

Getting Started with X-12-ARIMA (Version 0.3) Using the Command Prompt on Your PC

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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 and of writing a spec file. You will find more details in the *X-12-ARIMA Reference Manual* (US Census Bureau, 2009) and the "X-12-ARIMA Quick Reference" (US Census Bureau, 2009).

We realize that in the age of Microsoft Windows[®], running programs with the command prompt can sometimes be a difficult adjustment. Therefore, the Census Bureau does have a Windows interface to X-12. More information on that program is found in the paper "Getting Started with Win X-12, a Windows interface for X-12-ARIMA Version 0.3" (Hood, 2010) and "Win X-12: A Windows Interface for X-12-ARIMA" (Lytras, 2009b). However, we also understand that in some situations and in some operating systems, running from a command prompt is preferable to running through an interface.

The authors of this paper 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).

To download X-12-ARIMA for your PC, please see the US Census Bureau website at http://www.census.gov/srd/www/x12a/x12downv03_pc.html. At the web site, you will find program files for the latest PC version of X-12-ARIMA and the companion graphics package, X-12-Graph; files containing the *X-12-ARIMA Reference Manual*; and a link to the instructions for downloading the program.

This document is organized into the following topics:

1. X-12-ARIMA data formats
2. X-12-ARIMA input specification files
3. Running X-12-ARIMA at a command line
4. Command-line options in X-12-ARIMA
5. Output Overview
6. Options for production
7. Composite spec
8. 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.

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 '1R' file

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

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 | +0.494699000000000E+04 |
| 199602 | +0.500582000000000E+04 |
| 199603 | +0.526215000000000E+04 |
| 199604 | +0.540324000000000E+04 |
| 199605 | +0.575886000000000E+04 |
| 199606 | +0.534965000000000E+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 the spec files first.

The spec file is a text file used to specify program options. Because it's a text file, you will need to use a text editing program, like Notepad. When you save the file, make sure you use the extension .spc and not .txt.

RULE – The name of the spec file must end with a ".spc" file extension.

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.

2.1 General Syntax

You can enter input in either 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.

Dates are in the form *yyyy.period*. For monthly series, the period can be the first three letters of the English 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.

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, "}".

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.
```

2.2 Example "Initial" Input File

Below is an example of the basic spec produced by the interface. We will discuss all the individual specs listed in the example.

Example "Initial" X-12 Spec for a monthly series

```
series{
    title = 'Example 1'
    file = 'Example1.DAT'
    format = datevalue
    period=12
}
transform{function=auto}
regression{ aictest=(td Easter) }
automdl { }
outlier{ }
forecast{maxlead=24}
check{print=all}
x11{ }
slidingspans{ }
history{estimates=(sadj sadjchng)}
```

Example "Initial" X-12 Spec for a quarterly series

```
series{
    title = 'Example 2'
    file = 'Example2.DAT'
    format = datevalue
    period=4
}
transform{function=auto}
regression{ aictest=(td Easter) }
automdl { }
outlier{ }
forecast{maxlead=8}
check{print=all}
x11{ }
slidingspans{ }
history{estimates=(sadj sadjchng)}
```

The spec files given above are a good first step when running X-12 for your series. Next, we'll review all the specs we've used.

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 transformation for seasonal adjustment is the log transformation. If you know that your series needs a log transformation, you can specify **function=log**. In our example spec above, we've set **function=auto**. With **function=auto**, X-12 will do a likelihood comparison to decide whether or not to transform the data. With the automatic transformation test, X-12 also automatically sets the seasonal adjustment mode. If the log transformation is preferred, then X-12 will compute a multiplicative seasonal decomposition. If no transformation is preferred, then X-12 will compute an additive decomposition. If you specify a regARIMA model (with a regression spec, an automdl spec, and/or an arima spec – details to follow), leaving out the transform spec corresponds to no transformation, but then you must set **mode=add** in the x11 spec to tell X-12 you want an additive adjustment.

regression – Specifies the regression components of a regARIMA model: trading day effect, holiday effects, and outliers. With the argument **aictest=(td Easter)**, X-12 will do an AIC test to test for the presence of trading day and Easter effects. If you know you don't have Easter effects, you 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**. 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).

automdl – The automatic ARIMA model selection procedure. No arguments are required. If you leave out this spec, it could cause problems if you're trying to fit a regression model or search for outliers (unless you specify an ARIMA model explicitly with the arima spec – more about that later).

outlier – The 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, use **types=all**. Leaving out this spec means there will be no automatic outlier identification.

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 the automdl procedure couldn't find an acceptable model, then you won't get any forecasts.) In the example spec above, we've added the argument **maxlead=24** for the monthly series so the program will forecast two years ahead and **maxlead=8** for the quarterly series for two years of forecasts.

check – 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**. This spec is an optional diagnostic spec. 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 to add the argument **mode=add** for an additive decomposition. Without an x11 spec, you will not get a seasonally adjusted series.

slidingspans – Generates sliding spans analysis, a seasonal adjustment stability diagnostic. This spec is an optional diagnostic spec.

history – Generates "historical" analysis of seasonal adjustment estimates and/or regARIMA model forecast performance. With **estimates=(sadj sadjchng)**, we have asked for estimates of the seasonally adjusted series and the month-to-month (or quarter-to-quarter) percent changes of the seasonally adjusted series. (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. This spec is an optional diagnostic spec.

2.3 Details for the Series Spec

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.

2.3.1 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.

2.3.2 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.

2.3.2.1 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' }
```

2.3.2.2 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 }
```

2.3.2.3 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'
}
```

2.3.2.4 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.

3. Running X-12-ARIMA at a command line

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

To run X-12 at the command-line level, you first need to open a command prompt window on your PC. There are several ways to do this. In some versions of Windows, you can simply type “cmd” at the Run/Search line of the Start menu. You can also find the command line if you look for the program “Command Prompt” under “Accessories” in the programs list.

Hint: At the DOS prompt, you can enter the command

```
> doskey
```

This command lets you use the arrow keys to move through previous commands. If you enter this first, you can recall past calls to X-12, and it is easier to make multiple calls and to fix typing errors.

The first step is to change to the directory where you've installed X-12. At the command prompt, enter

```
> cd dirname
```

where *dirname* is the name of the directory where X-12 is installed. For example, if the file **x12a.exe** and the spec file is in the directory *c:\x12a*, then the command would be

```
> cd c:\x12a
```

Next, at the command prompt, enter

```
> x12a filename
```

where *filename.spc* is an input file like the one shown in Section 2 above.

RULE – Enter the filename without the .spc extension.

For example, to run a spec file named *mwtot.spc*, at the command prompt, enter

```
> x12a mwtot
```

The output files will be **mwtot.out** (main output) and **mwtot.err** (error output). We will look more closely at the output files later in this paper.

If you want to run X-12 and not overwrite previous output, you can direct the output to another file by entering two filenames on the DOS command line. For example, for the *mwtot.spc* input file, enter

```
> x12a mwtot mwtot2
```

Now the output files are **mwtot2.out** (main output) and **mwtot2.err** (error output).

Hint: To help manage the input files, it can be useful to store spec files in a folder (subdirectory) inside the c:\x12a folder/directory. For example, say you've stored the mwtot.spc in the folder c:\x12a\starts. To run X-12, go to the c:\x12a\starts directory and enter

```
> ..\x12a mwtot
```

Output files will be in the directory c:\x12a\starts.

4. Command-Line Options for X-12-ARIMA

Input Flags are input options that are specified on the command line. Some of the input flags require arguments immediately following the flag. For example,

```
> x12a -m usmeta -w
```

We will review some of the most often used input flags.

4.1 X-12-ARIMA Metafiles

Besides running the series one at a time, you can also run X-12-ARIMA in "multi-series" 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.

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. You can list up to 500 input files. We run an X-12 metafile with the `-m` input flag.

The command for running an X-12 metafile is

```
> x12a -m metafile
```

where *metafile.mta* is the name of the metafile.

RULE – Enter the metafile name without the .mta extension.

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.

If you want to specify an alternate name for the output files, you can have two filenames listed on each line. This is not required. If you have two filenames, the first filename is used for the name of the input specification file, and the second is used to form the name of the output files. If a second filename isn't specified, then the output filename is taken from the name of the input specification file.

4.2 X-12-ARIMA Data Metafiles

Another way to run multiple series is to run one spec file for multiple data files. While this is maybe not quite so useful for production, it can be very useful in some cases, perhaps when running the series with

an "initial" spec file. To run X-12 in "data metafile mode," you need to create a list of the data files for the series you want to run. This list is called a *data metafile*. The data metafile is a text file with the extension .dta. You can list up to 500 data files. We run an X-12 data metafile with the `-d` input flag.

The command for running an X-12 data metafile is

```
> x12a filename -d datameta
```

where *filename.spc* is the name of the input specification file and *datameta.dta* is the name of the metafile.

RULE – Enter the filename without the .spc extension and the data metafile name without the .dta extension.

If your data files have extensions, you will need to include their extensions in the list in the data metafile.

Let's say that the contents of *starts.dta* is

```
nehs.dat
mwhs.dat
sohs.dat
wehs.dat
```

One possible spec file for these series would be the example "initial" spec file shown in Section 2 with some modifications, as shown below.

Example—"Initial" Spec file to use with a Data Metafile

```
series{
    title="Example for Data Metafiles"
    format=datevalue
    period=12
}
transform{function=auto}
regression{ aictest=(td Easter) }
automdl { }
outlier{ }
forecast{maxlead=24}
check{print=all}
x11{ }
slidingspans{ }
history{estimates=(sadj sadjchng) }
```

Note that we don't need a file or data statement because the name of the file will be provided by the data metafile.

If our spec file is called *initstar.spc*, we would run X-12-ARIMA with the command

```
> x12a initstar -d starts
```

to run the input file *initstar.spc* for the data files *nehs.dat*, *mwhs.dat*, *sohs.dat*, and *wehs.dat* listed in the data metafile *starts.dta*. The resulting output files would be named *nehs.out*, *mwhs.out*, *sohs.out*, and *wehs.out*. The log file would be named *initstar.log*.

If you want to specify an alternate name for the output files, you can have two names listed on each line. This is not required. If you have two names, the first name must be the name of the data file with any extension on the file. The second name, without an extension, is used to form the name of the output files.

If a second filename isn't specified, then the output filename is taken from the name of the data files without the extension.

4.3 Graphics Mode

Another input flag, `-g`, calls the graphics export option. The `-g` flag precedes the directory name where X-12 will output the files that can be used by external graphics routines. (For more information on time series diagnostics graphs, see Hood and McDonald-Johnson (2010), Lytras (2009a), and Findley and Hood (2000).)

For example, to run `mwtot.spc` in graphics mode and save the graphics files to the directory `c:\x12a\graphics`, enter the command

```
> x12a mwtot -g c:\x12a\graphics
```

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.

The graphics files generated include

- the graphics metafile (extension `.gmt`) which contains the series codes and filenames for all files generated by X-12-ARIMA in the graphics directory,
- the diagnostic summary file (extension `.udg`) which contains information about the series and the modeling and seasonal adjustment options used, and
- the series to be graphed.

The specific series that are included depend on the options specified in the input specification file.

4.4 Other Run-time Flags

Some other useful Input Flags:

- `-n` : Only tables specified by the user are printed in the main output
- `-w` : Wide printout format (132 characters)
- `-p` : No pagination in main output
- `-q` : Suppress warning messages that are usually written to the screen
- `-s` : Additional diagnostic file is created (with the extension `.udg`)
- `-v` : Only check spec files for errors, no further processing
- `-c` : Sum components of a composite adjustment, but only model and adjust the total (see Section 7 for discussion of composite adjustments)

Input flags can be entered in any order after the spec filename and any alternate output filename. They can be entered in upper or lower case.

5. Output Overview

5.1 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, mwl1fam.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 mwl1fam.spc
 Storing any program output into mwl1fam.out
 Storing any program error messages into mwl1fam.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 mwl1fam.spc

Check error file mwl1fam.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.

5.2 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.

5.2.1 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.

5.2.2 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).

5.2.3 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 civl f

A 1 Time series data (for the span analyzed)
  From 1978.Jan to 2003.Apr
  Observations          304
-----
          Jan      Feb      Mar      Apr      May      Jun
          Jul      Aug      Sep      Oct      Nov      Dec      TOTAL
-----
1978      99664.    99640.    100166.    100610.    101092.    104010.
          104512.    103946.    102748.    103474.    103586.    103565.          1227013.

1979      102802.    103185.    103606.    103198.    103476.    106210.
          107096.    106489.    105510.    106084.    105871.    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 | Feb | Mar | |
|------|--------------|--------------|--------------|---------------|
| | Apr | May | Jun | |
| | Jul | Aug | Sep | |
| | Oct | Nov | Dec | TOTAL |
| 1989 | 221193059.00 | 166563923.00 | 244108688.00 | |
| | 195587392.00 | 220191183.00 | 191808167.00 | |
| | 196973908.00 | 177601246.00 | 164176577.00 | |
| | 177539973.00 | 176125940.00 | 145689339.00 | 2277559395.00 |
| 1990 | 179856116.00 | 149132611.00 | 187536238.00 | |
| | 160422086.00 | 172766543.00 | 174700905.00 | |
| | 174866119.00 | 154469392.00 | 171658752.00 | |
| | 164978370.00 | 179405927.00 | 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 | . . . | | | |

5.2.4 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).

5.3 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.

5.4 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 7"
  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) }

```

5.5 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

```

5.6 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:

6. Options to Change the "Initial" Options to "Production" Options

Once you've run X-12 initially, you might want to change some of the automatic procedures so that the arguments are fixed to a certain value. **Note:** The reason to do this is to keep the program from changing the decision later and introducing possible sources of instability as you run X-12 in following months.

transform – If the automatic transformation procedures selects a log transformation, then you can change **transform{function=auto}** to **transform(function=log)**. If the automatic transformation procedures selects no transformation, then you can delete the transform spec or change **transform{function=auto}** to **transform(function=none)**. In the case of no transformation, you also need to add **mode=add** to the x11 spec to tell X-12 you want an additive adjustment. Again, with the automatic transformation test, X-12 automatically sets the x11 mode to additive when no transformation is selected.

regression – If the test for TD or Easter accepts these variables in the model, and if any outliers are found, you can specify these variables directly in the regression spec with the variables argument. For example, a series with a trading day effect, an eight-day Easter effect, one point outlier (or AO, additive outlier) at January 1990 and one level shift at July 1992 could have a regression spec similar to the following: **regression{variables=(td Easter[8] ao1990.1 LS1992.jul) }**

We also now use a spec not shown in the "initial" spec files above.

arima – Specifies the ARIMA part of a regARIMA model. The results from the automatic modeling procedure can be entered into X-12 with the **arima** spec. For example, if the automatic modeling procedure select the model (0 1 1)(0 1 1), then you can specify this with the command **arima{model=(0 1 1) (0 1 1) }**.

Please see Section 8 for a list of other specs not mentioned elsewhere in this paper.

7. 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.spec

Example—Spec file us1fhs.spec

```

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/88 (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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Disclaimer

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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