock series as accumulations of monthly flows can be used to derive holiday regressors for end of month stock series from cumulative sums of holiday regressors for flow series.

Let $E(w)_{m,y}^{flow}$ denote the deseasonalized `Easter[w]` regressor for a monthly flow series derived for month m and year y. The end of month stock Easter regressor $E_{m,y}^{stock}$ had the following formula:

$$E(w)_{m,y}^{stock} = \begin{cases} 0, & \text{for } m = 1 \\ E(w)_{2,y}^{flow}, & \text{for } m = 2 \\ E(w)_{2,y}^{flow} + E(w)_{3,y}^{flow}, & \text{for } m = 3 \\ 0, & \text{for } 4 \leq m \leq 12. \end{cases}$$

When $1 \leq w \leq 21$, $E(w)_{m,y}^{flow}$ is zero in February, so $E(w)_{m,y}^{stock}$ is nonzero only in March.

See Findley (2009) for more details on moving holiday regressors for stock series and an application for manufacturing inventory series and Titova and Monsell (2009) for results of an empirical study on detecting these calendar regressors on a larger set of Census Bureau inventory series.

A spec file specifying such a regressor is given in Table 3; note that the stock day w must be specified as with the current stock trading day regressor. It is recommended that the stock day (i.e., the day that inventory is assumed to be taken) utilized for the Easter and trading day regressors be the same. X-13ARIMA-SEATS only has the end-of-month Easter regressor implemented at this time. There is a separate utility called **Genhol** that will generate stock Easter regressors for different stock days; this utility is available from the Census Bureau web site.

3.2 Temporary level shift regressors

X-13ARIMA-SEATS has a test for temporary level changes that can be specified in the `outlier` spec. *T*-statistics are computed to test the null hypotheses that each run of successive level shifts (up to a value set by the `lsrun` argument of the outlier spec) cancels to form a temporary level shift. The *t*-statistics are computed as the sum of the estimated parameters for the level shifts in each run divided by the appropriate standard error, see Otto and Bell (1993). An example of this test taken from X-13ARIMA-SEATS output is given in Table 4.

```
series{
   title= "Shoe store inventories"
   format="datevalue"
   file="invshoe.dat"
   name="invshoe"
   }
transform {  function = log  }
arima { model = (0 1 1)(0 1 1) }
regression {
# specify 1 coef. stock TD  and end of month stock easter
   variables = (  tdstock1coef[31]  stockeaster[8]  )
   aictest = ( td easter )
   save = td
   }
check {  }
outlier {  }
forecast {  maxlead = 24  }
```

Previously, if a temporary level shift was suspected, there were two options available to the user: (a) create a user defined regressor for the effect, or (b) specify a series of AO outliers for the span of data covered by the temporary level shift.

X-13ARIMA-SEATS now has a temporary level shift regressor as one of the predefined regressors. This will allow users to potentially simplify their regression models by specifying one temporary level shift regressor rather than two or more LS or AO outlier regressors.

Let $TL_t^{(t_0, t_1)}$ be a temporary level shift regressor at time t, where the level change spans from observation t_0 to t_1. The regressor can be formed as follows:

Table 4: Temporary Level Shift test from X-13A-S output of M120000

```
 Tests for Cancellation of Level Shifts
  Dates of LS Sets   Span t-value
  ------------------------------
  1996.Jun+1996.Oct     4    -0.71
```

$$TL_t^{(t_0,t_1)} = \begin{cases} 0 & \text{for } t \le t_0 \\ 1 & \text{for } t_0 < t < t_1 \\ 0 & \text{for } t \ge t_1 \end{cases}$$

This outlier can only be specified in the `variables` argument of the `regression` spec; it cannot be automatically identified in the `outlier` spec. Table 5 shows how the temporary level shift can be specified in an X-13ARIMA-SEATS input file and how it can replace two LS outlier regressors.

Table 5: Input specification files with and without temporary level shift regressors

```
series{                              series{
  title= "Import m12000"               title= "Import m12000"
  format="datevalue"                   format="datevalue"
  file="m12000.dat"                    file="m12000.dat"
  name="m12000"   }                    name="m12000" }
arima {                              arima {
  model = (0 1 1)(0 1 1)               model = (0 1 1)(0 1 1)
}                                    }
regression {                         regression {
  variables = (                        variables = (
   LS1996.Jun                           TL1996.Jun-1996.Sep
   LS1996.Oct                           TC1999.Apr
   TC1999.Apr                          )
  )                                  }
}                                    check {   }
check {   }                          outlier {   }
outlier {   }                        forecast {
forecast {                             maxlead = 24
  maxlead = 24                       }
}
```

3.3 User-defined holiday regression groups

X-13ARIMA-SEATS has built in regressors for three moving holidays with important effects for U. S. economic series. Other moving holidays (for example, Chinese New Year or Ramadan) need to be incorporated into regARIMA models with user-defined regression variables. Users can incorporate their own holiday effects into regARIMA models estimated by X-13ARIMA-SEATS.

However, if a user wishes to incorporate more than one moving holiday into their reg-ARIMA model, previous versions of X-12-ARIMA and X-13ARIMA-SEATS would refer

to this combined effect as one holiday. The combined effect could be tested as a whole, but the individual moving holidays could not be specified separately.

The current version of X-13ARIMA-SEATS allows users to specify up to five groups of user-defined holiday regressors. These groups are listed separately in the program output, and diagnostics such as the chi-square statistic are generated for the groups separately, so users can determine if a particular effect can be removed.

Table 6 shows how to specify the user-defined regression group within the regression spec. Note that this is only implemented for holiday regressors at this time.

Table 6: `Regression` spec with user-defined regression groups specified

```
regression {
   variables = (  AO1995.Sep AO1997.Jan AO1997.Feb  )
   user=(
      Beforecny       Betweencny       Aftercny
      Beforemoon      Betweenmoon      Aftermoon
      Beforemidfall   Betweenmidfall   Aftermidfall
   )
   file="u1u2u3.dat"
   format="datevalue"
   start=1991.1
   usertype=(
      holiday     holiday     holiday
      holiday2    holiday2    holiday2
      holiday3    holiday3    holiday3
   )
   chi2test = yes
     savelog = chi2test
}
```

3.3.1 Chi-square test for user-defined holiday regressors

When this type of user-defined regressor is specified, the `chi2test` argument of the `regression` spec can be used to check if groups of user-defined holiday regressors should be kept in the regARIMA model. When `chi2test = yes`, chi-squared statistics will be generated for all user-defined holiday regression groups, and those which are not significant (given by the argument `chi2testcv`) are removed from the regARIMA model.

With $\hat{\beta}$ denoting the estimated coefficients vector of the vector of the group's regressors, the chi-square test statistic is given below:

$$\hat{\chi}^2 = \hat{\beta}' \left[Var(\hat{\beta})^{-1} \right] \hat{\beta}. \tag{5}$$

Table 6 shows how to specify groups of user-defined holiday regressors for payments made to child care workers in Taiwan. Holiday regressors are specified for Chinese New Year, the Moon Festival, and the Mid Fall Festival. Table 7 shows the X-13ARIMA-SEATS output for the regression part of the regARIMA model. Here the regression groups for the different moving holidays are separated into three groups, making it easier to determine the significance of the individual groups.

Table 7: Regression output from using X-13A-S spec file given in Table 6

```
 Regression Model
 ------------------------------------------------------------------
                                Parameter         Standard
 Variable                        Estimate            Error    t-value
 ------------------------------------------------------------------
 AO1995.Sep                        0.0905          0.01991       4.55
 AO1997.Jan                       -0.2660          0.01722     -15.45
 AO1997.Feb                        0.2759          0.01694      16.28

 User-defined Holiday
   Beforecny                       0.5877          0.01459      40.28
   Betweencny                      0.0346          0.02112       1.64
   Aftercny                       -0.0148          0.02277      -0.65

 User-defined Holiday Group 2
   Beforemoon                     -0.0335          0.01098      -3.05
   Betweenmoon                     0.2891          0.03474       8.32
   Aftermoon                      -0.0059          0.01427      -0.41

 User-defined Holiday Group 3
   Beforemidfall                   0.1738          0.04236       4.10
   Betweenmidfall                  0.0638          0.01878       3.40
   Aftermidfall                   -0.0184          0.01170      -1.58
 ------------------------------------------------------------------
```

In this example, the chi-squared test is used to determine which of the groups are significant. The X-13ARIMA-SEATS output for the example given in Table 6 is given in Table 8. Note that all regression groups are very significant - all the regression groups will be kept in the regARIMA model. Users can set the significance level for this test using `chi2testcv`. This can be important when doing tests on multiple groups of moving holidays on a large group of series.

3.4 AICC test for length-of-month or length-of-quarter regressors

X-12-ARIMA has long had an automated test based on AICC (Akaike's Information Criterion, bias Corrected); the formula for AICC is given below:

Table 8: Chi-squared Tests for user-defined groups of regressors from using X-13A-S spec file given in Table 6

```
Chi-squared Tests for Groups of Regressors
------------------------------------------------------------------
 Regression Effect                 df      Chi-Square      P-Value
------------------------------------------------------------------
User-defined Holiday                3        7807.00         0.00
User-defined Holiday Group 2        3          84.79         0.00
User-defined Holiday Group 3        3         166.77         0.00
All User-defined Regressors         9        8066.38         0.00
------------------------------------------------------------------
```

$$AICC_N = -2L_N + 2n_p \left(1 - \frac{n_p + 1}{N} \right)^{-1}. \tag{6}$$

The `aictest` argument of the `regression` spec tests for the presence of trading day, Easter, and user-defined regression effects by estimating models with and without the target regressor and choosing the model with the lowest AICC.

In X-13ARIMA-SEATS, the length of month, length of quarter, and leap year regressors have been added to the regressors that can be specified by the `aictest` argument. The sequence in which regressors are tested is

1. trading day regressors;

2. length of month, length of quarter, or leap year regressors;

3. Easter regressors;

4. user-defined regressors.

It should be mentioned that regressors specified by the `aictest` argument must not conflict with other regressors specified either in the `variables` and the `aictest` arguments. For example, the following `regression` spec is incorrectly specified, as the `td` and `lpyear` arguments cannot be specified together in the `variables` argument:

```
regression{
   variables = td
   aictest = lpyear
}
```

Using `tdnolpyear` instead would allow a model with the 6 trading day regressors and the length-of-month regressors. In addition, users should not specify `aictest = lom` for series that are not monthly series, or `aictest = loq` for series that are not quarterly.

If trading day and leap year regressors are specified for the same regARIMA model, then the program will test the trading day and leap year regressors together if `aictest = td` is specified, or will test the sets of regressors separately if `aictest = (td lpyear)` is specified.

Roberts, Holan, and Monsell (2009) uses this test to determine whether length of month regressors should be used with country-specific trading day regressors.

4. Other changes to the software

4.1 Model-based F-statistic for the presence of a stable component of seasonality

A recent addition to the set of diagnostics included in the X-13ARIMA-SEATS software is a model-based F-statistic for determining if there is stable seasonality in the original series.

This F-test is generated from the chi-square test of groups of regressors which was already present in earlier versions of the X-12-ARIMA and X-13ARIMA-SEATS software, which is used to determine if a particular group of regression parameters in the regARIMA model is collectively zero.

One such group of predefined regressors is the fixed seasonal regressors. This type of regressor can be expressed in two ways: monthly (or quarterly) indicator variables or a trigonometric representation of a fixed monthly pattern. More details on these regressors can be found in Census (2007).

When these regression terms are included in the regARIMA model, the chi-square test of the seasonal regressors is produced, and serves as an indication of the stable seasonality in the series.

The chi square test of the seasonal regressors is corrected to account for the error in the estimation of the innovation variance by using the test statistic $\tilde{\chi}^2/k$, generated as follows:

$$\frac{\tilde{\chi}^2}{k} = \frac{\hat{\chi}^2}{k} \times \frac{n-d-k}{n-d} \tag{7}$$

where $\hat{\chi}^2$ is the chi-squared statistic from (5), n is the number of observations in the series, d is the degree of differencing, and k is the number of regressors for the group being tested in (5). The test statistic in (7) follows an $F_{k,n-d-k}$ distribution.

Table 9 shows the X-13ARIMA-SEATS output for the Chi-Squared and F-tests for the stable seasonal regressors. Note that the F-test is not produced if seasonal regressors are not specified in the regARIMA model.

Lytras, Feldpausch, and Bell (2007) compared the performance of the $\tilde{\chi}^2/k$ statistic to several tests for stable seasonality that are commonly used by seasonal adjustors but whose statistical properties are unknown. The simulation studies examined led the authors to recommend the use of the $\tilde{\chi}^2/k$ statistic over more traditional diagnostics found in X-12-ARIMA. A series with no stable component of seasonality is usually excluded from consideration for seasonal adjustment.

4.2 Log-Normal adjustment of forecasts

A new argument in the `forecast` spec, `lognormal`, allows the user to make an adjustment to the forecasts generated by the user's regARIMA model when a log transformation is specified to reflect that the forecasts are generated from a log-normal distribution (`lognormal = yes`).

Table 9: Chi-squared and F-tests for seasonal regressors

```
Chi-squared Tests for Groups of Regressors
------------------------------------------------------------
Regression Effect              df      Chi-Square      P-Value
------------------------------------------------------------
Seasonal                       11          73.76         0.00
------------------------------------------------------------


F Tests for Seasonal Regressors
------------------------------------------------------------
Regression Effect              df      F-statistic     P-Value
------------------------------------------------------------
Seasonal                    11, 114          6.12         0.00
------------------------------------------------------------
```

As the mean of a log-normal distribution is known to be

$$E(X) = e^{\mu + \sigma^2/2},$$

the forecast on the original units of measure is given as

$$e^{y_{t+i|t} + \sigma_i^2},$$

where $y_{t+i|t}$ is the i-step ahead forecast at time t and σ_i is the standard error of the i-step ahead forecast. The default is to produce forecasts without this correction.

4.3   Improved program performance

The performance of the X-13ARIMA-SEATS program has been improved in two areas.

Restructuring how the SEATS routines are run to generate estimates for the sliding spans and history diagnostics has increased the speed of generating stability diagnostics for model-based seasonal adjustments. Testing has shown that the software is now generating history diagnostics for SEATS seasonal adjustments about 9 times faster than with previous version of X-13ARIMA-SEATS.

Also, making some corrections in the difference identification procedure of the `automdl` spec greatly improved the performance of the program in identifying ARIMA models, substantially reducing convergence problems within the automatic model identification procedure. Extensive testing with simulated series has improved the error handling of this routine as well.

5. Future research and implementation

Currently, work is proceeding to create accessible HTML output for the X-13ARIMA-SEATS software. Rather than create a separate utility, as was done with X-12-ARIMA,

HTML generating routines from SEATS will be used to render the SEATS output accessible, and will be used within the output from the old X-12-ARIMA program as much as possible. New Fortran routines will be developed to generate other HTML output.

In addition, we will attempt to incorporate enhancements from the most recent version of SEATS, as well as research in developing model based seasonal adjustment diagnostics based on goodness-of-fit tests which take model uncertainty into account, see Blakely and McElroy (2009).

There is a release date set for December 1. If the HTML output is not ready by then, another build of X-12-ARIMA will be released, and the official release of X-13ARIMA-SEATS will be pushed back to 2010.

6. Acknowledgments

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