Getting Started with X-12-ARIMA Input Files on Your PC, Windows

Catherine C. Hood and Roxanne M. Feldpausch, U.S. Census Bureau
Last update: February 18, 2004

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, 2003) and the X-12-ARIMA Quick Reference (US Census Bureau, 2003).

We assume that the reader has already installed the Windows Interface to X-12-ARIMA. It is available at the Census FTP site for Windows XP at http://www.census.gov/ts/TSMS/WIX12/winx12xp.zip and for Windows NT/2000/98 at http://www.census.gov/ts/TSMS/WIX12/winx12.zip. Download and installation instructions are available on the site and documentation in HTML is included in the zip files.

We 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
    1.1   Datevalue Format
    1.2   Free Format
    1.3   X-11 Formats
    1.4   X12save Format
2.   X-12-ARIMA Specification Files
    2.1.   General Syntax
    2.2.   Example "Initial" Input File
    2.3.   Details for the Series Spec
3.   Running X-12-ARIMA in Windows
    3.1.   Single Spec Mode
    3.2.   Batch Mode
    3.3   Options When Running in Windows
4.   Output Overview
5.   X-12 Options for "Production"
6.   Composite Spec
7.   Other X-12-ARIMA Specs

1.   X-12-ARIMA Data Formats

The first step in running X-12-ARIMA is to get your time series data in a form that can be read by X-12. X-12 can't read files 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. There is a program called X-12-Data that will help you export from Excel spreadsheets. Please see Appendix B for more information on X-12-Data.

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 2.4.

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.

The end of a Sample '1L' file:

```
NE1FAM92    961    864   1071   1123   1059   1140   1076   1055   1068   1139   1049   1074
NE1FAM93    922    873   1126   1074   1094   1252   1165   1171   1097   1208   1118   1134
NE1FAM94   1078    985   1259   1290   1419   1363   1397   1466   1243   1336   1417   1416
NE1FAM95   1304   1196   1374   1435   1491   1505   1538   1554   1290   1500   1462   1419
NE1FAM96   1423   1358   1526   1755   1803   1761   1811   1716   1567   1772   1652   1701
NE1FAM97   1620   1496   1842   1918   1993   1903   1999   1915   1868   2069   1747   1907
NE1FAM98   1660   1736   2150   2157   2125   2199   2146   2096   2079   2152   2056   2104
NE1FAM99   1918   2006   2317   2458   2499   2360   2227   2289   2176   2358
```

Piece of a Sample '2L' Data File with the end of one series and the beginning of another series:

```
MWTOT  96       494699       500582       526215       540324       575886       534965
                516057       565268       577409       621912       565056       496747
MWTOT  97       558286       566271       609662       630206       636660       601691
                573106       612178       668663       704814       646872       587746
MWTOT  98       593201       628169       709245       688366       681078       664887
                536477       603478       642580       660612       622998       562297
MWTOT  99       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.

The end of a Sample '1R' file:

```
 961    864   1071   1123   1059   1140   1076   1055   1068   1139   1049   107492NE1FAM
 922    873   1126   1074   1094   1252   1165   1171   1097   1208   1118   113493NE1FAM
1078    985   1259   1290   1419   1363   1397   1466   1243   1336   1417   141694NE1FAM
1304   1196   1374   1435   1491   1505   1538   1554   1290   1500   1462   141995NE1FAM
1423   1358   1526   1755   1803   1761   1811   1716   1567   1772   1652   170196NE1FAM
1620   1496   1842   1918   1993   1903   1999   1915   1868   2069   1747   190797NE1FAM
1660   1736   2150   2157   2125   2199   2146   2096   2079   2152   2056   210498NE1FAM
1918   2006   2317   2458   2499   2360   2227   2289   2176   2358               99NE1FAM
```

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 an input specification file, or spec file. 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 be eight characters or less and 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 15 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 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" X-12 Spec

Example 1 – For a monthly series:

```
series{
  file="data1.dat"
  start=1981.1
  period=12
  title="Example 1"
}
transform{ function=auto }
regression{ aictest=(td easter) }
automdl{ }
outlier{ }
forecast{ maxlead=24 }
check{ print=all }
x11{ }
slidingspans{ }
history{estimates=(sadj sadjchng)}
```

Example 2 – For a quarterly series:

```
series{
  file="data2.dat"
  start=1981.1
  period=4
  title="Example 2"
}
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 discuss all the specs listed above.

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, we've set **function=auto**. With **function=auto**, X-12 will do an 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 by the program, then X-12 will compute a multiplicative seasonal decomposition. If no transformation is preferred by the program, then X-12 will compute an additive decomposition. If you leave out the transform spec and specify a regARIMA model (with a regression spec, an automdl spec, and/or an arima spec – details to follow), it corresponds to no transformation and you must set **mode=add** in the x11 spec.

regression – Specifies the regression components of a regARIMA model. 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 – Automatic ARIMA model selection procedure. No arguments are required. Leaving out this spec 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 (details on arima to follow in Section ___).

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, 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 "initial" spec above, we've added the argument **maxlead=24** so the program will forecast two years ahead for the monthly series or **maxlead=8** for the quarterly series.

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. No arguments are required. 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 revisions 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

Again,

> **RULE** – If you have a series spec in your spec file, it must be the first spec listed.

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.

2.3.1   Data Argument

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

Example 3
```
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 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
199607    +0.516057000000000E+04
199608    +0.565268000000000E+04
```

Example 4
```
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. With free format, you are not allowed to have a format statement.

Example 5
```
series{ file='example5.dat'
  start = 1982.jan }
```


2.3.2.3   X-11 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 6
```
series{
    file = 'test2L.dat'    format = '2L'
    name = 'MWTOT'
    title = 'Midwest Total Housing Starts'
}
```

2.3.3. 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 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 in Windows

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

X-12-ARIMA is a DOS program. To run X-12 in Windows, you will need the X-12 Runner program. You may need to check the initial settings for the program. You may also want to use some of the options when running X-12. Please see the documentation on the X-12 Runner (Feldpausch, 2003).

Open the X-12 Runner program. Use the box on the left to change to the directory where you've saved your spec file.

3.1 Single Spec Mode

To run your 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 file will be listed in the box on the right. The 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 files to open them in the editor.

To edit the spec file, select your spec file and click on the Edit button.

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

3.2 Batch Mode

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.

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. Up to 500 input files can be listed.

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

To run in batch mode, simply double click the metafile. X-12-ARIMA will run all the spec files listed inside the metafile.

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 and save files, you can have two filenames listed on each line of the metafile. 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 and save files. If a second filename isn't specified, then the output filenames are taken from the names of the input specification files.

There is no way to rename the log file from a metafile except to save the metafile to a new name before you run the metafile.

4.   Output Overview

4.1   Controlling Printing 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, 2003).

4.2   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, 2003).

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 7 shows a spec file with some of our favorite savelog arguments.

Example 7 – For a monthly series:
```
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) }
```

4.3   Saving 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, 2003).

Example 8 shows a sample spec file named test.spc where we are saving the seasonal factors.

Example 8 – test.spc
```
series{
     file = "test.dat"
     start = 1987.jan
}
x11{ save =  seasonal }
```

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 seasonal factors will be in test.d10. 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\tes2.out and the seasonal factors will be saved to c:\x12test\test2.d10.

Most save files 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 decimals places. Every save file has a two line header.

Example of the top of a Save File:

```
Date       MWTOT.d10
------     ----------------------
198201     +0.952159433845930E+00
198202     +0.905457980509606E+00
198203     +0.904145921415339E+00
198204     +0.908306333090025E+00
198205     +0.992194160349269E+00
198206     +0.102848507677265E+01
198207     +0.106552609238023E+01
.
.
.
```

5.   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. The changes won't change you're seasonally adjusted series.

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 one below.

```
regression{variables=(td Easter[8] ao1990.1 LS1992.jul) }
```

And a new 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 Appendix A for the options to run X-12 for some other situations, for example, to run X-12 as if it were X-11.

6.   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 go back to our 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.spc, mw1fhs.spc, so1fhs.spc, and we1fhs.spc.

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 10 – Spec file for Northeast (ne1fhs.spc)

```
series {
  title = "Northeast 1 Family HS"
  file = "ne1hs.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 11 – 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.

7.   Other X-12-ARIMA Specs

There are several other specs we haven't discussed yet. These spec are not used in production at the Census Bureau.

estimate – Estimate model specified in regression and arima specs

identify – produces ACF and PACF plots for all combinations for specified orders of differencing (useful for choosing appropriate orders of differencing and ARMA model orders)

x11regression – irregular component regression options

There are many other options available for X-12-ARIMA. Details on all the options are given in the *X-12-ARIMA Reference Manual*.

Appendix A — 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.1 – a multiplicative "X-11 only" run for a monthly series
```
series{
  file="data1.dat"
  start=1981.1
  period=12
  title="Example"
}
x11{ }
```

Example A.2 – 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.3 – 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 **identify** and **check** specs.

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.4
```
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.5
```
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 { }
```

Appendix B — Other Useful Utilities When Running X-12-ARIMA

X-12-Data converts time series data stored in Excel spreadsheets into a format that can be read by X-12-ARIMA. It can also convert X-12 input and output files to Excel. It is available to download at http://www.census.gov/ts/TSMS/X12Data/x12data.zip. Documentation for the program in HTML format is available in the zip file.

X-12-Write is a SAS program that will write X-12-ARIMA input files for you. The features are similar to some of the features found in the Windows interface to X-12. The program will write metafiles and spec files using regARIMA models chosen either by X-12 or by TRAMO. The program also lets you edit spec files in batch. A self-extracting zip file is available to download at http://www.census.gov/ts/TSMS/X12Write/x12write.exe. Documentation is included in the zip file.

References

Box, G.E.P., G.M. Jenkins, and G. Riensel (1994). *Time Series Analysis: Forecasting and Control, 3rd Edition.* Prentice-Hall: New York, NY.

Brockwell, P.J. and R.A. Davis (2002), *Introduction to Time Series and Forecasting, 2nd Edition.* Springer-Verlag: New York, NY.

Feldpausch, R.M. (2003), "X-12 Runner: A Windows Program to Run X-12-ARIMA, Users' Guide, Version 1.0," Washington, DC: U.S. Census Bureau, U.S. Department of Commerce.

Feldpausch, R.M. (2003), "X-12-Data: An Excel® Macro for X-12-ARIMA Data Files, Users' Guide, Version 1.0," Washington, DC: U.S. Census Bureau, U.S. Department of Commerce.

Findley, D.F. and C.C. Hood (2000), "X-12-ARIMA and Its Application to Some Italian Indicator Series," *Seasonal Adjustment Procedures – Experiences and Perspectives*, Istituto Nazionale di Statistica, Rome, 231-251.

Findley, D.F., B.C. Monsell, W.R. Bell, M.C. Otto and B.-C. Chen (1998), "New Capabilities and Methods of the X-12-ARIMA Seasonal Adjustment Program" (with discussion), *Journal of Business and Economic Statistics*, 16: 127-176.

Hood, C.C. (2000), "SAS Programs to Get the Most from X-12-ARIMA's Modeling and Seasonal Adjustment Diagnostics," *Proceedings of the Twenty-Fifth Annual SAS® Users Group International Conference*, SAS Institute Inc, Cary NC, 1388-1393.

Hood, C.C. (2001), "X-12-Graph: A SAS/GRAPH® Program for X-12-ARIMA Output, User's Guide for the X-12-Graph Interactive for PC/Windows, Version 1.2," Washington, DC: U.S. Census Bureau, U.S. Department of Commerce.

Ladiray, D. and B. Quenneville (2001). *Seasonal Adjustment with the X-11 Method.* Springer-Verlag: New York, NY.

Makridakis, S.G., S.C. Wheelwright, and R.J. Hyndman (1998). *Forecasting: Methods and Applications, 3rd edition*. John Riley & Sons, Inc.: New York, NY.

McDonald-Johnson, K.M. (2003), "X-12-Rvw: The Review Sheet Program, Users' Guide to the Interactive SAS/AF® Version," Washington, DC: U.S. Census Bureau, U.S. Department of Commerce.

U.S. Census Bureau (2003), *X-12-ARIMA Reference Manual, Final Version 0.2*, Washington, DC: U.S. Census Bureau, U.S. Department of Commerce. The self-extracting zip file: http://www.census.gov/ts/x12a/final/pc/omegapdf.exe

U.S. Census Bureau (2003), *X-12-ARIMA Quick Reference for DOS, Final Version 0.2*, Washington, DC: U.S. Census Bureau, U.S. Department of Commerce. http://www.census.gov/ts/TSMS/SADoc/qrefdos.pdf