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Getting Started with Win X-12, A Windows interface for X-12-ARIMA Version 0.3

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Before running X-12-ARIMA (or X-12 for short), you must have your data in a form that X-12 can read, and you must create an input specifications file (or "spec file"). This document will explain the basics of X-12 data formats, writing a spec file, and running X-12 with Win X-12.

We assume that the reader has already installed the Windows Interface to X-12-ARIMA. It is available at http://www.census.gov/srd/www/winx12/winx12_down.html. Download and installation instructions are available on the above page and at <http://www.census.gov/srd/www/winx12/winx12doc.html>. This interface allows you to run X-12-ARIMA, and it can also create basic input files for you, as we will discuss below. You will find more details about X-12-ARIMA and spec files in the *X-12-ARIMA Reference Manual* (US Census Bureau, 2009) and the "X-12-ARIMA Quick Reference" (US Census Bureau, 2009). The documentation for Win X-12 is on the web at <http://www.census.gov/srd/www/winx12/winx12doc.html> (Lytras, 2009).

We will also assume the reader has a general understanding of time series, ARIMA modeling, and the basic concepts of seasonal adjustment. For basic information on ARIMA time series modeling and basic seasonal adjustment, see Makridakis, Wheelwright, and Hyndman (1998). For detailed information on the X-11/X-12 method for seasonal adjustment, see Ladiray and Quenneville (2001). For information about new features in X-12-ARIMA, see Findley, Monsell, Bell, Otto and Chen (1998). For a more advanced treatment of ARIMA time series modeling and time series analysis, see Box, Jenkins, and Riensel (1994) or Brockwell and Davis (2002).

This document is organized into the following topics:

1. X-12-ARIMA Data Formats
2. X-12-ARIMA Input Files
3. Running X-12-ARIMA with Win X-12
4. Output Overview
5. Composite Spec
6. Other X-12-ARIMA Specs

1. X-12-ARIMA Data Formats

You have several options when deciding on a format for the data. One option is to type the data directly into the input file. We'll cover this later in the document in Section 2. However, we recommend keeping the data in a separate text file. There are several predefined formats available in X-12. We'll review the datevalue format, free format, X-11 formats, and the X12save format. (There are also formats for reading files from the program TRAMO/SEATS and from valid FORTRAN formats, but we won't discuss those in this paper.)

X-12 can't read data from spreadsheet programs like Excel. If your data is stored in a spreadsheet program, then you will need to ask the program to output the data to a text file or cut and paste into a text file.

1.1 Datevalue Format

For most series, using the datevalue format is the best approach. The date is stored along with the value, and this format is very easy to use and to read. This format can be particularly useful if you have your data stored in columns in a spreadsheet. With the datevalue format, only one series can be stored in each separate data file.

The datevalue format is the year, a tab or space, the month/quarter, a tab or space, and then the value for the series.

Example— Datevalue Format, selected dates only

1998 1	97.5
1998 2	102.5
1998 3	118.6
1998 4	109.0
1998 5	105.1
1998 6	112.3
1998 7	113.1
1998 8	95.6
1998 9	100.7
1998 10	101.5
1998 11	98.4
1998 12	97.7
1999 1	98.7

1.2 Free Format

Free format means that the data are entered with either tabs or spaces separating the numbers. Only the data is in the file. Additional information, like dates, is not allowed. As before, only one series can be stored in each separate data file.

1.3 X-11 Formats

X-11 formats are a family of formats, four of which are

- 1L – one line per year with label and year on left,
- 2L – two lines per year with label and year on left,
- 1R – one line per year with year and label on right, and
- 2R – two lines per year with year and label on right.

The advantage of X-11 formats is that the data have labels, so you can have more than one series inside a data file, with different series having different labels. The labels can be at most 6 characters long, and are left justified.

The disadvantage of using X-11 formats is that if you have series with real zero values at the beginning or end of the series, X-11 formats can be difficult to work with because they treat zeros at the beginning or end of the series as "zero filled."

The data are stored in 6 or 12 character fields, depending on whether one or two lines per year is used. Only the final two digits of the year are used to denote the year of the observations. By default, X-12 assumes that any year read from an X-11 format that is less than or equal to 45 occurs in the 21st century; otherwise, the year is assumed to occur in the 20th century.

Example—The end of a Sample '1L' file

NECOND02	961	864	1071	1123	1059	1140	1076	1055	1068	1139	1049	1074
NECOND03	922	873	1126	1074	1094	1252	1165	1171	1097	1208	1118	1134
NECOND04	1078	985	1259	1290	1419	1363	1397	1466	1243	1336	1417	1416
NECOND05	1304	1196	1374	1435	1491	1505	1538	1554	1290	1500	1462	1419
NECOND06	1423	1358	1526	1755	1803	1761	1811	1716	1567	1772	1652	1701
NECOND07	1620	1496	1842	1918	1993	1903	1999	1915	1868	2069	1747	1907
NECOND08	1660	1736	2150	2157	2125	2199	2146	2096	2079	2152	2056	2104
NECOND09	1918	2006	2317	2458	2499	2360	2227	2289	2176	2358		

Example—Part of a Sample '2L' Data File with the end of one series and the beginning of another series

MWTOT 06	494699	500582	526215	540324	575886	534965
	516057	565268	577409	621912	565056	496747
MWTOT 07	558286	566271	609662	630206	636660	601691
	573106	612178	668663	704814	646872	587746
MWTOT 08	593201	628169	709245	688366	681078	664887
	536477	603478	642580	660612	622998	562297
MWTOT 09	577816	613525	714613	674296	671250	0
	0	0	0	0	0	0
MW1FAM64	8254.0	11552.0	16806.0	23947.0	24616.0	26846.0
	21784.0	24397.0	20949.0	22082.0	15055.0	10402.0
MW1FAM65	5743.0	6764.0	15291.0	23819.0	26452.0	26702.0
	26935.0	20726.0	18136.0	22935.0	17014.0	15935.0
MW1FAM66	6165.0	9189.0	18859.0	26328.0	21790.0	21299.0
	17373.0	20229.0	15110.0	14112.0	10546.0	8323.0

Note: The end of the series is zero-filled. By default, the zeros at the beginning or end of the series are ignored.

Example—The end of a Sample 'IR' file

961	864	1071	1123	1059	1140	1076	1055	1068	1139	1049	107402NECOND
922	873	1126	1074	1094	1252	1165	1171	1097	1208	1118	113403NECOND
1078	985	1259	1290	1419	1363	1397	1466	1243	1336	1417	141604NECOND
1304	1196	1374	1435	1491	1505	1538	1554	1290	1500	1462	141905NECOND
1423	1358	1526	1755	1803	1761	1811	1716	1567	1772	1652	170106NECOND
1620	1496	1842	1918	1993	1903	1999	1915	1868	2069	1747	190707NECOND
1660	1736	2150	2157	2125	2199	2146	2096	2079	2152	2056	210408NECOND
1918	2006	2317	2458	2499	2360	2227	2289	2176	2358		09NECOND

1.4 X12save Format

The X12save format is the format of files that are saved by X-12. The data are in two columns, date and value, separated with a tab with a two line header at the top of the file.

Example—X12save Format, selected dates only

date	MWTOT.a1
-----	-----
199601	+0.4946990000000000E+04
199602	+0.5005820000000000E+04
199603	+0.5262150000000000E+04
199604	+0.5403240000000000E+04
199605	+0.5758860000000000E+04
199606	+0.5349650000000000E+04

2. X-12-ARIMA Input Specification Files

Once you have the data, the next step is to write the input files. There are two basic types of input files, the input specification file (also called a spec file) and the metafile. We will discuss spec files first.

Each input spec file is made up of functional units called specs. Each spec inside the spec file controls options for a specific function. For example, the **series** spec controls options for data input, and the **arima** spec controls options to specify the ARIMA model. There are 18 different specs that you can use in a spec file. We will discuss all of them to some extent in this document.

Before we begin, let's discuss the general formats for dates in the specification file. Dates are in the form *yyyy.mm* or *yyyy.q* format where *yyyy* is the four-digit year, *mm* is the two-digit month (for monthly series) and *q* is the quarter (for quarterly series). For monthly series, the period can be the first three letters of the name of the month, or the number of the month. For quarterly series, the period is the number of the quarter. So January of 1990 can be written as 1990.1 or 1990.jan (also 1990.01 or 1990.Jan or 1990.JAN). First quarter 1990 is written as 1990.1.

2.1. Creating Basic Spec Files

The spec file is a text file used to specify program options. One way to create a spec file is to write one with a text editing program, like Notepad, and save the file with a file extension of .spc and not .txt.

RULE – The name of the spec file must end with a ".spc" file extension.
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However, the simplest way to create spec files for your data is with the interface. The instructions for creating spec files are given in the documentation (See Lytras, 2009), but we will review the most useful options below.

Step 1. Open the Win X-12 program.

Step 2. In the menu on the top bar, click Create → Spec file. This will open the “Create New Spec File” Window.

Step 3. On the data tab, we will specify the data file and the name for the spec file.

- Select the radio button for “Create individual spec files for each series.”
- In the box labeled as “Data file or data metafile,” enter the full filename of the data file. You can also use the Browse button to select the filename from a pop-up window.
- Once you have a data file entered, a spec file name will appear in the box labeled as “Name of new spec file.” You may change this name if you wish.

Note: By default, Win X-12 will create the spec file in the same folder/directory as the data file. If you change the location of the spec file to another directory (or plan to move the file to another directory in the future), you should check the box labeled “Include the full path of the data file in the spec.” If the two files are in the same directory, the full path names are unnecessary. (I usually leave out the path name so that if I send the spec file and data file to someone, my folder name won’t be in the path name.)

Step 4. Check the “Spec file options” at the bottom of the data tab.

- Enter a title for the series. Though titles are optional, they are useful and highly recommended. The title will be shown in the log file, the output file, and as secondary titles for graphs in X-12-Graph.
- Select the format of the data file. If you select free format, then you will also need to enter the start date for the data. If you select a FORTRAN format (1L, 1R, etc.), then you will also need to enter a name. The name must match exactly with the label in the data file; it is case sensitive.
- Select the period: “12” for monthly data, “4” for quarterly data, and “1” for annual data.
- The span and modelspan options set the time intervals used. The span statement sets the interval for the seasonal adjustment, and the modelspan statement sets the interval used for the RegARIMA models. We will discuss these options more in Section 2.2.3 below.

Step 5. On the prior adjustments tab, we will specify the transformation, regression, and automatic outlier options.

- For the transformation, you can select either “log” or “none” if you know what transformation you need. Otherwise, you can select “auto” and leave the box checked for “Hard-code transformation.”
- For the regression section, we can select known regression effects or have X-12 test for these effects and add them if they are present. If you know what predefined regression variables you need, then you can select them in the regression variables section. To have X-12 test for the effects, check the boxes for both TD (trading day) and Easter in the “AIC Test” section and leave the box checked for “Hard-code AIC results.”

Note: By default, the trading day test will be for a six-coefficient trading day variable for a flow (sales) series. If you have an inventory/stock series, then check the box labeled “This is a stock series” above the options for the AIC test. By default, the AIC test for Easter will test for a 1-, 8-, or 15-day Easter effect.

- For the outlier test, we can ask X-12 to test for additive outliers, level shifts, and temporary change outliers. Check the AO, LS, or TC box to search for each type you need and leave the box checked for “Hard-code outliers.” Note: The LSrun option has X-12 test for the cancellation of successive level shifts. A value of “2” is usually sufficient. You can also have X-12 test for outliers in only a specific interval as given in the span start and span end, with dates in the general data formats (either *yyyy.mm* or *yyyy.q*).

Step 6. On the ARIMA model tab, if you know the ARIMA model you need, you can select “Use ARIMA model specified” and enter the model in the box labeled “ARIMA model.” Otherwise, you can select “Select model automatically” and leave the box checked for “Hard-code automodel selection.” This allows X-12 to select an ARIMA model and write the results in the spec file.

Optional: You may also want to change the length of the forecasts here. We usually select the option “Half filter length.”

Step 7. On the Seasonal Adjustment tab, select “x11” as the type of adjustment. Select “Hard-code Global MSR” under x11 filter options.

If the series is part of an aggregate, you can select an option here. We will discuss aggregate series in Section 5 below.

Optional: You can ask for the sliding span diagnostic and history diagnostic on this screen.

Step 8. Click on the “Create Spec” at the bottom of the menu to create the spec file. Win X-12 will run X-12-ARIMA once, gather the results, and write a spec file based on the results from the first run.

Note: If you already have a spec file with that name, Win X-12 will ask if you want to overwrite the file or assign a new name to the file you are creating.

2.2 Reading Spec Files

Now that you have a spec file, you can open this file easily inside the interface by highlighting the file name in the top center box and right-clicking to select “View Input File” or by select “View” from the top menu.

2.3 General Syntax

You can enter input in upper, lower, or mixed case. **Note:** If you have a “name” argument to give a name to a label in your data file, then the name needs to match exactly with the label, including the case.

As discussed above, dates are in the form *yyyy.period*. Character values, such as titles and file names, should be enclosed in quotes. X-12 treats everything after a “#” as a comment.

You can set a variety of arguments within each spec. If you have more than one value for an argument, you must enclose all values in parentheses. If an argument is not specified, X-12 usually assumes a

default value. X-12 only performs the functions you specify (or that are implied by other specs). You can enter the arguments in any order.

Every spec begins with the name of the spec and a left curly bracket, "{". After all the arguments for the spec, close the spec with a right curly bracket, "}".

Example—General Input Syntax

```
specname{
  argument1 = value
  argument2 = ( value1 value2 value3 )
  argument3 = 'A string value'
  argument4 = 2000.apr
}
# This is a comment.
# It is not executed.
```

2.4 Components the Spec File Created by Win X-12

series – The main function is to specify the location and format of the data. This is a very important spec and has several options that depend on the form of the data. We will cover this spec in detail in the next section.

RULE – The series spec comes first. All other specs can be in any order.

transform – The most common function for the transform spec is to specify a data transformation. The most common choices are either **function=log** or **function=none**, and the most common transformation for seasonal adjustment is the log transformation. In the case of no transformation, you will need the **mode=add** in the x11 spec to tell X-12 you want an additive adjustment. Leaving out this spec can cause several different things to happen depending on what other specs you have in the spec file, therefore, it is recommended that you include this spec for every series.

regression – Specifies the regression components of a regARIMA model: trading day effect, holiday effects, and outliers. Leaving out the regression spec means you don't have any regression variables in your regARIMA model (with the possible exception of outlier variables from the outlier spec). In the example above, X-12 selected a trading day effect and one point outlier (or AO, additive outlier) at January 1990.

Note: The **aictest** argument has been commented out, but if you would like to test for regression effects, you can add it back to the spec file. This argument tells X-12 to do an AIC test to test for the presence of regression effects. If you know you don't have Easter effects, you can test only for may want to change the argument to **aictest=td**. If you have an inventory series, you may want to change the argument to **aictest=(tdstock Easter)** or **aictest=tdstock**. The argument **savelog=aictest** has also been commented out. If we do the AIC test, then this command tells X-12 to save the results to the log file.

outlier – Automatic outlier identification procedure for point outliers, level changes, and temporary change outliers. No arguments are required, but then, by default, X-12-ARIMA identifies only point outliers and level shifts. To identify all three types of outliers, the spec file has **types=all**. The

argument **lsrun=2** tests to see if level shifts that are identified cancel each other out. Leaving out this spec means there will be no automatic outlier identification.

arima – Specifies the ARIMA part of a regARIMA model. The notation is from Box-Jenkins, where the model is specified as $(p\ d\ q)(P\ D\ Q)$. Leaving out this spec will result in a model of $(0\ 0\ 0)(0\ 0\ 0)$, and this could cause several problems for seasonal series, especially if you are trying to forecast or do outlier detection.

forecast – Generates forecasts from the estimated regARIMA model. Without a forecast spec, in the presence of a regARIMA model and an x11 spec, X-12 will forecast one year ahead if there is an arima model. The argument **maxlead=42** tells X-12 to forecast 42 months ahead. This is half of the filter length of the 3x5 filters specified in the x11 spec.

estimate – Estimates model specified in regression and arima specs. This spec is not required. If you specify a regARIMA model, X-12 will estimate the model even without the estimate spec.

check – An optional diagnostic spec that generates diagnostics for the fit of the estimated regARIMA model. To see all the diagnostics available in with the check spec, we have added the argument **print=all**. The argument **savelog=(lbq nrm)** asks X-12 to print the Ljung-Box Q statistics and the normality diagnostics to the log file. Leaving out this spec has no effect on the model or model estimates, but X-12 doesn't print out some diagnostics to the output file.

x11 – Generates the seasonal adjustment using X-11 seasonal adjustment methods and filters. No arguments are required unless you omit the transform spec and use a regARIMA model, and in that case, you will need the argument **mode=add** for an additive decomposition. Without an x11 spec, you will not get a seasonally adjusted series.

slidingspans – An optional diagnostic spec that generates sliding spans analysis, a seasonal adjustment stability diagnostic. No arguments are required, but the spec file above requests diagnostics to be sent to the log file with the command **savelog=percent**. The command **additivesa=percent** is useful for additive adjustments and has no effect on multiplicative adjustments.

history – An optional diagnostic spec that generates "historical" analysis of seasonal adjustment estimates and/or regARIMA model forecast performance. With **estimates=(fcst aic sadj sadjchng trend trendchng)** we have asked for estimates of the revisions of the forecast errors, AIC diagnostics, the seasonally adjusted series, the month-to-month percent changes of the seasonally adjusted series, the trend, and the month-to-month percent changes of the trend. (For additive adjustments, instead of a percent change, the program calculates differences.) If you don't specify any arguments, you will get estimates for the seasonally adjusted series by default. The command **savelog=(asa ach atr atc)** requests that diagnostics be sent to the log file.

2.5 Details for the Series Spec

As mentioned above, the main function of the series spec is to provide the time series data to X-12. Therefore, you are required to have either a file statement or a data statement. The file statement gives the name of an external data file. The data statement lists the data inside the spec file. Again, if you have a series spec, it must be the first spec listed.

2.5.1 Data Argument

Since the data argument is easy to use, we will start with that.

Example — Data Argument

```
series {
  data=( 88.0  97.7 102.5  96.9 101.1 102.7  93.6  87.0
        92.1  89.3 103.9 131.0  78.0  93.0  80.6 109.0
        91.3 118.0 113.8  88.9 117.4 122.1 112.3 126.6
        100.8 98.6 114.9 113.6 103.1 112.9 109.8  86.7
        94.4  97.8 119.4 104.9 107.8  89.4 105.4 117.2
        95.0 115.3 112.3  82.4 109.6 113.9 127.6 125.3 )
  start = 1980.1
  period = 4
}
```

There is no set format for the data argument. In the example above, we have two years of a quarterly series on each line.

RULE – With the data argument, a start date is required. X-12-ARIMA will compute the rest of the dates for the series based on the start date.

2.5.2 File Argument

Data entered directly in the series spec can be hard to update. Another way to provide data to X-12 is with the file statement. There are several predefined formats available, discussed above in Section 1.

If you want the series to start at a point later than the start date of the file, see the span argument below.

2.5.2.1 Datevalue and X12save Formats

Recall that both datevalue and X12save formats include dates, so a start argument isn't required. Labels aren't allowed inside the data file, so a name argument isn't required either.

Example — File Statement with X12save Format

```
series{ file = 'MWTOT.a1'    format = 'x12save' }
```

2.5.2.2 Free Format

The default format for the file statement is free format. Recall that only the data is in the file and additional information, like dates and labels, is not allowed.

RULE – With a free formatted file, a start date is required. X-12-ARIMA will compute the rest of the dates for the series based on the start date.

Example—File Statement with Free Format Data

```
series{ file='example5.dat'
  start = 1982.jan }
```

2.5.2.3 X11 Formats

Recall that the advantage of X-11 formats is that you can have labels inside the data file so that you can have more than one series inside a data file. Because X-11 formats include dates, a start argument isn't required.

RULE – When using a X-11 format, a name statement is required to identify the series in the data file. This is one place where X-12-ARIMA is case sensitive. The value of the name argument and the label in the data file must match exactly.

Example—File Statement with 2L formatted data

```
series{
  file = 'test2L.dat'    format = '2L'
  name = 'MWTOT'
  title = 'Midwest Total Housing Starts'
}
```

2.5.2.4 Other Useful Series Options

name – As we've seen already, the name argument is required with X-11 formats. It is also used in other places as a short name for the series, so it may be useful even if you use a format other than an X-11 format.

period – The frequency of the series. The default is 12 (a monthly series), so this argument isn't required unless you have a quarterly series, and then you must have **period=4**.

RULE – For quarterly series, you must have **period=4** in the series spec.

title – Title statements are useful and highly recommended. They are used by the log file, the output file, and as secondary titles for graphs in X-12-Graph.

decimals – The number of decimals shown in the printed output file, except for tables that contain percentages or ratios. The default is 0 – no decimals. (Tables with percentages/ratios with display either 1 or 2 decimals, depending on the table.) This argument does not affect the format of files produced by the save command. See Section 5 below for more information on saving files.

span – Sets the time interval for the data used for seasonal adjustment

modelspan – Sets the time interval for the data used for modeling

The forms of the arguments are **span=(startdate, enddate)** and **modelspan=(startdate, enddate)**. By leaving the end date blank, you can set only the start date: (yyyy.period,). Or you can set only the end date: (, yyyy.period). Or you can set both: (yyyy.period, yyyy.period). The default span for seasonal adjustment is the entire series. The default span for modeling is the interval in the span argument.

2.6 Creating Metafiles

Besides running the series one at a time, you can also run X-12-ARIMA in "multi-series" or batch mode. Running in multi-series mode can save some typing. It also provides an easier way to look at the diagnostics since the diagnostics from all the series are written to the same log file. You can also use X-

12 to compute aggregates of many series. For example, if you have data for the four regions of the United States, you can use X-12-ARIMA to compute the aggregate for the United States.

To run more than one series with one call to X-12, you can create a metafile. The metafile is a text file with the extension .mta with a list of the input specification files you want to run.

RULE – A metafile must end with the .mta extension.

To create metafiles using the interface, select Create → Metafile from the top menu. To create a basic metafile that is simply a list of the files you want to run, select the names of the spec files you want in the file, type a name for the metafile, and click on the “Create metafile” button.

Win X-12 can also create metafiles for aggregate series. Details on computing aggregates for composite series are found in Section 5 below.

3. Running X-12-ARIMA with Win X-12

Once we have an X-12-ARIMA input file, we can run X-12-ARIMA.

To run a single spec file, double click on the name of the file (from the middle box), or select your spec file and click on the Run button. The output files will be listed in the box on the right. The main output file has an .out extension with the name of the file matching the name of your spec file (without the .spc extension). Double click on the output files to open them in the editor.

If you want to run X-12 and not overwrite previous output, you can direct the output to another file by checking the “New name for spec output” box under Options. Then enter the name of the alternate output file name in the box.

To run in batch mode, double click on the name of the metafile, or select the metafile and click on the Run button. X-12-ARIMA will run all the spec files listed inside the metafile.

For example, say that the contents of starts.mta is

```
nehs
mwhs
sohs
wehs
```

Then X-12 will run the input files nehs.spc, mwhs.spc, sohs.spc, and wehs.spc. The output files will be named nehs.out, mwhs.out, sohs.out, and wehs.out. The log file will be named starts.log.

To produce graphics output in Win X-12, check the box labeled “Run in graphics mode,” and then type the name of your graphics directory in the box. The directory name provided must

- be a complete path for the operating system (for example, c:\graphics, not \graphics),
- already exist, and
- be a different directory from the directory used for the output file to avoid filename conflicts.

To collect the diagnostics, check the box labeled “Run in graphics mode” or “Create summary file with diagnostics information,” and then check the box labeled “Diagnostics” on the right.

For more information on graphs and diagnostics, please see the paper “Getting Started with X-12-ARIMA Diagnostics.” (Hood and McDonald-Johnson, 2010)

4. Output Overview

4.1 Screen Errors, Warnings, and Notes

Error messages, warnings, and notes are sent to the screen by default. The messages on the screen are a very important part of the X-12 output. The example below (using a spec file named `civ.spc`) shows what a screen message looks like for a series with no errors or warnings.

Example—Screen Output for a series with no errors or warnings

```
X-12-ARIMA Seasonal Adjustment Program
Version Number 0.3  Build 188
Execution began Apr 23, 2010  16.06.27

  Reading input spec file from civ.spc
  Storing any program output into civ.out
  Storing any program error messages into civ.err

Execution complete for civ.spc
```

If you run in batch mode, then the screen output lists all the series in the metafile. The next example shows a run from a metafile and also shows an error message. In the example, the message tells us that we’re trying to do a multiplicative adjustment (and take the logs) of a series with zero values. For this series, we know that there should be only positive values, so we know that the problem is in the data file. If, however, the series really did contain zeroes, then we could change the input specification file, `mwlfam.spc`, and set **function=none** in the transform spec to fix the problem.

Example—Screen Output for a metafile, with an error message

X-12-ARIMA Seasonal Adjustment Program

Version Number 0.3 Build 188

Execution began Apr 23, 2010 15.45.18

Reading input metafile from MW.mta

Reading input spec file from mwlfam.spc

Storing any program output into mwlfam.out

Storing any program error messages into mwlfam.err

ERROR: Multiplicative or log-additive seasonal adjustment cannot be done with a series with zero or negative values.

No seasonal adjustment this run

****Correct input and rerun mwlfam.spc****

Check error file mwlfam.err

Reading input spec file from mwtot.spc

Storing any program output into mwtot.out

Storing any program error messages into mwtot.err

Execution complete for mwtot.spc

NOTE: Correct input errors in the order they are detected since the first one or two may be responsible for the others (especially if there are errors in the SERIES or COMPOSITE spec).

Check MW.log to see which input files defined in MW.mta were terminated due to errors.

A very common warning message is a message about spectral peaks. An example of this type of message is shown below. This is a message that could mean there is residual seasonality or calendar effects in the series, or that the original series itself is seasonal but isn't being adjusted. For more information on spectral diagnostics, see "Getting Started with X-12-ARIMA Diagnostics" (Hood and McDonald-Johnson, 2010).

Example—Screen Output for a series with no errors or warnings

X-12-ARIMA Seasonal Adjustment Program

Version Number 0.3 Build 129

Execution began Jan 23, 2004 15.19.39

Reading input spec file from civ.spc

Storing any program output into civ.out

Storing any program error messages into civ.err

WARNING: At least one visually significant seasonal peak has been found in the estimated spectrum of the regARIMA residuals.

Execution complete for civ.spc

To suppress warnings and notes and see only the error messages on the screen, you can run X-12-ARIMA in quiet mode. However, quiet mode isn't recommended for novice users.

4.2 The Output File

The main output file will have the extension `.out` and will be named for the spec files unless you specify an alternate output name when running X-12.

4.2.1 Important Output Tables

The output file easily can be 50-100 pages. To help you look for some of the most important tables, we've listed some below.

- The original series is in Table A1.
- The prior-adjusted series (if there are prior adjustments) is in Table B1. (If there are no prior adjustments, then Table B1 and Table A1 are identical.)
- The seasonally adjusted series is in Table D11.
- The trend-cycle is in Table D12.
- The combined (seasonal, trading day, and holiday) factors are in Table D16.
- The seasonal factors alone (no trading day or holiday) are in Table D10.
- The original series divided by the final seasonally adjusted series is in Table E16. This will match Table D16 for multiplicative adjustments. For additive adjustments with nonnegative values, Table E16 gives a set of seasonal factors that are centered on 1 and can be divided into the original series.

4.2.2 Controlling the Tables Sent to the Output File

Every spec (except the arima spec) contains a print argument to control the tables that are sent to the output file.

You can specify a printout level. **Print=none** corresponds to no tables printed for that particular spec. **Print=brief** corresponds to a reduced number of tables printed for that particular spec. **Print=default** corresponds to printing the default tables for the spec. **Print=alltables** corresponds to printing all the tables but no plots for the spec. **Print=all** corresponds to printing all tables and plots for the spec.

Also, an individual table can be added or removed from a print level. For example, in the x11 spec, to reduce the number of tables in the output, you can specify a brief printout. Along with the brief output, if you want to see the irregulars (Table D13) but don't want to see the calendar effects (Table D18), use the argument **print=(brief +irregular -calendar)** or **print=(brief +d13 -d18)**. If you only wanted to see the seasonally adjusted series in the output from the x11 spec, use the argument **print = (none +d11)**.

For a list of all the tables with their names and codes, please see the “X-12-ARIMA Quick Reference” (US Census Bureau, 2009).

4.2.3 Formatting for Pages and Tables

Pages have a one line header at the top with the title of the series, the page number, and the series name. The title and the name are set in the series spec of the X-12 input specification file. For quarterly data, each year is generally given on one line. For monthly data, the number of months per line depends on the size of the numbers in the table and could be six months or as few as two months across.

The example below shows the top of Table A1, the original series, for a civilian labor force series.

Example—Yearly output on two lines

X-12-ARIMA run for CIV

PAGE 2, SERIES civlf

A 1 Time series data (for the span analyzed)

From 1978.Jan to 2003.Apr

Observations 304

	Jan Jul	Feb Aug	Mar Sep	Apr Oct	May Nov	Jun Dec	TOTAL
1978	99664. 104512.	99640. 103946.	100166. 102748.	100610. 103474.	101092. 103586.	104010. 103565.	1227013.
1979	102802. 107096.	103185. 106489.	103606. 105510.	103198. 106084.	103476. 105871.	106210. 106040.	1259567.
1980	. . .						

The next example shows the top part of the original series for a U.S. import series which has much larger values. You can see the difference in the two formats.

Example—Yearly output on four lines

U.S. Imports of Rubber

PAGE 2, SERIES Imrubr

A 1 Time series data (for the span analyzed)

From 1989.Jan to 2002.Dec

Observations 168

	Jan Apr Jul Oct	Feb May Aug Nov	Mar Jun Sep Dec	TOTAL
1989	221193059.00 195587392.00 196973908.00 177539973.00	166563923.00 220191183.00 177601246.00 176125940.00	244108688.00 191808167.00 164176577.00 145689339.00	2277559395.00
1990	179856116.00 160422086.00 174866119.00 164978370.00	149132611.00 172766543.00 154469392.00 179405927.00	187536238.00 174700905.00 171658752.00 160290498.00	2030083557.00
1991	. . .			

Also, you can see in the examples above that the table from the civilian labor force series has no decimals printed and the table from the import series has two decimals printed (even though they are all zeros). The number of decimals printed is zero by default. The argument to have X-12 print decimal places is the decimal argument in the series spec, in this example **decimals=2**. Though perhaps not so useful in this example of the original series, we do see some decimal values in the seasonally adjusted series, as shown in the example below.

Example—Decimal output in the seasonally adjusted series

D 11 Final seasonally adjusted data

(also adjusted for trading day)

From 1989.Jan to 2002.Dec

Observations 168

	Jan	Feb	Mar	
	Apr	May	Jun	
	Jul	Aug	Sep	
	Oct	Nov	Dec	TOTAL
1989	215289892.87	183352538.60	219569381.20	
	203329832.48	207090900.02	187478779.86	
	189504534.28	177437470.21	175646755.86	
	175378603.49	175747715.48	166555633.65	2276382037.99
1990	172325709.19	163323818.54	165613473.61	
	163346587.75	162785100.03	173820430.27	
	164392309.68	159100753.51	188603234.99	
	160874429.30	178785110.06	178368198.08	2031339155.03
1991	. . .			

4.2.4 Additional Information Not Listed in Standard Format Tables

Some useful information is printed in the table headings. Below is a list of some of the additional information found in an X-12 output file.

- The seasonal filter used by X-12 to compute the final seasonal factors is listed in the header of Table D10 (the seasonal factors).
- The final Henderson filter is listed in the header of Table D12 (the trend-cycle).
- F-tests for the presence of stable and moving seasonality are in Table D 8A.
- The Monitoring and Quality (Ms and Q) diagnostics are in Table F3.
- Spectral graphs are in Tables that begin with a G.

For more details on the diagnostics, please see the paper “Getting Started with X 12 ARIMA Diagnostics” (Hood and McDonald-Johnson, 2010).

4.3 Save Files

You may want to save some of the tables in individual files. For example, particularly in production, you may want to save the seasonally adjusted series or the seasonal factors instead of reading them from the output file.

The save argument is available for all specs except the arima spec. The save argument's function is to cause X-12 to write the specified tables to individual files. Saved tables are stored in files in the same directory as the program output, with the same filename as the program output but with a different extension. The extension is a distinct extension of up to three characters, which also serves as the table abbreviation.

For a list of all the tables with their names and codes, please see the “X-12-ARIMA Quick Reference” (US Census Bureau, 2009).

The example below shows a sample spec file where we are saving the seasonally adjusted series (from Table D11) and the combined seasonal/trading day factors (Table D16).

Example—Saving important files

```
series{
    file = "test.dat"
    start = 1987.jan
}
x11{ save = (d11 d16) }
```

If you rename the output, the save files will also be renamed. For example, if you run the spec file test.spc, the output file will be in test.out, and the combined factors will be in test.d16. If you run the same spec file, but ask that the output be renamed to c:\x12test\test2, then the output will be in c:\x12test\test2.out and the combined factors will be saved to c:\x12test\test2.d16.

As mentioned in the first section, most files saved from X-12 have two columns. The columns are delimited by a tab character. Dates are in the format *yyyymm* (199706 for June 1997). The corresponding series values are given in scientific notation to 15 decimal places, regardless of the number of decimals printed in the output file. Every save file has a two line header.

4.4 The Log File

Log files are produced for every X-12 run. If requested, the log file contains a summary of some of the modeling and seasonal adjustment diagnostics. You control which diagnostics are saved to the log file with the **savelog** argument. For a list of all the diagnostics available to save to the log, please see the “X-12-ARIMA Quick Reference” (US Census Bureau, 2009).

The name of the log file has the same name as the output file but with a .log extension. For example, if you rename the output file, the log file will also be renamed.

Example—Our favorite savelog arguments

```
series{
    file="data1.dat"
    start=1981.1
    period=12
    title="Example of my favorite savelog arguments"
    savelog = peaks
}
transform{ function=auto savelog=atr }
regression{ aictest=(td easter) savelog=ats }
automdl{ savelog=amd }
outlier{ }
forecast{ maxlead=24 }
check{ print=all savelog=lbq }
x11{ savelog=(q2 q m1 m7 m8 m9 m10 m11 fd8) }
slidingspans{ savelog=pct }
history{ estimates=(sadj sadjchng) savelog=(asa ach) }
```

4.5 Summary File

Some of the information found in the output is also found in the summary file. The summary file has the extension `.udg`. The summary file is colon delimited so that you can read it easily into other programs, such as spreadsheet programs. Part of an example file is shown below.

Example—summary diagnostics file (.udg file)

```

date: Jan 23, 2004
time: 16.37.32
version: 0.3
build: 129
srstit: X-12-ARIMA run for CIV
srsnam: civlf
freq: 12
span: 1st month,1978 to 4th month,2003
transform: Log(y)
samode: multiplicative seasonal adjustment
siglim: 1.5 2.5
seasonalma: M.S.R.
trendma: default
automdl: (0 1 1) (0 1 1)
aictest.td: no
aictest.e: no
autoout: 0
sfmsr: 3x5

```

4.6 The Error File

The error file will have the extension `.err` and will be named for the spec files unless you specify an alternate output name. The messages that are sent to the screen are also in the error file. Please note that the error file will exist even if there are not errors or warnings. The example below shows the error file for a series without errors or warnings.

Example—Error file for a series without errors

```

Error messages generated from processing the X-12-ARIMA spec file
civ.spc:

```

5. Composite Spec

The main function of the composite spec is to generate indirect and direct adjustments of an aggregate series from a set of component series.

What is an indirect or direct adjustment? For example, the Census Bureau publishes Housing Starts information for four regions of the US (Northeast, Midwest, South and West) and the total for the US. We can either sum the four regional series first and then seasonally adjust at the US level (the direct adjustment), or we can adjust the four regional series first and then sum the four seasonally adjusted series to get an adjustment at the US level (the indirect adjustment).

RULE – The composite spec replaces the series spec and must come first in the spec file for the composite (or aggregate) series.

There are four steps when asking X-12 to calculate a composite seasonal adjustment.

- Step 1: Create spec files for component series
- Step 2: Create a spec file for composite series
- Step 3: Create a metafile that lists the component and composite series
- Step 4: Run X-12-ARIMA

Let's continue with the Housing Starts example. Single-Family Housing Starts for the Northeast, Midwest, South and West will be summed together to get the total for the US.

Step 1 – Create spec files for the component series

We create spec files called `ne1fhs.spec`, `mw1fhs.spec`, `so1fhs.spec`, and `we1fhs.spec`.

In the spec files for the individual regions, we need to tell X-12 how we want the series combined. In this case, we want to add the series, so we use the argument **comptype=add**. The `comptype` argument is the only change that we need to make from a usual spec file for the series.

Example—Spec file for Northeast (ne1fhs.spec)

```

series {
  title = "Northeast 1 Family HS"
  file = "ne1fhs.ori"
  name = "NE1HS"
  format = "2R"
  comptype = add
  savelog = peaks
}
transform{ function=log }
arima{ model=(0 1 1) (0 1 1) }
regression { aictest=td }
outlier{ }
forecast{ maxlead=24 }
check{ print=all savelog=lbq }
x11{ savelog=(q2 q m1 m7 m8 m9 m10 m11 fd8) }
slidingspans{ savelog=pct }
history{ estimates=(sadj sadjchng) savelog=(asa ach) }

```

Step 2 – Create a spec file for composite series

We will store the spec file for the total in `us1fhs.spc`

Example—Spec file `us1fhs.spc`

```

composite {
    title = "Total 1 Family HS"
}
transform{ function=log }
arima{ model=(0 1 1) (0 1 1)}
regression { aictest=td }
outlier{ }
forecast{ maxlead=24 }
check{ print=all savelog=lbq }
x11{ }
slidingspans{ savelog=pct }
history{ estimates=(sadj sadjchng) savelog=(asa ach) }

```

Note: For a composite (aggregate) series, the direct seasonal adjustment of the series is controlled by the `x11` spec. Modeling options given in this spec file are applied to the composite series only. Print, save, and savelog options for the indirect adjustment are controlled by the composite spec. Print, save, and savelog options for the direct adjustment are controlled by the `x11` spec.

Step 3 – Create a metafile for the component and composite series

We create the metafile `tot1f.mta` with the following five lines:

```

ne1fhs
mw1fhs
so1fhs
we1fhs
us1fhs

```

RULE – The spec file for the composite series is listed last in the metafile.

Step 4 – Run X-12-ARIMA

We run the metafile like any other metafile. X-12 stores the output for both the direct and indirect adjustments in `us1fhs.out`. Diagnostics for all the series are in the file `tot1f.log`.

8. Other X-12-ARIMA Specs

There are several other specs we haven't discussed yet. These specs are either not important for novice users or are not used in production at the Census Bureau.

estimate – Estimates model specified in regression and arima specs. This spec is not required. If you specify a regARIMA model, X-12 will estimate the model even without the estimate spec.

force – An optional spec that allows users to force yearly totals of the seasonally adjusted series to equal those of the original series for convenience.

identify – Produces ACF and PACF plots for all combinations for specified orders of differencing. This spec is useful for choosing appropriate orders of differencing and ARMA model orders if you have experience using ACF/PACF plots to select an ARIMA model.

metadata – Allows users to insert metadata into the diagnostic summary file.

pickmdl – The automatic model selection procedure from X-11-ARIMA (in Version 0.3, replaced with the automdl procedure)

x11regression – irregular component regression options, not to be used when using the regression spec.

There are many other options available for X-12-ARIMA. Details on all the options are given in the *X-12-ARIMA Reference Manual* (US Census Bureau, 2009).

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There is no warranty with regard to the information provided above, and we assume no responsibility for any damage resulting from any use of any methods, products, instructions, or ideas contained in this paper.

Appendix — Alternative Options for Some Common Situations

Options to Run X-12-ARIMA as if it were X-11

If you want to run X-12-ARIMA as if it were X-11 (no forecasting, no regARIMA models, and no outlier identification), you need only two specs: **series** and **x11**.

Example—A multiplicative "X-11 only" run for a monthly series

```
series{
  file="data1.dat"
  start=1981.1
  period=12
  title="Example"
}
x11{ }
```

Example—An additive run "X-11 only" for a monthly series

```
series{
  file="data1.dat"
  start=1981.1
  period=12
  title="Example"
}
x11{ mode = add }
```

If you want the program to choose the seasonal adjustment mode, include the **transform** spec:

Example—A monthly series in "automatic X-11 only" mode

```
series{
  file="data1.dat"
  start=1981.1
  period=12
  title="Example"
}
transform { function=auto }
x11 { }
```

Options to Run X-12-ARIMA for Forecasting Only

If you want to use the regARIMA modeling features of X-12-ARIMA, but don't need to seasonally adjust your series, then you need the following specs, **series**, **transform**, **automdl** (or **arima**), **regression**, **outlier**, and **forecast**. For diagnostics, you may also want the **check** spec.

In the example below, we've widened the prediction intervals of the forecasts from 95% (the default) to 90%. We've also saved the forecasts and the prediction intervals.

Example—A spec for forecasting, without seasonal adjustment

```

series{
  file="data1.dat"
  start=1981.1
  period=12
  title="Example"
  savelog = peaks
}
transform{ function=auto savelog=atr }
automdl { savelog = amd }
regression { aictest=(td Easter) savelog=ats }
outlier { }
forecast {
  maxlead = 24
  probability=0.90
  save = fct
}
identify { }
check { print=all savelog=lbq }

```

Options to Run X-12-ARIMA for Short Series

For short series, you may want to consider some alternative options. For example, it is difficult to get a good ARIMA model with less than 60 points, so for quarterly series of less than 15 years or monthly series of less than five years, you might want to specify an airline model instead of using the automatic modeling procedure. Also, you might not have enough data for the sliding spans and history procedures in X-12-ARIMA.

Below is a suggested spec file for running a short series.

Example—A spec file for a short series

```

series{
  file="short.dat"
  start=1981.1
  period = 12
  title="Example"
}
transform{ function=auto }
arima { model = (0 1 1)(0 1 1) }
outlier { }
forecast { maxlead = 24 maxback = 24 }
check { print=all }
x11 { }

```

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